COORDINATED INTER-ORGANIZATIONAL DECISION-MAKING

DEALING WITH PROJECT COMPLEXITY IN THE DUTCH RAILWAY CONTEXT

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“Education is the most powerful weapon which you can use to change the world.”

- Nelson Mandela
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Summary (English)

The fundamental systems and services that contribute to the economic prosperity and social well-being of a nation, such as public transportation, are highly important for society. According to the European Commission, public transportation in particular, such as the railway system, must become safer, more reliable, and increasingly connected in order to meet the expected increase in demand over the coming years while also dealing with the capacity boundaries of the system. This requires the railway system operators to upgrade their processes, systems and technology, while managing any risks.

In order to reach the aforementioned railway system performance goals of safety, reliability, and interconnectedness, the separate system entities need to be smoothly integrated in increasingly complex projects. One of the complexities of system integration is that it often requires many different stakeholders working together. Decisions have to be made jointly by the diverse system stakeholders in a generally complex inter-organizational and socio-technical context. As such, coordinating inter-organizational projects for effective decision-making is crucial. Concerning this, Williams (2005), in his seminal work on project complexities, revealed that project management needs to take on a wider perspective than the overarching one-size-fits-all, positivistic, and reductionist view it has relied on since the 1960s. This perspective draws particular attention to ensuring that the complexities experienced when tackling system integration challenges are addressed in a more inclusive manner.

This dissertation investigates practical considerations and the complexities experienced in inter-organizational projects in the Dutch railway system. Taking the aforementioned wider perspective on project management revealed that the complexities of railway system projects are diverse in nature. In addition, there is currently a predominant focus on planning & control-based management when coordinating projects. As such, the focus seems to be on a one-size-fits-all approach to coordinating different types of complexity. Finally, project managers are often unaware of how to address context-dependent decision-making complexities with fitting strategies.

For these reasons, this research project investigates “how inter-organizational project coordination can be improved in order to support decision-making concerning system integration challenges across the entire project lifecycle.” To research this, the dissertation is divided into two research themes. The first research theme establishes a thorough understanding of the complex problem context of inter-organizational projects which address system integration challenges. The second research theme aims to improve inter-organizational project coordination in order to achieve more effective decision-making. In order to thoroughly address these two topics, a total of five sub-research questions have been formulated, which are addressed in individual chapters, using methodologies such as ‘Context, Intervention, Mechanism, Outcome logic’ for increased understanding, and ‘design science research’ to develop solutions.
The first research theme is explored by investigating coordination mechanisms from a process perspective, using two cases as well as exploring the coordination fit between the employed coordination mechanisms and the complexities experienced in four additional cases. This revealed that when relational coordination is used at the start of inter-organizational projects, agreement on decision-making seemed to be reached more smoothly.

The second research theme is explored by developing two design artifacts for inter-organizational project coordination, and implementing and testing these in railway system cases. The first design artifact has been applied in the context of decision-making in inter-organizational railway projects in order to deal with the different stakeholder perspectives when making decisions in a system context. The second design artifact has been employed in a more general context, namely: addressing the complexities experienced from a macro perspective. The second artifact can aid in creating more awareness of different coordination mechanisms and encourages a shift away from one-size-fits-all coordination approaches.

Based on the implemented design artifacts, several lessons have been learned, which were summarized into six generalizable design propositions (GDPs) which can be used in other complex system contexts.

Design propositions GDP1-GDP3 focus on the context of decision problems in inter-organizational projects specifically, and show that a stronger focus on and more effort toward creating a mutual understanding of the problem before engaging extensively in solution development is prudent. An incomplete understanding of the various stakeholder needs can easily result in sub-optimal solutions. The research results indicate that understanding can be improved through, for example, intervision exercises among the project team, especially when done using a jointly developed process which creates more ownership of decisions. These principles appear to be particularly important in inter-organizational contexts where the various individuals representing the stakeholders have limited understanding of other parts of the system, have technical backgrounds, and/or are not familiar with each other.

Design propositions GDP4-GDP6 appear to be more generally applicable to project coordination in systems integration challenges, and indicate that more awareness of both coordination effectiveness and different coordination options is needed. Identifying individual coordination preferences and comparing and discussing team preferences are two principles that aid increasing coordination awareness. The complexity-response framework aids in matching the experienced complexity with strategies for navigating that complexity. This is especially important in the Dutch railway context, where the awareness of the potential of using coordination mechanisms other than planning & control is generally low.

As such, by improving our understanding of the problem context of inter-organizational railway projects and designing, implementing and testing tools aimed at improving project coordination, this dissertation provides professionals and
empirical researchers with the means to address the project complexities of system integration challenges in a more fitting manner.

The dissertation concludes by presenting the theoretical and managerial implications discovered, for example that the developed artefacts should be considered a toolkit for professionals to assist them in choosing more appropriate responses to complexity they experience. As the social element is becoming increasingly important, the first three design propositions GDP1-GDP3 focus on situations where there is an identified need to build relationships among project participants. This contributes to a better understanding of what happens in inter-organizational projects when managing complexity. The second three design propositions GDP4-GDP6 reveal that effective coordination can be achieved by a better fit at the individual and inter-organizational team level. This will help managers in the railway or similar contexts to increase their effectiveness in coordinating their decision-making activities in increasingly interconnected (project) contexts. Finally, future research opportunities into more effective coordination in inter-organizational railway projects are highlighted, including the suggestion to focus on promoting flexibility and the recommendation to test tools in the pre-project phase within the railway context.
Samenvatting (Nederlands)

De fundamentele systemen en diensten die bijdragen aan de economische welvaart en het sociale welzijn van een land, zoals het openbaar vervoer, zijn van groot belang voor de samenleving. Volgens de Europese Commissie moet met name het openbaar vervoer, zoals het spoorwegsysteem, continue veiliger en betrouwbaarder worden, en steeds beter op elkaar aangesloten zijn om de komende jaren aan de verwachte toenemende vraag te voldoen, terwijl tegelijkertijd rekening gehouden moet worden met de capaciteitsgrenzen van het systeem. Hiervoor moeten de exploitanten van het spoorwegsysteem hun processen, systemen en technologie verbeteren, en tegelijkertijd ook eventuele risico’s beheersen.

Om de bovengenoemde doelstellingen van het spoorwegsysteem - veiligheid, betrouwbaarheid en interconnectiviteit - te bereiken, moeten de afzonderlijke systeementiteiten soepel worden geïntegreerd in steeds complexere projecten. Een van de complexiteiten van systeemintegratie is dat vaak veel verschillende belanghebbenden moeten samenwerken. Beslissingen moeten gezamenlijk worden genomen door de verschillende systeembetrokkenen, in een doorgaans complexe inter-organisatorische en socio-technische context. Om deze reden is het coördineren van inter-organisatorische projecten van cruciaal belang voor een doeltreffende besluitvorming. In dit verband heeft Williams (2005) in zijn baanbrekend werk over projectcomplexiteit aangetoond dat projectbeheer een breder perspectief moet innemen dan de overkoepelende, positivistische en reductionistische visie, waarop projectcoördinatie sinds de jaren zestig is gebaseerd. Dit breedere perspectief vraagt aandacht voor de complexiteiten die worden ervaren bij het aanpakken van systeemintegratie-uitdagingen en hoe deze op inclusieve manier kunnen worden benaderd.

Dit proefschrift onderzoekt de praktische overwegingen en complexiteiten die worden ervaren bij inter-organisatorische projecten in het Nederlandse spoorwegsysteem. Uit het eerder genoemde breedere perspectief op projectmanagement, blijkt dat de complexiteiten van projecten in het spoorwegsysteem divers van aard zijn. Bovendien is er een overheersende focus op ‘planning & control’ gebaseerd management bij het coördineren van hedendaagse projecten. De nadruk lijkt dus te liggen op een one-size-fits-all benadering voor de coördinatie van verschillende soorten complexiteiten. Ten slotte weten projectmanagers vaak niet hoe zij contextafhankelijke besluitvormingsproblematiek met passende strategieën kunnen aanpakken. Om deze redenen onderzoekt dit onderzoeksproject “Hoe kan de inter-organisationale projectcoördinatie verbeterd worden om de besluitvorming bij systeemintegratie-uitdagingen gedurende de gehele projectlevenscyclus te ondersteunen?” Om dit te onderzoeken is het proefschrift verdeeld in twee onderzoeksthema’s. Het eerste onderzoeksthema richt zich op het grondig begrijpen van de complexe probleemcontext van inter-organisatorische projecten die systeemintegratie-uitdagingen aanpakken. Het tweede onderzoeksthema is gericht op het verbeteren van inter-organisatorische projectcoördinatie om tot effectievere
besluitvorming te komen. Om deze twee onderwerpen grondig aan te pakken, zijn in totaal vijf deelonderzoeksvragen geformuleerd, die in afzonderlijke hoofdstukken worden behandeld, waarbij methodologieën als ‘Context, Intervention, Mechanism, Outcome logic’ worden gebruikt voor een beter begrip, en ‘design science research’ voor het ontwikkelen van oplossingen.

Het eerste onderzoeksthema wordt verkend door coördinatiemechanismen te onderzoeken vanuit een procesperspectief, aan de hand van twee casussen. Hiernaast wordt nagegaan in hoeverre de toegepaste coördinatiemechanismen aansluiten bij de ervaren complexiteiten in vier andere casussen. Hieruit bleek, dat wanneer relationele coördinatie wordt gebruikt aan de start van inter-organisatorische projecten, overeenstemming over besluitvorming soepeler lijkt te worden bereikt.

Het tweede onderzoeksthema is onderzocht door twee ontwerppartefacten voor inter-organisatorische projectcoördinatie te ontwikkelen en deze te implementeren en te testen in casussen binnen het spoorwegsysteem. Het eerste ontwerppartefact is toegepast in de context van besluitvorming in inter-organisatorische spoorwegprojecten, helpt om te gaan met de verschillende perspectieven die belanghebbenden kunnen hebben bij besluitvorming in een systeemcontext. Het tweede ontwerppartefact is toegepast in een meer algemene context, namelijk: het aanpakken van de complexiteit die wordt ervaren vanuit een macroperspectief. Het tweede artefact kan helpen bij het creëren van het bewustzijn over het bestaan van andere coördinatiemechanismen, en helpt daarmee een eendimensionale ‘one-size-fits-all’ benadering voor projectcoördinatie te voorkomen.

Op basis van de geïmplementeerde design artefacten zijn verschillende lessen geleerd, die zijn samengevat in zes gegeneraliseerde design proposities (GDPs) die in andere complexe systeemcontexten kunnen worden toegepast.

Design proposities GDP1-GDP3 richten zich specifiek op de context van besluitvormingsproblemen in inter-organisatorische projecten, en laten zien dat het verstandig is om de aandacht te besteden aan, en meer inspanningen te leveren voor, het creëren van een wederzijds probleembegrip voordat het merendeel van deze aandacht en inspanningen opgaan aan de ontwikkeling van oplossingen. Een onvolledig begrip van de behoeften van de verschillende belanghebbenden kan namelijk gemakkelijk leiden tot suboptimale oplossingen. De onderzoeksresultaten wijzen erop dat dit begrip kan worden verbeterd door bijvoorbeeld intervisieoefeningen in het projectteam, vooral wanneer daarbij gebruik wordt gemaakt van een gezamenlijk ontwikkeld proces, dat meer eigen verantwoordelijkheid voor beslissingen creëert. Deze principes blijken bijzonder belangrijk te zijn in de inter-organisatorische contexten waarin de verschillende personen die de belanghebbenden vertegenwoordigen, een beperkt begrip hebben van andere delen van het systeem, een uiteenlopende technische achtergrond hebben, en/of elkaar niet kennen.

De ontwerpverklaringen GDP4-GDP6 lijken meer algemeen van toepassing te zijn op projectcoördinatie bij systeemintegratie-uitdagingen, en geven aan dat
er meer bewustzijn nodig is van zowel de doeltreffendheid van de coördinatie, als voor de verschillende coördinatie opties. Het identificeren van individuele coördinatievoorkeuren en het vergelijken en bespreken van teamvoorkeuren, zijn twee principes die helpen bij het vergroten van het coördinatiebewustzijn. Het complexiteits-respons raamwerk helpt om de ervaren complexiteit te koppelen aan strategieën om die specifieke complexiteit te navigeren. Dit is vooral belangrijk in de Nederlandse spoorwegcontext, waar het bewustzijn van, en de mogelijkheden die andere coördinatiemechanismen dan planning & controle bieden, over het algemeen laag zijn.

Door een beter begrip te creëren van de probleemcontext van inter-organisatorische spoorwegprojecten, en het ontwerpen, implementeren en testen van instrumenten gericht op het verbeteren van projectcoördinatie, biedt dit proefschrift professionals en empirische onderzoekers de middelen om de projectcomplexiteit van systeemintegratie uitdagingen op passendere manier aan te pakken.

Het proefschrift sluit af met de ontdekte theoretische en managementimplicaties, bijvoorbeeld dat de ontwikkelde artefacten moeten worden beschouwd als een gereedschapskist voor professionals om hen te helpen met het kiezen van geschiktere antwoorden op de complexiteit die zij ervaren. Aangezien het sociale element steeds belangrijker wordt, richten de eerste drie ontwerpverklaringen GDP1-GDP3 zich op situaties waarin er een vastgestelde behoefte is om relaties tussen projectdeelnemers op te bouwen. Dit draagt bij aan een beter begrip voor wat er in inter-organisatorische projecten gebeurt bij het managen van complexiteit. De laatste drie ontwerpverklaringen GDP4-GDP6 laten zien dat effectieve coördinatie kan worden bereikt door een betere aansluiting op individueel- en inter-organisatorisch teamniveau. Dit helpt managers in de spoorweg- of vergelijkbare contexten om hun effectiviteit te vergroten bij het coördineren van hun besluitvormingsactiviteiten in steeds meer onderling verbonden (project)contexten. Tot slot worden toekomstige onderzoeksmogelijkheden naar effectievere coördinatie in inter-organisatorische spoorwegprojecten belicht, waaronder de suggestie om zich binnen de spoorwegcontext te richten op het bevorderen van flexibiliteit, en de aanbeveling om instrumenten al vroeg te testen tijdens de pre-projectfase.
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>ATO</td>
<td>Automatic Train Operation</td>
</tr>
<tr>
<td>BOB-model</td>
<td>Dutch decision-making model (creating awareness, judging, deciding)</td>
</tr>
<tr>
<td>CIMO-logic</td>
<td>Context, Intervention, Mechanism, Outcome -logic</td>
</tr>
<tr>
<td>CO</td>
<td>Contractor</td>
</tr>
<tr>
<td>COMPASS</td>
<td>COoordination Mechanism Preference ASsessment</td>
</tr>
<tr>
<td>CRF</td>
<td>Complexity-Response Framework</td>
</tr>
<tr>
<td>DP</td>
<td>Design Principle</td>
</tr>
<tr>
<td>DSR</td>
<td>Design Science Research</td>
</tr>
<tr>
<td>ERTMS</td>
<td>European Rail Traffic Management System</td>
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<tr>
<td>FO</td>
<td>Freight Operator</td>
</tr>
<tr>
<td>FYRA</td>
<td>Highspeed train Netherlands - Belgium</td>
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<tr>
<td>GDP</td>
<td>Generalizable Design Proposition</td>
</tr>
<tr>
<td>GOVT</td>
<td>Governmental body for Infrastructure- and Water Management</td>
</tr>
<tr>
<td>IB</td>
<td>Inspection Body</td>
</tr>
<tr>
<td>IENW</td>
<td>Ministry of Infrastructure- and Water Management</td>
</tr>
<tr>
<td>ILT</td>
<td>Inspection Environment and Transport</td>
</tr>
<tr>
<td>IM</td>
<td>Infrastructure Manager</td>
</tr>
<tr>
<td>MIRO</td>
<td>Online brainstorming tool</td>
</tr>
<tr>
<td>NS</td>
<td>Netherlands Railways</td>
</tr>
<tr>
<td>PD</td>
<td>Program Management</td>
</tr>
<tr>
<td>PHS</td>
<td>Program High-frequency Rail</td>
</tr>
<tr>
<td>PMBOK</td>
<td>Project Management Body Of Knowledge</td>
</tr>
<tr>
<td>PRINCE II</td>
<td>PRojects IN Controlled Environments II</td>
</tr>
<tr>
<td>RU</td>
<td>Railway Undertaking</td>
</tr>
<tr>
<td>SCRUM</td>
<td>Framework from agile project management</td>
</tr>
<tr>
<td>SPAD</td>
<td>Signal Past At Danger</td>
</tr>
<tr>
<td>T1</td>
<td>Time interval 1</td>
</tr>
<tr>
<td>T2</td>
<td>Time interval 2</td>
</tr>
<tr>
<td>TKI</td>
<td>Thomas-Klimann Instrument</td>
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<tr>
<td>TO</td>
<td>Transport Operator</td>
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Chapter 1: General Introduction

The first chapter of this dissertation lies the foundation of the work. It discusses inter-organizational project complexities and different ways to coordinate these. It also presents the theoretical and practical motivation of this research, which leads to the main research question guiding this research. Finally, it introduces the methodology and structure of this dissertation.
1.1. Introduction to the topic

The principal systems and services which contribute to the economic prosperity and social well-being of a nation are of great importance to society (Rinaldi, Peerenboom, & Kelly, 2001). These systems include bridges and roads, power grids and sewage systems, canals and ports, and airports and public transportation systems. Especially the latter, which includes the railway system, must become safer, more reliable, and increasingly connected in order to meet the expected increase in demand over the coming years (European Commission, 2016). To accommodate this, systems must be modernized by means of integrating new technology and by mitigating risks across the system.

Integrating new technology into the operating system involves collaboration between many different railway parties, since responsibilities within the system are split and individual decision preferences are not aligned (Aaltonen & Kujala, 2010; Flyvbjerg, 2014). Moreover, integrating these systems costs millions of euros and implementation and operationalization take years to complete (Flyvbjerg, 2017). As the need for economic growth continues to increase and these upgrades therefore become larger and more interconnected, a common feature of large system upgrades is growing complexity (Söderlund, Sankaran, & Biesenthal, 2017). To navigate this complex socio-technical context, the system integration challenges are arranged into inter-organizational projects.

Past experiences show that such inter-organizational transportation projects often experience budget issues and delayed implementation (Flyvbjerg, Bruzelius, & Rothengatter, 2003). This is particularly difficult to manage since the results are directly observable by the wider public (Flyvbjerg, 2017) and may impact millions of train travelers each day. In the context of the Dutch railway system, for example, the failed implementation of the high-speed train FYRA, which resulted in the train series being decommissioned after only a brief period, is still brought up regularly (van Silfhout & van den Berg, 2014).

One reason for the arising of such project issues is the difficulty in coordinating the complexities that are experienced in these projects (Maylor & Turner, 2017). In this context, coordination is understood as the organization of different elements of a complex process so as to enable them to work together effectively. The term coordination, rather than management, was chosen since management is also associated with the management of the content instead of being solely focused on the process. Coordinating railway project complexities is considered an important but challenging endeavor, since effective coordination can overcome decision-making issues and facilitate proper implementation (Antillon, Garvin, Molenaar, & Javernick-Will, 2018). A focus on planning & control coordination, which is the basis of conventional project management methodologies (Morris, 1994), is very common. However, employing planning & control coordination is not effective in all project contexts (Geraldi, Maylor, & Williams, 2011). As such, a good starting point for finding more appropriate ways to coordinate project complexities that arise during system integration challenges is the project complexity literature based on Williams...
Williams defines complexity not merely as a structural problem, but also as uncertainty, which means that classic project management methodologies are not sufficient to cope with complexity.

1.2. Theoretical background

The following section deals with the theoretical background of this dissertation. It examines why inter-organizational transport projects are an interesting context for investigation and which aspects are particularly difficult to coordinate, thus underscoring the need for research.

1.2.1. Inter-organizational transportation projects

Large-scale inter-organizational transportation projects, as seen from the perspective of Flyvbjerg (2017, p. 2) are “large-scale, complex ventures that typically cost US$1 billion or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and the outcome impacts millions of people”. This definition shows that such inter-organizational projects have several characteristics that make them an attractive starting point for research. Firstly, they provide great societal value, which leads to significant interest from society, since the results of transportation projects, such as major infrastructure improvements, are immediately visible to the general public (Flyvbjerg, 2017; Maylor & Turner, 2017). Because the Dutch railway system is tightly interconnected, large-scale projects are also mostly inter-organizational. Therefore, in this dissertation both terms are used interchangeably.

Previous research has shown that projects which involve an interface between two or more collaborating and risk-sharing organizations exhibit critical deficiencies (Lehtiranta, 2014). These deficiencies can lead to failure, delayed implementation, and increased costs (Flyvbjerg et al., 2003). In turn, these performance shortcomings can cause public dissatisfaction, whereas the reasons why these shortcomings emerge are often poorly understood (Lenfle & Loch, 2016). One possible explanation is offered by Flyvberg’s performance paradox (Flyvbjerg et al., 2003), which states that the importance of projects is often at odds with their performance. According to Maylor and Turner, the increasing complexity of projects is another possible explanation for this lack of performance (Maylor & Turner, 2017). These suggestions indicate a lack of coherence in the literature focused on understanding the performance shortcomings of large inter-organizational projects.

At present, research which focuses on understanding the complexity of processes fails to provide important parameters to be considered. Processes in inter-organizational projects, for example, are often investigated from an external perspective without a thorough understanding of how processes evolve within large-scale projects (Söderlund et al., 2017). Moreover, project management research currently reflects a lack of solid insight into why large-scale projects are unsuccessful (Lenfl & Loch, 2016). Similarly, research on complex inter-organizational projects has long inclined towards a ‘hard system’ view, based on the ‘best practice’
perspective (Maylor, Meredith, Söderlund, & Browning, 2018). However, in order to adequately cope with the vagaries of complex project dynamics (Dahlgren & Söderlund, 2010), it is necessary to understand the context in which projects operate. All of this provides an interesting opportunity for research into system integration challenges and decision-making questions.

1.2.2. System integration challenges in railway systems

Transportation projects are typically concerned with optimizing the transport system in areas such as safety, reliability (including capacity optimization), access, and sustainability (Handy, 2008). Transportation systems, such as the railway system, can be considered a complex socio-technical system because they involve interaction between people and technology in a work environment, as well as between society and complex infrastructures (Stranks, 2007). These social and technical sub-systems work together to accomplish a predefined goal (Wilson, 2014). As such, transportation projects that aim to improve these types of transportation systems are often complex as well, because there are multiple organizations that interact to create value together while stakeholder behavior is unpredictable (Hass, 2008). In these projects, system integration is the process that is used for integrating these separate system entities within projects into the operating (railway) system (International Council on Systems Engineering, 2015).

Artto, Ahola, and Vartiainen (2016) note that complexity and dynamics increase within projects which involve multiple organizations working to achieve adequate system integration. Artto et al. (2016) also consider the perspective of the system lifecycle to be critical to system integration, implying that the work of these organizations must be integrated in order to create shared value for operations. As such, it remains relevant over the entire lifespan of the system, which can be several decades. Davies (2004) describes a continuous value creation process through system integration, which is effected by the participating stakeholders, starts in the project phase and continues in the operational phase. In line with this, Artto et al. (2016) note that the establishment of a coordinating body is an important integration mechanism to be carried out at the beginning of the system lifecycle (i.e., the project phase).

From a system lifecycle perspective, complexity appears to increase in cases where multiple organizations collaborate to achieve system integration, since these organizations often have different value creation systems (Morris, 2013) and/or risk appetites (Lehtiranta, 2014). Within the railway system, both system integration and collaboration are major challenges because projects are undertaken in an environment involving multiple interdependent organizations which can only create value together (van Dongen, Frunt, & Rajabalinejad, 2019).

1.2.3. Decision-making concerning system integration challenges

Major inter-organizational projects that address system integration challenges are typified by decision-making processes that require interdependent, complex operations to be carried out at different times and by different actors whose
interests are often in conflict with each other (Levitt & Scott, 2017; A. Pitsis, Clegg, Freeder, Sankaran, & Burdon, 2018). Regarding this Van Marrewijk, Ybema, Smits, Clegg, and Pitsis (2016) state that decision-making between organizations is more prone to conflict than decision-making processes within one organization. This is partly because these stakeholders have different risk appetites with respect to the shared decision-making process (Lehtiranta, 2014) and/or different value creation approaches (Morris, 2013). This, in turn, can affect trust between project stakeholders (Van Marrewijk et al., 2016), which can ultimately pose a challenge to the successful completion of high-volume projects. Since there are a large number of different stakeholders in inter-organizational projects, each with their own goals and responsibilities within the system, individuals or organizations may be working on optimizing their own part of the system while being unaware of the complex interdependencies between the different actors in the system.

In inter-organizational projects, differing goals and perspectives are especially significant during the problem identification phase of the decision-making process, when the participants involved may not grasp the whole problem or each other’s perspectives (Daft & Lane, 2008), see Figure 1.1. These decision problems are often ‘fuzzy’ because the information is ambiguous and challenging to measure (Ghadimi, Dargi, & Heavey, 2017). Therefore, such decision-making processes are creative, complex, and highly subjective and thus cannot be automated or made objective (Adamides & Karacapilidis, 2020). When decisions are made while there is limited shared understanding, this can lead to frustration among stakeholders and disagreements over work practices (Van Marrewijk et al., 2016), ultimately delaying the project. As such, it is important to establish a thorough understanding of the problem context, and the perspectives of all involved stakeholders first.

Figure 1.1. The contingency decision-making framework, emended from Daft and Lane (2008).
According to Geraldi et al. (2011), fuzziness, interdependencies of actors, and differences in stakeholder perspectives reveal a high level of complexity of these decision-making processes. Nevertheless, an understanding of the complexities of the project context in which decisions are made, has been underemphasized in literature up to this point (Hetemi, Jerbrant, & Mere, 2020). Moreover, understanding the context of project decisions can facilitate the recognition of the mechanisms that enable project success (Hetemi et al., 2020). As such, these project management complexities do not only need to be managed from a technical perspective, but careful attention needs to be paid to how they are coordinated (Fernandes, Spring, & Tarafdar, 2018).

1.2.4. Inter-organizational project complexities

As mentioned above, there are two primary factors investigated that contribute to the high degree of complexity of inter-organizational transportation projects, namely, the need to coordinate system integration challenges, and the need to make decisions in fuzzy problem contexts.

Understanding project complexities is a topic that has been widely discussed in literature (Geraldi et al., 2011; Ramasesh & Browning, 2014; Williams, 2005), it has been defined in a variety of ways. According to Williams (1999), complexity consists of structural complexity (number of elements and their interdependence) and uncertainty (in goals and methods). Expanding on this definition, Geraldi et al. (2011) define five dimensions of complexity, namely structure (size, variety and interdependence), uncertainty (novelty, experience and information availability), dynamics (changes in the project), pace, and socio-political complexity (importance, support, convergence with, and transparency of agendas). Elaborating on this further, Maylor and Turner (2017) cluster these five dimensions into three dimensions, namely structural, socio-political and emergent complexity: see Figure 1.2. This research will build on the complexity dimensions as identified by Maylor and Turner (2017).

Figure 1.2. Project complexity categories according to Maylor and Turner (2017)
This definition of complexity is based on multiple assumptions that have been acknowledged as accurate for the purposes of this research project. Firstly, we include aspects that are not addressed by some other academics in this field as they consider them merely complicated (Baccarini, 1996). Secondly, complexities can be categorized as either ‘complexity in projects’: a reductionist perspective, or ‘complexity of projects’: a perspective in which practitioners strive to identify the characteristics of complex projects (Cicmil, Cooke-Davies, Crawford, & Richardson, 2017). Since complexity is experienced by individual project members, each has a subjective assessment of it, according to the ‘complexity of projects’ perspective posited by Cicmil et al. (2017). Within projects, understanding complexity can contribute to project success because it provides a better understanding of the context the project is operating in, so that it represents the realities of projects better (Geraldi et al., 2011). This is especially important since it has been concluded that conventional project management methodologies are not equipped to address all complexities equally well (Williams, 2005). Additionally, the complexities of problems are typically fuzzy in nature (Daft & Lane, 2008), making them hard to explore thoroughly. As such, Hass (2008) proposes investigating the complexities of a project in order to understand the root causes of problems.

1.2.5. Inter-organizational project coordination

Projects in general, which include inter-organizational projects, have long been coordinated by means of planning & control (Williams, 2005). This is because the body of knowledge concerning the leading project management methodologies, such as PRINCE II and PMBOK, have been established based on the System Management/System Analysis principles of the 1960s, and have not been adjusted since (Morris, 1994). As a result, Williams (2005) summarizes three leading assumptions that clash with today’s project challenges:

- Project management is rational and presents itself as essentially ‘right’.
- Project management is based on a positivistic worldview, stressing that presented facts are assumed to be objective.
- Project management is based on a reductionist approach, believing that the whole of the work can be decomposed into smaller parts to make it manageable.

As a result, the body of knowledge on project management is heavily based on the principle of planning & control and is regarded as decoupled from the broader context the project is operating in (Packendorff, 1995; Williams, 2005). However, this approach leads to a number of inconsistencies between conventional project management methodologies and the complexities experienced during projects (Williams, 2005), namely:

- The dynamic and unpredictable behavior of projects leads to feedback loops, which is in stark contrast to the view that projects are decomposable into smaller parts,
- the ‘soft aspects’ that play a role in the interaction of project members are not
considered in the perspective that everything can be regarded as objective, and

• the fact that each manager may perceive the complexities of the project differently, contradicts the assumption that only one true reality exists.

As such, Williams (2005) concluded that there is no one-size-fits-all approach to complex projects. Such a contingency view also provides a common language for both practitioners and academics alike (Geraldi et al., 2011). Geraldi et al. (2011) call for research that produces more fitting project management approaches that better coordinate the ‘realities’ of projects.

The fundamental work of Thompson (2017) on coordination mechanisms shows that specifically the first two interdependencies (pooled and sequential) are often addressed by means of coordination through applying planning & control. However, complexity as we understand it is reflected only in the third (reciprocal) interdependency, which allows for feedback loops through continuous interactions. Thompson suggests addressing such reciprocal interdependencies with mutual adjustment. Because of the reciprocal interdependencies that enable feedback effects, the project will behave in ways that are difficult to intuitively predict and will deviate from what conventional approaches would suggest. Hence, when uncertainty affects a project which is managed traditionally, project performance may be impacted. In settings, which are inherently complex, uncertain, and time-sensitive, agile and lean management may be more appropriate (Williams, 2005). Similarly, Koppenjan, Veeneman, Van der Voort, Ten Heuvelhof, and Leijten (2011) show that in large technical projects there is often a tension between the intended emphasis on planning & control and the need to maintain flexibility in the face of task uncertainty. L. Liu and Leitner (2012) suggest that managers deal with complexity by being ambidextrous, employing both strategies of exploitation (applying known or planned responses) and exploration. Finally, Staadt (2012) elaborates on the complexity related to a lack of mutual understanding in projects, which can be addressed by using a soft systems methodology.

What all approaches have in common, is that different project management approaches trigger specific coordination mechanisms, depending on the complexities experienced. Therefore, this body of work is in alignment with the contingency view research on project complexities. One work that summarizes the contingency view of project complexities and how to coordinate these is the complexity-response framework (CRF) by Maylor and Turner (2017), shown in Figure 1.3.
Figure 1.3. The complexity-response framework emended from Maylor and Turner (2017).

According to Maylor and Turner (2017), CRF is a three-step approach which applies the following logic:

- ‘understand’: understand the experienced complexity
- ‘reduce’: how is/should the complexity (be) managed?
- ‘respond’: the managerial ‘response’ that is most suitable.

Their work identifies responses that can be classified into three different coordination mechanisms, namely planning & control, relationship-development, and flexibility. Planning & control is the preferred response to structural complexities, relationship-development addresses socio-political complexities, and emergent complexities can best be responded to with more flexibility (Maylor & Turner, 2017). Nevertheless, in their work they conclude that the two other coordination mechanisms can also be used to address a complexity, albeit possibly not as successfully.

When relating the contingency research of Maylor and Turner (2017) to the complexities that are experienced during decision-making on system integration challenges in the railway system, several aspects become clear. Firstly, due to the fuzziness of the problem context, there is often a lack of understanding of the context in which inter-organizational decisions on system integration challenges are taking place. In order to achieve proper understanding, the experienced complexities need to be explored in their proper context first (Williams, 2005). As such, by outlining the experienced complexities of inter-organizational projects, the context can be better understood, and managed. Secondly, the complexities experienced in projects that deal with system integration challenges are not just structural in nature. For example, cases where shared decisions between multiple interdependent stakeholders have to be made, and the interests and perspectives of the participating stakeholders do not align, indicate a high level of socio-political complexity, and as discussed previously, this is often best addressed by relationship-development. Furthermore, the fuzziness of the problem context in which decisions take place suggests that information is often unavailable or ambiguous, indicating high levels of emergent complexity, and as previously mentioned, this is often best addressed by means of flexibility. As such, contingency research into complexities, in particular CRF,
appears well suited to aid in addressing the issues identified in inter-organizational projects that focus on decision-making concerning system integration challenges, thus being especially relevant to the railway context.

Therefore, the concept of the complexity-response framework was used throughout the dissertation in the data structure, to explore the problem context, and to build the design artifacts (see Table 1.1).

Table 1.1. Usage of CRF per chapter.

<table>
<thead>
<tr>
<th>CRF used in…</th>
<th>CH. 2</th>
<th>CH. 3</th>
<th>CH. 4</th>
<th>CH. 5</th>
<th>CH. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data structure</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>Problem exploration</td>
<td>x</td>
<td>x</td>
<td>(X)</td>
<td></td>
<td></td>
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<tr>
<td>Design (criteria, propositions, principles)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

1.3. Practical background

The theoretical background has revealed a need for more research on improving the coordination of inter-organizational railway projects which focus on system integration challenges, and their benefits to society. In addition to pursuing societal relevance and a generalizable knowledge contribution, this dissertation also aims to make an empirical contribution by providing project managers working in the railway system with practical insights. The following section introduces the case companies that have sponsored this dissertation.

1.3.1. The Dutch railway system

The Dutch railway network is one of the most densely occupied railway networks in the world (Authority for Consumers & Markets, 2019). It is a vertically separated system, where train, track and other organizations are connected and have to manage the system jointly. The significance of railway transport for the mobility of the country is high, which leads to significant social and political pressure: commuters and leisure travelers alike are dependent on reliable train connections. In order to prepare the Dutch railway system for the increased capacity demands of the future, several inter-organizational projects are currently running in parallel, such as the High-frequency Rail (PHS) program and the European Rail Traffic Management System (ERTMS) program. These projects aim to decrease system weaknesses by developing and implementing cost-effective, multidisciplinary and innovative measures, which in turn rely on strong governance and collaboration between stakeholders. Nevertheless, past inter-organizational projects show several shortcomings resulting in unreliable performance such as delayed implementations and budget overruns, an example of which is the failed implementation of the high-speed train FYRA (Rajabalinejad, 2018; van Silfhout & van den Berg, 2014).
1.3.2. Case companies: NS & ProRail

Two of the main stakeholders of the Dutch railway system are the train operator: NS, and the railway infrastructure manager: ProRail. Under the supervision of the Dutch government, they are responsible for providing safe and reliable railway transportation, which includes the management of the railway system as well as the efforts to upgrade it.

Nederlandse Spoorwegen (NS) is the largest railway operator in the Netherlands, carrying over 1.1 million passengers each day along the core network. The fleet consists of approximately 3100 wagons (Nederlandse Spoorwegen, 2021). NS was founded in 1937 through the merger of Staats Spoorwegen and Hollandsche Ijzeren Spoorweg Maatschappij and has been providing railway services in the Netherlands ever since. The NS Group is comprised of approximately 36,000 employees and includes NS Operations, Commerce & Development, NS Stations, Abellio UK, Abellio Deutschland, and personnel services such as HR, finance, and IT, and the Dutch state is the sole shareholder (Nederlandse Spoorwegen, 2021, 2022).

ProRail is the infrastructure manager of the Dutch railway system. It is responsible for the maintenance, renewal, expansion, and safety of the Dutch railway network. They distribute space along 7,053 kilometers of track, regulate all train traffic (160 million km per year), and build and manage stations. Railinfratrust BV is the company that is owned by the Dutch state, and is the legal owner of the vast majority of the railway infrastructure, and its subsidiary company ProRail BV is the manager of the railway network. In 1995, as part of the reorganization of NS, Railinfratrust BV was established, and later in 2003, ProRail was founded as a subsidiary. ProRail has approximately 4,655 employees and has been transformed into a public, independent administrative body in 2021, and now outsources maintenance and construction works (ProRail, 2022).

1.3.3. Other project stakeholders

Several inter-organizational railway projects are being conducted to improve the performance of the Dutch railway system, in which other relevant stakeholders play a role depending on the size and scope of the project. One of the major stakeholders that is often consulted is the Ministry of Infrastructure and Water Management since it is the party accountable for the Dutch railway system. They give long-lasting concessions to NS allowing them to operate on the tracks, and they own the tracks ProRail manages. Thus, they have the final vote in complex inter-organizational projects in cases where NS and ProRail do not reach an agreement. Another important stakeholder that often needs to be consulted is the Inspection of Environment and Transport, which checks whether projects are executed according to all relevant rules and regulations. Depending on the scope of the project, contractors, who execute the maintenance of the tracks, and freight operators, who utilize the tracks to move goods through the country or to neighboring countries, may also be involved.
1.3.4. Practical system integration challenges

The Dutch railway system and its main stakeholders, NS and ProRail, face several important system integration challenges that play a role when making decisions together. Firstly, the Dutch government plans to upgrade the already very dense network in order to accommodate the increasing demand for passenger transport in the Netherlands. There are approximately 5,500 passenger and freight train operations daily, which are expected to increase by 30 to 40 percent in the coming years (ProRail, 2014). In order to accommodate this increase, measures have to be taken to enable the expected growth in passengers and freight, considering the current capacity limits of the system. These measures are part of PHS program, which falls under the responsibility of ProRail and transport companies such as NS. The program has been commissioned by the Ministry of Infrastructure and Water Management. The challenge lies in providing fast, high-quality, and more frequent connections, without constructing additional tracks. Several measures for achieving this are available, each with different advantages and disadvantages, requiring decision-making and coordination between the various stakeholders. Secondly, as part of EU legislation, the so-called ‘Fourth Railway Package’ will be implemented over the coming years (European Commission, 2016). As part of the package, safety will be improved and cross-border train traffic will be facilitated through the development and implementation of ERTMS (ProRail, 2019), which consists of both a system on the trains and a system within the infrastructure. Both systems communicate with each other by means of beacons named ‘balises’, between rails, using telecommunication. NS and ProRail have a leading role in the development and implementation and, as such, need to collaborate closely.

Both initiatives are extensive, and organized into large-scale inter-organizational projects. The leading project management approach to developing and implementing measures that improve the railway system currently is planning & control. The project managers employed by NS and ProRail, for example, are educated on the use of the PRINCE II methodology, which is also prominent in many internal training documents concerning the management of projects. This means that a high degree of planning is involved in the management and coordination of these projects (Koppenjan et al., 2011; Morris, 2013). Furthermore, in order to keep track of the progress of projects, regular reporting to the steering committee is required: this shows the regular usage of control mechanisms in these projects (Dahlgren & Söderlund, 2010).

When investigating these projects, many complexities relating to making decisions on system integration challenges are revealed, some of which are:

- Number of stakeholders; in addition to ProRail and NS the Ministry of Infrastructure and Water Management, the Inspection of Environment and Transport, other transport operators, freight operators, and contractors have a stake in the projects as well.
- Organizational and technical interdependencies; for example, the integration of ERTMS, the European standardized signaling system, requiring changes
to both trains and infrastructure, and their organizations.

- Divergent interests; stakeholders have different responsibilities in the system. As a result, when making decisions, they often favor different solutions depending on how these impacts their part of the system.
- Divergent perspectives; since stakeholders are responsible for specific system entities, their knowledge is often limited to how this part interacts with the system as a whole, but they lack knowledge about and awareness of other entities.
- Maturity of the technology; ERTMS is still being developed and stakeholders have limited to no experience with it. Therefore, information is often ambiguous, and cause and effect relations are not yet properly understood.
- Long time horizon; the implementation of the projects takes several years (e.g., PHS an estimated 14 years and ERTMS an estimated 11 years). Therefore, societal demands, regulations, and safety requirements may change over the project lifecycle.
- Ever-increasing performance goals; the Dutch railway system is reaching its current limits, while the demands for capacity, safety, service reliability and sustainability are becoming ever more pressing.

1.4. Research motivation

The challenges experienced in practical settings involve several complexities, outlined in the existing literature on project management. This makes the Dutch railway system, which is working to address system integration challenges, an interesting environment for research. The currently employed project management methodologies appear to be limited in their success in addressing the complexities of the problem context.

Firstly, there is a strong focus on conventional project management approaches in order to coordinate inter-organizational railway projects in practical settings. However, the complexities experienced in such projects are much more diverse than can be addressed through a one-size-fits-all approach (Geraldi et al., 2011). As such, the complexities of system integration challenges as experienced in the Dutch railway system, require a more varied approach than what the conventional project management methodologies can offer.

Secondly, project managers and controlling bodies appear to not question the planning & control-based approach when coordinating projects and fail to create a broader understanding of the context first. This lack of awareness of the context and how to address the complexities experienced may have various causes. For example, project managers may have a preference regarding certain coordination mechanisms which can originate from cultural aspects and personal competences (Turner & Müller, 2005). Therefore, there is a need to facilitate more awareness of the complexities experienced and possible coordination responses regarding decision-making issues of inter-organizational railway projects.
Thirdly, even if awareness is created, there may still be an issue with the implementation of suitable project management approaches. Socio-political complexities in particular, which appear to occur frequently when facing decision-making challenges and in railway projects in general, are difficult to manage for project managers (Maylor & Turner, 2017). Due to this, Dutch railway professionals can benefit from tools that enable more targeted coordination mechanisms for addressing the complexities experienced in inter-organizational projects.

A knowledge gap concerning how inter-organizational projects can be coordinated in the complex context of system integration in the railways currently exists in both theory, and practice. This indicates that there is a need for more awareness of, and assistance with, coordinating project complexities, especially regarding the project complexities experienced in the context of decision-making on system integration challenges in the railways. The main question that guides the research of this dissertation is therefore the following:

“How can inter-organizational project coordination mechanisms facilitate shared decision-making on system integration challenges over the project lifecycle?”

In order to answer the main research question, five sub-questions will be answered first:

1. What are the complexities and coordination mechanisms in inter-organizational railway projects?
2. To what extent do applied coordination mechanisms fit with inter-organizational railway project complexities, and how does this affect coordination effectiveness?
3. What coordination mechanisms are currently applied in decision processes in inter-organizational railway projects, and how do these facilitate decision-making?
4. How can the shared decision-making process of inter-organizational problem contexts be better designed and coordinated?
5. How can more awareness regarding personal coordination mechanism choices and fit with the project context be created among railway professionals?

Each of these sub-questions is answered in an individual chapter. Moreover, the sub-questions are related to two distinct research themes, firstly, gaining more understanding of the problem context, and secondly, improving inter-organizational project coordination. The first three questions, which are answered in chapters 2-4, constitute the first research theme, and question four and five, which are answered in chapters 5 and 6, comprise the second research theme (see Figure 1.4). The research themes are further elaborated on in section 1.6 which introduces the structure of this dissertation.
1.5. Methodology

As has been discussed in the section on theoretical background, the context of inter-organizational projects that solve system integration challenges is particularly complex. CRF is based on contingency theory, which argues that a good fit between challenges and coordination responses leads to high project performance. Therefore, investigating the fit between contingencies and coordination responses increases the knowledge on the problem context, and may reveal improvements. Moreover, the need for shared decision-making presents an interesting research context, since in a multi-stakeholder decision-making process environment, problems are often fuzzy.

As such, a better problem understanding of the context needs to be achieved first by employing a fit assessment (Donaldson, 2001) and CIMO (Context, Intervention, Mechanism, Outcome) logic (Denyer, Tranfield, & van Aken, 2008). Subsequently, Design Science Research (DSR) is employed in order to improve the coordination efforts in complex inter-organizational projects, because it is especially useful for developing solutions to practical problems (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). In order to ensure the generalizability and rigor of this research, several (design) validities will be introduced in each chapter. Particular attention has been paid to pragmatic validity based on a robust body of evidence (van Aken, Chandrasekaran, & Halman, 2016).

1.5.1. Fit assessment for establishing problem context knowledge

In the literature review section, it has been established that CRF is a contingency framework suitable for project coordination. Moreover, Geraldi et al. (2011) call for more research centered around the fit of project management approaches.
Therefore, the structural contingency theory, assessing the fit between contingency and organizational structure (Donaldson, 2001) appears to be a good starting point.

According to the structural contingency theory, there are a number of elements that can be classified as contingencies, for example, size, environment, and technology. Contingencies are factors of the environment that are continuously changing during operations, and impact the organizational structure. For this reason, when conditions change, organizations need to avoid mismatches that arise, and they do so by adopting new organizational characteristics that fit the new levels of contingencies. Therefore, given a certain level of structural variability, there is a fit to each level of contingency, with a high fit leading to high effectiveness (Donaldson, 2001). Effectiveness has a wide meaning in contingency theory that encompasses efficiency, profitability, and employee satisfaction (Donaldson, 2001).

Assuch, the principles of the structural contingency theory are also advantageous to use in the context of inter-organizational projects. These projects operate in a changing environment, where there can be a lack of fit between experienced project complexities and the coordination responses which are applied. Such a mismatch can impact project performance as it is not an intuitive response (Maylor & Turner, 2017). Moreover, since project complexities are dynamic, responses have to change continuously in order to preserve a high degree of fit (Geraldi et al., 2011; Maylor & Turner, 2017). Therefore, assessing fit also aids in raising awareness of the need for effective coordination behavior, and can potentially guide coordination response usage over the project lifecycle. The fit assessment can be executed using the process steps outlined in Figure 1.5.

**Figure 1.5. Process steps of assessing the coordination fit.**

In this dissertation, contingency theory is used to gain more knowledge about the problem context of coordination problems in inter-organizational projects in order to answer a ‘what’ question. Contingencies in this case are project complexities that are structural, socio-political, and emergent in nature, and include, but are not limited to, elements such as project size, stakeholders, and technology (Maylor & Turner, 2017). These contingencies impact projects, and can be addressed by means of coordination responses. Therefore, after the complexities and coordination responses have been identified (chapter 2), by investigating the fit between project contingencies and coordination responses, the effectiveness of such responses can be
evaluated, which ultimately aids in assessing project success (chapter 3).

1.5.2. Using CIMO-logic to increase understanding of problem contexts

As has been discussed in the literature review section, the context of inter-organizational projects can be characterized as fuzzy, which means that it is shaped by undefined requirements, complex interactions, design flexibility, and dependence on social and cognitive skills (Hevner, March, Park, & Ram, 2004). Therefore, the understanding of the knowledge relevant to problems related to project coordination depends to a large extent on the ability to analyze and disentangle complex inter-organizational contexts. CIMO-logic is a structured approach to decomposing chunks of knowledge that assist in clarifying the functioning of applied interventions in business contexts (Denyer et al., 2008). It is vital to design science research to identify changes in problems within the context relevant to practitioners (Holmström, Tuunanen, & Kauremaa, 2014). There are several advantages to using CIMO-logic in complex inter-organizational project contexts such as its ability to clarify complexities and shed light on dynamics. One of the reasons why inter-organizational projects are difficult to disentangle is the fact that complexities that emerge are varied and interdependent (Maylor & Turner, 2017). CIMO-logic provides a structured approach to breaking down these different complexities and their effects. Additionally, up to this point, large projects have predominantly been studied from an outside perspective, which makes it difficult to uncover the contents of the ‘black boxes’ (Söderlund et al., 2017). CIMO-logic is able to explain the workings of mechanisms that play a core role in the coordination of complex inter-organizational projects.

The CIMO approach used in this study employs the following logic: “in this class of problematic Context(s), use this Intervention type to invoke these generative Mechanism(s), to deliver these Outcome(s)” (Denyer et al., 2008, pp. 395-396), see Figure 1.6.

Figure 1.6. CIMO-logic steps used to understand the problem context.

In research, CIMO-logic can be used for different purposes, i.e. to explore, to abduct, or to explain (Holmström, Främling, & Ala-Risku, 2010). Firstly, exploration looks for promising interventions by employing problem solving or solution spotting activities. Especially the second approach can be used as input to structure the design science research process (Gregor & Jones, 2007). Secondly, abduction deepens and elaborates on specific means-purpose proposals by introducing ideas and results from other research areas (Holmström et al., 2010). Thirdly, this elaboration expands the initial assumptions into a CIMO hypothesis. The emphasis is on detecting mechanisms that might explain how interventions produce outcomes (Arthur, 2007).
In this research, CIMO-logic is employed to gain a better understanding of the problem context and to answer ‘what’-questions. Therefore, it uses explanatory CIMO-logic to understand the coordination mechanisms which are triggered by applied interventions within the inter-organizational project. As such, CIMO-logic provides support for explanations for how interventions lead to outcomes in different settings (chapter 4). Moreover, exploration is another research purpose used to increase the understanding of the problem context through establishing the effectiveness of applied interventions in the given problem context, thereby clarifying the problem that was previously fuzzy (chapter 5).

1.5.3. Using DSR to improve inter-organizational project coordination

The previous section discusses how CIMO-logic can aid in understanding complex problem contexts. Once the problem context is made less fuzzy, design science can be employed to better coordinate the complexities experienced in the context. As discussed in the literature review section, collaboration between two or more organizations generates accurate problem contexts which demand extensive, complex negotiations that impose significant limits determined by the feasibility of potential solutions (Groop, Ketokivi, Gupta, & Holmström, 2017). Therefore, drafting effective project coordination depends to a large extent on the ability to develop solutions that are compatible with the complex context of inter-organizational projects. The DSR method was developed for addressing problems that occur in practice, and focuses on the study of solutions that improve them (van Aken & Romme, 2009). Therefore, DSR can be used to create artifacts that solve decision problems in complex inter-organizational contexts. Although the benefits of DSR have been acknowledged within the field of organizational and management studies (Jelinek, Romme, & Boland, 2008; van Aken, 2007; van Aken & Romme, 2009), DSR has so far only been applied in a limited number of cases within an organizational context. This can be partially explained by the fact that DSR is often approached from a positivist worldview and used to generate prescriptive knowledge (Denyer et al., 2008; Iivari & Venable, 2009), which can be unfamiliar to organizational science researchers (van Aken et al., 2016), who chiefly focus on understanding general patterns. Nevertheless, there are several reasons why DSR is beneficial for the field of organization and management studies. Firstly, instruments for coordinating complex inter-organizational projects are often focused on planning & control, which appears inadequate for addressing all the complexities of inter-organizational processes (Maylor & Turner, 2017). However, employing DSR focuses on assessing which artifacts work well for practitioners for improving their practical situation (van Aken, 2007), thereby being able to addressing the contingencies more targeted. Secondly, in organizational and management studies, it is recognized that a connection between science and practice is often lacking (van Aken & Romme, 2009). DSR is an approach that encourages the exchange between science and practice by directly implementing theoretical concepts in real-world cases, thereby assisting practitioners (van Aken, 2007). Moreover, the feedback of practitioners can be incorporated into design iterations as well, further closing the gap between science and practice. Finally, the body of literature on complex inter-organizational
projects underscores a need to study projects from an inside perspective in order to learn about the internal dynamics (Söderlund et al., 2017): DSR is an approach that aids in identifying the internal dynamics of systems through testing means-end relationships that work well, and as such solving problems (van Aken & Romme, 2009).

In order to find solutions to complex inter-organizational coordination problems, the DSR process based on Peffers et al. (2007), combined with the design elements of Denyer et al. (2008) and van Aken and Romme (2009), is used in this dissertation (see Figure 1.7). This process is employed to develop artifacts that are presented within this dissertation in the form of methods, processes, and surveys.

Figure 1.7. DSR process for improving inter-organizational project coordination, emended from Peffers et al. (2007), van Aken and Romme (2009), and Denyer et al. (2008).

To accommodate the demands of organizational and management studies, the DSR process as outlined by Peffers et al. (2007) has been emended in order to produce less prescriptive research. This is particularly relevant in socio-technical systems, such as inter-organizational railway projects, where system behavior is harder to predict and the human agency impact tends to make it much more context-dependent than in technical systems (van Aken et al., 2016). As such, two important additions have been made to the process, which underline the drive to retrieve generalizable knowledge regarding the solutions that were designed using the DSR process, specifically design propositions and design principles.

Firstly, one of the starting points for design science research in the field of organization and management studies can be found in so-called design propositions, which are chunks of generalizable knowledge that can be used to compose an artifact (Denyer et al., 2008). Interventions are a key component of design propositions, and these are employed to solve practical problems, and as such can be regarded as input for solving complex business problems (Denyer et al., 2008). Compared to engineering studies, which are generally more prescriptive, design propositions in organizational and management studies are not limited to if-then logic, but
can also take forms such as a report or a training manual. An essential element in
design propositions is the aspect of practitioners’ learning rather than the execution
of rules. Therefore, van Aken (2007) refers to the practitioners as co-designers,
meaning that participants take part in a collaborative development process and gain
a deep understanding of the implications of design decisions by jointly evaluating
multiple iterations of the design and using feedback. This participation promotes
learning and practitioner engagement by examining the problem and the solution
collaboratively (Hocking, Brown, & Harris, 2016). Additionally, a co-designed
process can enable stakeholders to act on the insights gained from the interventions
taking place, which in turn promotes an increased acceptance of the implemented
solutions (Missimer & Mesquita, 2022). Therefore, the use of the co-designing in the
field of organizational and management studies aids in creating context awareness
and linking research and practice more closely, a link that is currently often absent.
Establishing, identifying and implementing design propositions which enable the
learning process of practitioners through the process of co-designing is a core aspect
of chapter 5.

Secondly, when focusing on improving the coordination mechanisms used in
inter-organizational projects, the use of DSR can help practitioners identify, learn,
and adopt new processes from design principles (van Aken, 2007). Design principles
are understood as sets of knowledge about how to create artifacts, which in turn can
be used as rules for creating similar artifacts (Markus, Majchrzak, & Gasser, 2002;
Romme & Endenburg, 2006). They relate to the principles that govern the structure,
organization and operation of the designed product or designed method. Design
principles are a form of solution spotting (Goldenberg, Lehmann, & Mazursky,
2001), as these principles define the functioning of the design and can be regarded
as a mental model which shows how an intervention addresses a set of different
problems in their contexts (Holmström et al., 2010). Emphasizing the learning and
development that takes place, shifts the focus from the ends (the design) to the
means (how and why the design works) (Romme & Endenburg, 2006). Identifying
and evaluating such design principles is a core part of chapter 6 which enables the
use of generalizable principles from other organizational settings. Moreover, general
design principles will be provided in the final discussion chapter which forms the
main knowledge contribution of this dissertation.

1.5.4. Theoretical approach

For this dissertation, the researchers have adopted a constructivist lens to
study the research questions posed. Constructivist research assumes that reality
is constructed by individuals and groups through their subjective experiences and
social interactions (Cohen, Manion, & Morrison, 2002). This has several benefits
for studying the complex context of inter-organizational projects. First, it allows
for a more nuanced understanding of the social phenomenon studied. This view
recognizes that complexities are experienced by individual project members rather
than they can be observed from the environment (Williams, 2005). Second, this
approach values the diversity of perspectives and aims to understand the reasons
behind the different experiences of actors (Creswell & Creswell, 2017). As such, it is well suited for studying complex project decisions, where project stakeholders have different views and interests. Third, constructivist research recognizes the interview as expert in their own experiences and that their insights are valuable for forging the research outcomes (Mackenzie & Knipe, 2006). It acknowledged the importance of including subjective experiences in shaping the reality around complex projects. As such, the case studies conducted in this dissertation are taken using qualitative methods. The qualitative data that has been collected and analyzed in the case studies are interviews, observations, and studying of documents collected, such as project reports written. This produced rich and detailed data sources to analyze and draw conclusions from.

1.6. Overarching dissertation structure

The structure of this Ph.D. dissertation is based on the publication strategy employed throughout the research process, which was publishing and presenting research findings through the medium of conference proceedings and journal articles. Therefore, this dissertation is a compilation of several individual publications, that each contribute to answering the main research question. Together with chapter 1 (introduction) and chapter 7 (discussion and conclusion) they form the content of this dissertation. As such, chapters two through six can be read as standalone articles.

Since this dissertation employs two main methodological steps, namely assessing the problem context of inter-organizational projects and improving inter-organizational project coordination, the five chapters can be divided into these two main research themes. The first research theme understanding the problem context of inter-organizational projects, is primarily focused on answering ‘what’ questions (problem exploration) and is studied by means of CIMO-logic and fit investigation. Chapter 2 has a preparatory role, since it operationalizes the main conceptual framework at the level of the railway system. The second research theme improving inter-organizational project coordination, is focused on answering ‘how’ questions (solution development) and is studied by means of the design science process. Both research themes explore complexities from a micro perspective which encompasses complexities specific to decision-making processes and from a macro perspective which includes all project complexities (see Figure 1.8).

<table>
<thead>
<tr>
<th>Design process</th>
<th>Problem exploration (Research theme 1)</th>
<th>Solution development (Research theme 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro perspective (CIMO-logic)</td>
<td>Ch. 4</td>
<td>Ch. 5</td>
</tr>
<tr>
<td>Macro perspective (Fit investigation)</td>
<td>Ch. 3</td>
<td>Ch. 6</td>
</tr>
</tbody>
</table>

Figure 1.8. Depiction of the complexity focus and phase of the DSR process that is focused on per chapter.
To ensure continuity and comparability of the different chapters, in both research themes the chapters use the same theoretical concept as input. As discussed in paragraph 1.2.3, the main concept used for understanding and improving inter-organizational project coordination is CRF (see Figure 1.3).

**Research theme 1: Understanding the problem contexts of inter-organizational projects (problem exploration)**

The first research theme, which focuses on understanding the problem context of inter-organizational projects, consists of three chapters. To start the investigation, in chapter 2 the complexity-response framework is operationalized for the complex context of the Dutch railway system. Following this, Chapter 3 assesses the fit of coordination mechanisms, thereby emphasizing the causes of shortcomings in inter-organizational project coordination. Chapter 4 employs CIMO-logic as the main methodological input to increase the understanding of inter-organizational project workings from the inside, investigating the decision-making process in more depth. The research deals with coordination issues both on the micro level of decision-making processes, and on the macro level of overall project coordination (see Figure 1.8).

**Chapter 2: Coordinating Project Complexities in Inter-Organizational Railway Projects – the Operationalization of the Complexity-Response Framework**

This chapter operationalizes the complexity-response framework by means of design science research. The chapter aims to explore the complexities and coordination responses of inter-organizational railway projects. It aids in understanding the problem context, which is further explored in chapter 3 and 4 by means of the application of the complexity-response framework. Moreover, it is an important first step in demonstrating that this framework can be employed in the context of inter-organizational railway projects.

**Chapter 3: Coordinating Project Complexities in Inter-Organizational Railway Projects – highlighting the Importance of Relational Coordination**

This chapter assesses the fit of inter-organizational project coordination based on the complexities experienced in projects and its impact on project effectiveness. A multiple case study is conducted in which the fit is assessed based on the complexity-response framework, and project effectiveness is determined based on how satisfied project stakeholder are with the process.

**Chapter 4: The Dynamics of Inter-Organizational Decision Process Coordination: A Multiple Case Study on Large Railway Projects**

This chapter investigates the dynamic behavior of coordination mechanisms in decision processes in inter-organizational railway projects, and how it facilitates decision-making. It utilizes the process perspective, in which CIMO-logic is applied to understand the functioning of the two coordination mechanisms of planning & control and relationship-development in both the pre-project and the project phase.
Research theme 2: Improving inter-organizational project coordination (solution development)

The second research theme focuses on improving inter-organizational project coordination, and is addressed in chapters 5 and 6. These chapters employ the design science research process to create practical solutions to problems in the complex context of coordinating and making decisions in inter-organizational projects. The research focuses specifically on the designing of solutions in inter-organizational projects (see Figure 1.8). In order to do this, the findings of the problem exploration phase are utilized. Throughout the chapters, the concept of CRF has been employed for both the data structure and the design itself.

**Chapter 5: Co-Designing Sustainable Coordination to support Inter-Organizational Decision-Making**

This chapter investigates how the shared decision-making process of inter-organizational problem contexts can be better designed and coordinated. In order to achieve this, the complexities experienced by inter-organizational project stakeholders, who must make decisions together despite a limited awareness of each other’s interests and perspectives, are first explored. CIMO-logic is applied to gain an improved understanding of the process stakeholders employ to make decisions, and of the change they desired. Subsequently, the design science research process is used to develop an intervision process, which improves the shared coordination efforts within the inter-organizational project.

**Chapter 6: COMPASS – Design of a Coordination Mechanism Preference Assessment**

This chapter examines how awareness of railway professionals regarding their personal coordination mechanism choices and fit with the project context can be improved. In order to achieve this, the research focuses on identifying professionals’ and teams’ coordination preferences, and enabling reflection on their usage of coordination mechanisms. To develop such a tool, the design science research process is used, and the principles of the Thomas-Klimann conflict mode instrument are incorporated.

The main empirical inputs for the various chapters are case studies. The case studies conducted in the Dutch railway system are summarized in Table 1.2, which outlines which chapter focuses on which case.
Table 1.2. Overview of case studies per chapter.

<table>
<thead>
<tr>
<th>Case</th>
<th>Decision context</th>
<th>Description</th>
<th>Research theme</th>
<th>Main project stakeholders</th>
<th>Ch.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>Safety improve initiative</td>
<td>Deciding on the effects of an initiative to reduce the amount of signals past at danger.</td>
<td>1</td>
<td>NS, PR, IENW, ILT</td>
<td>3, 4</td>
</tr>
<tr>
<td>CAPACITY</td>
<td>Intro new material</td>
<td>Deciding on the axle load limit of a new train: trade-off between passenger capacity vs. Infrastructure compatibility.</td>
<td>1</td>
<td>NS, PR, (IENW)</td>
<td>3, 4</td>
</tr>
<tr>
<td>ERTMS</td>
<td>Control of safety level</td>
<td>Safety control board controlling hazards that are emerging at the interfaces.</td>
<td>1, 2</td>
<td>PD, PR, NS, FO, CO, IENW</td>
<td>2, 3, 5</td>
</tr>
<tr>
<td>NEW VEHICLE</td>
<td>Intro new railway vehicle</td>
<td>Deciding on when the new vehicle is ready for operation, e.g., responsibilities, safety assessment.</td>
<td>1</td>
<td>PR, NS, (IENW)</td>
<td>2, 3</td>
</tr>
<tr>
<td>IMPLEMENTATION</td>
<td>Supporting implementation of projects</td>
<td>Supporting large inter-organizational system integration questions</td>
<td>2</td>
<td>NS</td>
<td>6</td>
</tr>
</tbody>
</table>
Publication history

This chapter was published in the proceedings of the 10th International Conference on Through-Life Engineering Services 2021:

Chapter 2: Coordinating Project Complexities in Inter-Organizational Railway Projects – the Operationalization of the Complexity-Response Framework

Abstract

Large-scale inter-organizational transportation projects play a critical role in the design and development of existing and new railway networks. However, in the past, inter-organizational projects have shown shortcomings in effective decision-making and system integration due to a unilateral use of coordination mechanisms. The goal of this work is to provide an operationalization of the complexity-response framework for the Dutch railway project context, thereby extending the coordination mechanisms currently considered.

To that end, we conducted design science research to operationalize the complexity-response framework based on an analysis of the specific inter-organization railway context and evaluate its validity by means of follow-up discussions with project members.

The operationalization of the framework can be used to capture and evaluate the coordination mechanisms employed and identify potential matching coordination responses to the assessed railway system project complexities at the outset of the project. Further research is needed to assess the fit between the coordination responses applied and those proposed.
2.1. Introduction

Previous inter-organizational transportation projects have shown performance deficiencies due to the increasing complexity of coordinating these, especially when diverse stakeholders are involved in multiagency projects (Flyvbjerg et al., 2003). Furthermore, these transportation projects are responsible for improving and updating infrastructure, whose societal value is directly visible to the general population (Flyvbjerg, 2017). However, the social value created in projects becomes visible only after integration (Artto et al., 2016). Artto, Ahola, and Vartiainen state that in order to achieve proper system integration in projects which involve multiple organizations, the complexity and dynamics within them increase (Artto et al., 2016). Additionally, decisions in inter-organizational transportation projects involve a large number of stakeholders from different organizations, whose interests do not always align (Geyer & Davies, 2000). As a result, decision-making is often more conflictual than in intra-organizational projects (Van Marrewijk et al., 2016) which adds complexity to decision-making in inter-organizational projects.

Understanding how to manage these complexities forms the basis for responding to them (Williams, 2005). Building on the need to establish contingency approaches to project management (J. Thomas & Mengel, 2008), Maylor and Turner developed the so-called complexity-response framework (CRF) to aid in understanding project complexities and trigger appropriate coordination mechanisms by means of targeted responses, which enable coordination (Maylor & Turner, 2017). Their assumption is that no single type of project management approach addresses all complexities equally well, but rather than casting a wide net, a more focused approach is needed. This is consistent with other literature (e.g. (Koppenjan et al., 2011)) which observes a mismatch between the commonly desired focus on planning & control and the flexibility required to deal with uncertainty.

Particularly in technical and engineering-driven fields, such as transportation, the literature observes a dominant focus on planning & control responses (Koppenjan et al., 2011), which have also shaped the project management field during the last years (Kapsali, 2013). However, given the increasing complexity of inter-organizational projects, planning & control measures may not always be the most appropriate approach in such an environment, especially due to the need to manage different interests in joint decision-making (Van Marrewijk et al., 2016). Research on identifying coordination responses addressing distinct project complexities (Maylor & Turner, 2017) has been conducted. The authors are not aware of an application of the framework in the context of system integration and joint decision-making. To identify complexities and coordination mechanisms, we conducted design science research by operationalizing the CRF and test it in the context of the Dutch railway system.

This paper is organized as follows: First, an overview of project complexity and coordination mechanisms is provided, and the design science research methodology is introduced. Thereafter, the results of the operationalization are presented. In
the discussion which follows, the applicability of the CRF for inter-organizational railway projects is evaluated, and finally, suggestions for future research are offered.

2.2. Coordination of inter-organizational projects

This section investigates the latest literature on coordination of inter-organizational projects. First, the peculiarities of transportation projects are outlined. After which complexities of inter-organizational projects are discussed. Lastly, it is reported how it can be responded to these complexities.

2.2.1. Inter-organizational transportation projects

Transportation projects have several characteristics which make them an interesting starting point for research. On the one hand, the outcomes of transportation projects, such as major infrastructure improvements, are visible to the general public. Consequently, this leads to increased social interest of such transportation projects (Flyvbjerg, 2017; Maylor & Turner, 2017). On the other hand, these major transportation projects often result in performance shortcomings that leads to societal dissatisfaction. The reasons for these inadequacies are not well understood (Lenfle & Loch, 2016). One possible explanation is offered by Flyvbjerg’s performance paradox (Flyvbjerg et al., 2003), which states that the importance of projects often contrasts with their performance. According to Maylor and Turner, increasing complexity is cited as a possible explanation for this lack of performance (Maylor & Turner, 2017).

2.2.2. Complexities of inter-organizational projects

There are two important factors that contribute to the increased complexity of inter-organizational transportation projects, these are the need for system integration, and coordinated decision-making. Firstly, the need for system integration arises because transportation projects are often undertaken in an environment involving multiple interdependent organizations which can only create value together. This is described by Davies, who characterizes a continuous value creation process between multiple organizations, beginning in the project phase and continuing through the operations phase (Davies, 2004). Artto, Ahola, and Vartiainen consider this system lifecycle view to be critical to system integration (Artto et al., 2016), which means the work of these organizations must be integrated to create shared value for operations. Viewing the system lifecycle view through a complexity lens, in cases where multiple organizations collaborate to achieve system integration, complexity appears to increase. Secondly, coordinated decision-making in multi-organizational projects is complicated by the fact that it affects a large number of different stakeholders across organizational boundaries, and their respective interests are not always perfectly aligned (Geyer & Davies, 2000). This misalignment can lead to conflict among the various stakeholders. Similarly, Van Marrewijk et al. (2016) state that inter-organizational decision-making is more prone to conflicts. Based on this view of conflict and shifting interests, the setting of inter-organizational decision-making appears to be more complex than intra-organizational decision-making.
Inter-organizational transportation projects exhibit a high degree of variation in complexities, e.g. socio-political complexities: the dynamics of these complexities require specific coordination (Maylor & Turner, 2017).

2.2.3. Coordinating inter-organizational project complexities

As stated above, various complexities are present in inter-organizational transportation projects. These complexities can be addressed by means of appropriate coordination responses (Maylor & Turner, 2017). Commonly, there is a natural desire to address complexity in projects by means of planning & control responses, which can be explained by Thompson’s coordination mechanisms (Thompson, 2017). Johnson (2013), for example, argues that technical complexity and novelty were important drivers for the establishment of project management as an activity in the twentieth century, which heavily relies on the coordination mechanism of planning & control. Furthermore, Koppenjan et al. (2011) demonstrate that for coordination in projects, planning & control is often a strong focus, especially when it comes to managing risks. Additionally, for system projects, the focus on work breakdown structures constitutes one of the most commonly used tools in project management (Morris, 2013), and is part of the planning & control coordination responses. Although empirically there is a strong focus on planning & control activities, there are also arguments in favor of a more nuanced view of project coordination. For instance, Koppenjan et al. (2011) demonstrate that in large engineering projects, tension exists between the ambition to focus on planning & control, and the requirement to remain flexible in the face of task uncertainty. Other authors conclude that managers respond to complexity by being ambidextrous in their approaches – using both strategies of exploitation and exploration (L. Liu & Leitner, 2012). Finally, Staadt (2012) addresses the complexity related to mutual lack of understanding in projects by means of soft systems methodology, highlighting the social aspect of coordination.

Maylor & Turner developed a contingency approach for dealing with project complexity (Maylor & Turner, 2017). The so-called complexity-response framework (Figure 2.1) distinguishes between three different types of complexities. These dynamic complexities pose unique challenges due to their variable nature, as they can consist of structural (e.g., interdependencies), socio-political (e.g., people), and emergent (e.g., uncertainties) elements (Geraldi et al., 2011; Maylor et al., 2018). For each of these complexity elements, the authors identify a preferred coordination response, see Figure 2.1. Structural complexity is characterized by scope, interdependence, and speed. Its responses are shaped by project management tools (Meredith, Shafer, & Mantel Jr, 2017) and can be described as “planning & control” responses. Socio-political complexity, defined by conflict, politics, and lack of mutual understanding, seeks an approach that builds relationships between people, especially in conflict-laden cases (Park & Lee, 2014). Relational coordination requires increased communication efforts or shared sensemaking activities. Finally,

1 Relational coordination is used interchangeably with relationship-building of the CRF.
emergent complexity, characterized by elements of novelty, uncertainty, and lack of experience, can be addressed with flexibility. Examples of flexibility include agile project management and working with SCRUM (Highsmith, 2009). Maylor & Turner also note that other coordination responses can be used to address complexities (Maylor & Turner, 2017).

To summarize, the relevant literature suggests that in technical environments, such as transportation projects, the focus is generally placed on coordination by means of planning & control. Operationalizing and applying the CRF to the railway system context can potentially provide these specific technical environments with a more nuanced tool that helps them to expose complexities and identify other coordination mechanisms. To date, most research has focused on establishing the contingency approach. However, we have limited data on the practical applicability of the framework in environments such as the railway system.

2.3. Research Design and Methodology

This paper uses the design science research methodology (DSR) which results in an “artifact created to address an important organizational problem” (Hevner et al., 2004). This entails a research process which employs both theoretical and empirical knowledge in order to find a solution to the defined problem. In addition to designing the artifact, another important process step is the evaluation of the artifact in the chosen context in order to verify that it is a valid solution to the problem (Hevner et al., 2004). As such, DSR starts by outlining a relevant research problem and culminates in a design that is operationalized and evaluated in a non-theoretical context (Peffers et al., 2007), see Figure 2.2.
Figure 2.2. Design science research process adopted from Peffers et al. (2007).

The DSR process begins with the identification and definition of a problem. This problem that is defined is essentially constructed by understanding the context of the problem (Holmström, Ketokivi, & Hameri, 2009). After the problem is derived, criteria for the solution are defined that the design must meet. This can serve as a mental model for the characteristics of the research outcome that will be produced in the end (Peffers et al., 2007). Then, the actual solution is designed by looking at the literature to see what possible principles and practices can help solve the defined problem. Based on the characteristics of the design, thematic codes can be defined that are both context-specific and consistent with the principles identified in the literature. This is an iterative process that involves both deductive and inductive reasoning and is informed by theory and practice. Next, the developed artifact can be implemented to demonstrate its suitability for the context. Finally, the implemented design artifact can be evaluated based on the solution criteria defined at the beginning (Peffers et al., 2007).

2.3.1. Rigor and quality of the study

In this study, several approaches are used to ensure the rigor and quality of the study; see Table 2.1 for more details. Construct validity represents tests used for qualitative studies, while internal and external validity represent measures that ensure the quality of quantitative studies (Golafshani, 2003). Although this is a qualitative case study, it is important for our study to ensure that we can use the results as input for follow-up studies on inter-organizational rail projects that use the CRF. Therefore, we also make use of some quantitative case study tests.
Table 2.1. Approaches used to ensure rigor and quality.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Approach</th>
<th>Research phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>Project members review interview transcripts and results of analyses (Party) investigator triangulation</td>
<td>Data collection</td>
</tr>
<tr>
<td>Internal validity</td>
<td>Focused coding using the predefined codes derived from literature review and context-specific codes derived from interviews Pattern matching (cross-case comparison)</td>
<td>Data analysis</td>
</tr>
<tr>
<td>External validity</td>
<td>Literal replication logic: same system (Dutch railway system), same object (inter-organizational project), different teams, different issues to solve</td>
<td>Research design</td>
</tr>
<tr>
<td>Reliability</td>
<td>Data source tables: Appendix Table A1.5 -Table A1.7</td>
<td>Data collection</td>
</tr>
</tbody>
</table>

2.4. Operationalization of the CRF to the railway system

An initial investigation has shown that the CRF has the potential to mirror the complexities and responses used in inter-organizational railway projects to a greater extent than the currently employed standard project management responses. That is why, it was chosen to investigate the potential to operationalize the CRF to the specific context of transportation projects. In the following, this operationalization of the CRF has been guided through pursuing the DSR process.

2.4.1. Problem identification

In the literature review and while reviewing case documents, it became apparent that in technical environments, such as that of a railway system, coordination in inter-organizational projects often has a unilateral focus, employing standard PRINCE II methodology. Nevertheless, the project complexities that are experienced by project practitioners suggest the use of more broadly diversified coordination mechanisms. Complexities that are reported in interviews are often also socio-political in nature, i.e. the different organizational cultures of the stakeholders that take part in inter-organizational projects. Other complexities that are experienced reveal features of being emergent in nature, for example, the difficulty to predict the consequence of an action when making decisions. These type of complexities may not be suitably coordinated by mechanisms of planning & control, which is the basis of PRINCE II project methodology. In interviews, the difficulty in managing such complexities is addressed, however, little has been discussed regarding the appropriateness of available responses. Hence, it seems that project members may be unaware of the available options regarding coordination responses, or their intended use.
2.4.2. Objectives of the solution

As a result of the problem exploration, the objectives of the solution are threefold: concerning the developed method itself, the results of the method and the usability of the method.

- The method should assist project members in choosing appropriate coordination actions to manage project complexities. Such a method should build on the uncertainties of the project environment to better inform coordination decisions.
- The results of the method should highlight positive aspects of the current coordination methods, as well as suggest areas for improvement. This will ensure that responses which are already working well are not disadvantaged and that the focus for improvement is on the right aspects.
- The usability of the method should provide a reference point for the individual project members. It is important that it is easy to use in practice and that it incorporates the language of the railway system.

2.4.3. Choosing the design

The project complexity literature is used to identify appropriate responses to the complexities (paragraph 2.2.3.). The CRF brings the various complexities under one umbrella and guides the search for appropriate coordination mechanisms. The CRF is expanded on by adding two important aspects to the original framework. Firstly, the coordination response part of the framework is improved by distinguishing between coordination activities that are positive and those that need improvement. In this way, the appropriate coordination for each project context can be identified. Secondly, an additional level of detail is added to the framework to better represent the complexity experienced and the coordination responses applied. This aligns the responses mentioned by Maylor & Turner (Maylor & Turner, 2017) more specifically to the railway context. The responses identified are derived from interviews conducted with our expert-group of rail project members by clustering them to the predefined codes. As a result, they are better adapted to the language of the railway system.

2.4.4. Operationalization to context

The complexity-response framework was operationalized for the railway system context. Additional context-specific complexities and coordination responses were identified in the case studies through semi-structured interviews with railway project experts. First, the complexities were operationalized using Maylor & Turner’s (Maylor & Turner, 2017) categories, with an additional (third context-specific) level of detail added to the categories as sub-categories. For the added sub-categories, the codes associated with each sub-category are reported (Table 2.2). Coordination responses were then operationalized in a similar manner categorizing either:

1. Positively perceived coordination responses, or
2. Proposed improvements to coordination responses.
The codes were defined based on what our expert-group, consisting of current and former senior project staff, as project coordination working well and as suggested improvements to project coordination (Table 2.3).

2.4.5. Demonstration in two railway projects

In the following section the operationalization of the CRF in the context of the railway system is tested. First, the operationalized framework is implemented in two different railway projects. The adapted CRF was applied in two inter-organizational railway projects of NS and ProRail (ERTMS and NEW VEHICLE, for more information on the cases see Table 1.2). In both cases, information on project complexity and on coordination responses was collected in semi-structured interviews (interview guides in appendix A4.4 and A4.7) with the involved project members from NS and ProRail, per case 8 and 12 interviews respectively. Notes were taken on these conversations, which were then transcribed and verified with the respective interviewees from the expert-group. Subsequently, these transcripts were coded using AtlasTI to thematically sort and cluster the responses into the three different complexity categories (summarized in Table 2.2) and the three different coordination response categories (summarized in Table 2.3).

Table 2.2. Complexities experienced in the Railway system.

<table>
<thead>
<tr>
<th>Complexity</th>
<th>Structural complexities</th>
<th>Socio-political complexities</th>
<th>Emergent complexities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category:</strong></td>
<td><strong>Sub-category</strong></td>
<td><strong>Pace:</strong></td>
<td><strong>Divergence of people involved:</strong></td>
</tr>
<tr>
<td><strong>Structural complexities</strong></td>
<td><strong>Scope:</strong></td>
<td>- Pressure on progress.</td>
<td>- New product raising uncertainties.</td>
</tr>
<tr>
<td><strong>Socio-political complexities</strong></td>
<td><strong>Interdependencies:</strong></td>
<td>- Broad project, interfaces with many different organizational sub-structures.</td>
<td>- Difficulties predicting the consequences of an action.</td>
</tr>
<tr>
<td><strong>Emergent complexities</strong></td>
<td><strong>Lack of shared understanding:</strong></td>
<td>- Many interdependent stakeholders, not all well represented in the project.</td>
<td>- Huge change impact of implementation (operational processes change).</td>
</tr>
<tr>
<td><strong>The novelty of work:</strong></td>
<td><strong>Lack of commitment:</strong></td>
<td></td>
<td>- Unclear responsibilities due to new processes.</td>
</tr>
<tr>
<td><strong>Other changes imposed on the project:</strong></td>
<td><strong>Disagreement regarding the actual problem:</strong></td>
<td></td>
<td><strong>Lack of previous experience:</strong></td>
</tr>
<tr>
<td><strong>Team members &amp; decision-makers change:</strong></td>
<td><strong>Unclear project ownership:</strong></td>
<td></td>
<td>- Limited supplier knowledge about a new product.</td>
</tr>
</tbody>
</table>
Table 2.3. Matched coordination responses with the complexities (* = positive response; ** = improvement response).

<table>
<thead>
<tr>
<th>Coordination responses</th>
<th>Structural complexities</th>
<th>Socio-political complexities</th>
<th>Emergent complexities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning &amp; control</td>
<td>*Good preparation of complex issues. **Better planning of activities at the start. **Better capacity planning. **Better preparation of supplier. **Overview of follow-up tasks;</td>
<td>**Assign project lead at both companies. **Overview of decision-making. **More process agreements defined. **Better description of roles &amp; responsibilities;</td>
<td>*Graphical notation structure in order to structure arguments for emergent issues. **Overview for coping with changes.</td>
</tr>
<tr>
<td>Relationship-development</td>
<td>*Follow-up on highlighted issues. **Better scope definition at the start. **Better external communication. **Better representation of all parties;</td>
<td>*Transparency in the project team. *Team collaboration. *Project lead with overarching interests. **Develop more empathy &amp; understanding;</td>
<td>*Short and informal communication lines.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>*Embrace change from standard processes;</td>
<td>*Engage in joint updating sessions with major stakeholders;</td>
<td>*Test &amp; learn approach. **More agile/scrum working;</td>
</tr>
</tbody>
</table>

2.4.6. Evaluation of the complexity-response framework

Finally, the results of the operationalization have been evaluated with project members and it has been investigated how these results can be used in inter-organizational railway projects. The complexity table (Table 2.2) and the response table (Table 2.3) were presented to the project members in order to evaluate the results. In the ERTMS case, 8 semi-structured interviews with the project members from NS and ProRail were held. For the NEW VEHICLE case, project members and system integration experts attended two workshops in which the results were presented and discussed together. The preliminary results of this evaluation show that the project members recognized the presented complexities. Additionally, project members confirmed the results of the CRF, which included both the proposed improvements and the positive coordination responses experienced. During the evaluation with project members, it was suggested that the framework should be used more at the start of the inter-organizational project in order to guide the use of coordination mechanisms. As such, the added value of this analysis was recognized. Furthermore, the project manager of the first project confirmed that she actually intended to use the coordination mechanisms identified in the framework, suggesting that the way responses were mapped correlated with the coordination mechanisms the project

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manager focused on in the project. Hence, the tables can serve as input for later studies, however, are subject to change depending on the requirements of the cases used. All in all, the operationalization of the complexity-response framework for the context of the Dutch railway system seems to reflect the complexity and coordination mechanisms present in inter-organizational railway projects well.

2.5. Conclusion

This paper observes that in technical environments, such as the railway system, there is often a unilateral coordination focus within projects. However, focusing on a specific coordination mechanism cannot address all experienced project complexities. To address this problem, the complexity-response framework was operationalized and applied to two railway system cases. The preliminary evaluation of the framework shows that the application of the CRF is well received in inter-organizational railway projects and seems to help project members achieve focused project coordination. Applying the CRF in the context of the railway system showed it can aid in identifying appropriate responses to the experienced project complexity. It was also demonstrated that it can create awareness of the use of the proposed coordination responses in the given environment. This is particularly relevant for alerting project members to the pitfalls of focusing too much on one-sided responses.

2.5.1. Future research suggestions

Having established that the CRF is strongly applicable to the context of the railway system, this provides opportunities for further study. Applying the framework to future railway system cases can help in assessing the “fit” between the complexities experienced and the coordination responses currently applied to deal with these complexities. In doing so, further conclusions can be drawn regarding (unintentional) overemphasis on a particular coordination mechanism and its consequences.
Publication history

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Chapter 3: Coordinating Project Complexities in Inter-Organizational Railway Projects – highlighting the Importance of Relational Coordination

Abstract

From a system lifecycle perspective, large inter-organizational transportation projects play a fundamental role in the much-demanded development of existing and new railway networks. Past inter-organizational projects have shown deficiencies in achieving effective decision-making and system integration. Coordination seems to be important however it does not seem to get much attention. The purpose of this paper is to provide insights into the ‘fit’ of these mechanisms in inter-organizational contexts.

We therefore conducted a multiple case study in the Dutch railway system in which we analyze the fit of coordination mechanisms in inter-organizational projects. We find that the primary coordination mechanisms used in the inter-organizational projects are planning- and control-based. However, there seems to be an increased need for the use of relational coordination mechanisms. In some cases, relationship-building proved to be a useful coordination mechanism to address socio-political complexities. It was found that if these complexities were neglected, that can be a source of organizational problems later on.

In this paper, we add to the literature on system lifecycle view by demonstrating the importance of collaboration early in the life of inter-organizational projects. Particularly in the more technical environment of inter-organizational transportation projects, it is important to create an awareness of the need for mutual understanding of each other’s interests and early relational coordination, which together seem to facilitate decision-making and system integration.

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2 Relationship-building is used interchangeably with relationship-development
3.1. Introduction

In part I of this study (chapter 2), the authors established that the operationalization of Maylor & Turner’s complexity-response framework can be applied to the railway system context. The framework aids in understanding project complexities and enables the identification of appropriate coordination mechanisms by means of the use of targeted responses (Maylor & Turner, 2017). This is essential, because project complexities in transportation projects increase with an increased need for system integration and joint decision-making activities (Artto et al., 2016; Van Marrewijk, Clegg, Pitsis, & Veenswijk, 2008), which requires more fitting responses. The need to match the project management approach with the contingencies experienced in the environment of complex projects has further been outlined by Geraldi et al. (2011). The purpose of chapter 3 is to explore the fit between the proposed coordination mechanisms of the contingency approach of Maylor and Turner (2017), to the experienced coordination mechanisms in inter-organizational railway projects, and how this affects coordination effectiveness. The proposed coordination mechanisms can be derived from the experienced complexities in inter-organizational projects.

To investigate this, a multiple case study on the Dutch railway system was conducted. The railway system is an excellent example of a transportation system in which the respective responsibilities are divided along the value chain, and where infrastructure management and train operation have been separated (van Dongen et al., 2019). This division requires collaboration between the entities involved to attain system integration and joint decision-making, in order to ensure that value is created for the customer during operation. To explore the complexities and coordination mechanisms adopted in projects, this paper focuses on the “actual experiences” of project stakeholders, using Maylor & Turner’s complexity-response framework as the analytical underpinning (Maylor & Turner, 2017).

This paper is organized as follows: the first section provides an overview of project complexity and coordination mechanisms. Then, the multiple case study approach and the results of the analysis of the fit are presented. The discussion which follows, addresses this fit and its empirical and theoretical significance. In the conclusion, future research suggestions are offered.

3.2. Coordination of inter-organizational projects

Various complexities exist within inter-organizational transportation projects, which can be addressed by means of coordination responses (Maylor & Turner, 2017). There is often a natural desire to address project complexities with planning & control responses, which can be attributed to Thompson’s coordination mechanism (Thompson, 2017). However, in particular in the context of system integration and shared decision-making in inter-organizational transportation projects, there seem to be potential difficulties in relying too strongly on the coordination mechanism of planning & control (Artto et al., 2016; Hetemi et al., 2020; Van Marrewijk et al., 2008).
The CRF (operationalized in chapter 2) distinguishes between three different categories of complexities (Maylor & Turner, 2017). These dynamic complexities pose unique challenges due to their variable nature, as they can consist of structural (e.g., interdependencies), socio-political (e.g., people), and emergent (e.g., uncertainties) elements (Geraldi et al., 2011; Maylor et al., 2018). For each of these complexity categories, the authors identified a preferred coordination mechanism, see Figure 3.1. Nevertheless, other coordination mechanisms can be used to address the complexity in question albeit in a less effective manner.

Figure 3.1. Overview of fit between complexities and coordination mechanisms.

3.2.1. Contingency theory for project coordination

Geraldi et al. (2011) consider assessing the fit of project management approaches to changing project conditions as a much needed research opportunity. Assessing fit is widely known from research on organizational structure (Mintzberg, 1981) and is summarized in structural contingency theory (Donaldson, 2001). According to structural contingency theory, three key elements form the core paradigm of this theory: (1) there is a relationship between contingency and organizational structure; (2) contingency affects organizational structure; and (3) there is a correspondence of a given level of structural variable with each level of contingency, with high correspondence leading to effectiveness and low correspondence leading to ineffectiveness. However, it is important to note that effectiveness in contingency theory has a broad meaning that includes efficiency, profitability, and employee satisfaction (Donaldson, 2001).

Relating this structural contingency view to project management, the organizational structure part can be exchanged with project coordination. It has already been established that there is a relationship between complexity and coordination responses and that complexity influences project management
approaches (Geraldi et al., 2011; Williams, 2005). In addition, Maylor and Turner identify preferred responses to project complexities. The question of how the fit between project complexity and coordination responses affects project effectiveness has not been studied. To date, most research on project complexities has focused on establishing the contingency approach and demonstrating that not every coordination mechanism can capture each of the complexities equally well. However, little is known about how this mismatch affects project organization, particularly with respect to project member satisfaction with the coordination mechanisms used.

3.3. Research Design and Methodology

The first aim of this study is to identify if there is a fit between the suggested coordination mechanism mentioned in the literature, and the coordination mechanism applied in practice. Afterwards, the study assesses the level of satisfaction of the project members with the coordination applied in practice to draw conclusions regarding the practical impact of the fit on project effectiveness.

In order to understand the fit between the coordination mechanisms in both theory and practice, a qualitative multiple case study (Yin, 2003) was conducted. Yin emphasizes that a case study design is particularly useful in context-dependent environments (Yin, 2003), which include inter-organizational projects. According to Eisenhardt, a multiple case study focuses on common patterns among cases and theory and emphasizes the theory-building attributes of case studies (Eisenhardt, 1989). Our multiple case study design is exploratory and empirical in nature; it explores the use of coordination mechanisms in inter-organizational projects in the railway system in order to assess their fit with the underlying context (Yin, 2003).

The research design consists of five phases (Figure 3.2) which are based on the thematic analysis of Braun (Braun & Clarke, 2006). As a first step, a theoretical approach which demands that the literature be studied prior to analysis (Braun & Clarke, 2006) was selected. After this, data collection by means of semi-structured interviews with project members was conducted, followed by verification of the transcripts with the interviewees. Secondary data, such as project documentation, was used to enhance the researchers understanding of the case and its context. More information on the data used for analysis can be found in the appendix A1 and on the interview guides are depicted in appendix A4. Then, transcripts were coded using the AtlasTI qualitative software. Initial coding was performed, and thematic searching was applied to the transcripts (Braun & Clarke, 2006) using the complexity-response framework (Maylor & Turner, 2017) as operationalized in chapter 2. Next, the fit between the proposed- and the applied coordination mechanisms was determined. Finally, a cross-case comparison to identify overlapping patterns across cases was performed (Yin, 2003).
Figure 3.2. The research design, adopted from (Braun & Clarke, 2006). Provides the average codes of the four cases for both coding steps.

3.3.1. Quality and rigor of the multiple case study

In this study, several approaches are used to ensure the quality and rigor of the cases; see Table 3.1 for more details. Construct validity is understood as a qualitative test to ensure rigor, while internal and external validity are tests used in quantitative studies to ensure generalizability (Golafshani, 2003). Since we are comparing multiple cases to draw more general conclusions, this multiple case study uses quantitative as well as qualitative measures.

Table 3.1. Approaches used to increase quality and rigor.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Approach</th>
<th>Research phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>Investigator triangulation in some cases</td>
<td>Data collection</td>
</tr>
<tr>
<td></td>
<td>Data triangulation: semi-structured interviews, project documentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Project members review interview transcripts and results of analyses</td>
<td></td>
</tr>
<tr>
<td>Internal validity</td>
<td>Focused coding using the predefined codes derived in chapter 2 and added context-specific codes derived from interviews</td>
<td>Data analysis</td>
</tr>
<tr>
<td></td>
<td>Pattern matching (cross-case comparison)</td>
<td></td>
</tr>
<tr>
<td>External validity</td>
<td>Literal replication logic: same system (railway system), same object (inter-organizational project), different teams, different issues to solve</td>
<td>Research design</td>
</tr>
<tr>
<td>Reliability</td>
<td>Data source tables: Appendix Table A1.1 - Table A1.7</td>
<td>Data collection</td>
</tr>
</tbody>
</table>
3.3.2. Case selection & description

This empirical study focuses on inter-organizational railway projects. By adopting a system lifecycle view (Artto et al., 2016), we assume that the multi-organizational environment unites in the project phase to jointly create value for operations. These projects include aspects of shared decision-making and system integration, which are influenced by the selected project management practice. For case selection, we conduct diverse sampling (Seawright & Gerring, 2008), which allows for a focus on two dimensions. The first dimension is that the sample is representative of inter-organizational projects in the railway system. The second ensures that there is meaningful variation in the project lifecycle phase. Table 3.2 provides an overview of the four inter-organizational projects.

Table 3.2. Introduction to the four cases.

<table>
<thead>
<tr>
<th>Case study</th>
<th>Decision context</th>
<th>Scope</th>
<th>Description</th>
<th>Main involved parties</th>
<th>Project lifecycle phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>Safety improvement initiative</td>
<td>Material level</td>
<td>Deciding on the effects of an initiative to reduce the amount of signals past at danger.</td>
<td>NS, PR, ILT, IENW</td>
<td>Improving during operation / retrofitting</td>
</tr>
<tr>
<td>CAPACITY</td>
<td>Introduction new material</td>
<td>Material level</td>
<td>Deciding on the axle load limit of a new train: trade-off passenger capacity vs. infrastructure compatibility.</td>
<td>NS, PR, (IENW)</td>
<td>Design phase</td>
</tr>
<tr>
<td>NEW VEHICLE</td>
<td>Introduction new vehicle</td>
<td>Corridor level</td>
<td>Deciding on when the new vehicle is ready for operation, e.g., responsibilities, safety assessment.</td>
<td>NS, PR, (IENW)</td>
<td>Implement phase</td>
</tr>
<tr>
<td>ERTMS</td>
<td>ERTMS program – safety control</td>
<td>Country level</td>
<td>Safety control board deciding on the hazards that are emerging at the interface between 2 or more implementing organizations.</td>
<td>NS, FO, CO PR, ERTMS program direction (PD), IENW</td>
<td>Design phase</td>
</tr>
</tbody>
</table>
3.3.3. Data analysis

The semi-structured interviews with senior project members were coded using the qualitative software AtlasTI (see appendix A1 for more information on the data sources and appendix A4 for information on the interview guides). Codes identified in the transcripts were thematically sorted into the three complexity categories (structural, socio-political, emergent) and the three coordination mechanism categories (planning & control, relationship-building, flexibility) of the complexity-response framework ((sub-)categories are discussed in more detail in chapter 2). For instance, when an interviewee reported; “issues in coordination due to different interests of project members”, we coded this as “different interests” and assigned the code to the category socio-political complexity. Resulting from that primary complexity is given by the category to which the most codes were assigned. Following, secondary complexity is given by the category with the second most codes assigned to. Similar coding steps were performed for the applied coordination. To determine the suggested coordination, we adhered to the literature, which suggests that each of the three complexities is best addressed by a particular coordination mechanism (Maylor & Turner, 2017). For example, if project members primarily experience socio-political complexity, responses that help build relationships are most appropriate. Also, the fit of the applied coordination mechanisms to the case-specific experienced project complexities was assessed. This was carried out in a similar way by Mintzberg (Mintzberg, 1981), who assessed the fit between organizational structure and situation. In our study, when the suggested and applied coordination mechanisms match, a high fit is identified. Other coordination mechanisms can also be used to deal with a certain type of complexity, but less effectively so. As such, only the degree of fit can be estimated. Additionally, the effectiveness of coordination was determined by comparing codes related to positive coordination with suggestions for improving coordination. For instance, when more positive experiences with coordination, and correspondingly fewer suggestions for improvement of coordination, were mentioned, we rated this as project members being satisfied with coordination. Finally, some of the project members’ statements from the interviews were selected to illustrate the results.

3.4. Results

The case studies revealed different levels of fit between the proposed and applied coordination mechanisms (Table 3.3). The following section starts by discussing the coordination mechanisms which were applied in the project. After this, the fit between the proposed and applied coordination mechanisms is evaluated, and the coordination effectiveness is assessed by investigating the project members’ satisfaction with the chosen approach.
### Table 3.3. Results of the interview analysis: assessing fit between suggested and applied coordination.

<table>
<thead>
<tr>
<th>Case</th>
<th>Decision context</th>
<th>Complexities</th>
<th>Suggested coordination</th>
<th>Applied coordination</th>
<th>Fit</th>
<th>Coordination effectiveness</th>
</tr>
</thead>
</table>
| SAFETY        | Safety improve initiative | Primary: Socio-political (different interests & viewpoints; low solution acceptance)  
Secondary: Structural (system parts are interdependent) | Relationship-building | Planning & control (e.g., individual planning & decisions) | Low         | Project members less satisfied      |
| CAPACITY      | Intro new material        | Primary: Socio-political (different interests; conflicting views)  
Secondary: Structural (interfaces with shared decision responsibility) | Relationship-building | Relationship-building (e.g., regular and intense discussion and exchanging of viewpoints) | High        | Satisfied with coordination          |
| NEW VEHICLE   | Intro new railway vehicle | Primary: Emergent (unknown & new product / changing processes of organizations)  
Secondary: Socio-political (problem disagreement & little ownership at beginning) | Flexibility            | Flexibility (e.g., test and learn approach)  
Relationship-building | High        | Satisfied with coordination          |
| ERTMS         | ERTMS – safety control   | Primary: Socio-political (unclear about roles and responsibilities)  
Secondary: Structural (many different stakeholders) | Relationship-building | Planning & control (e.g., defining process agreements) | Low         | Project members less satisfied      |
3.4.1. Coordination mechanisms applied to inter-organizational projects

The project team used multiple types of coordination mechanisms to cope with the complexity of the projects.

In the SAFETY case, the applied coordination focused mainly on planning & control mechanisms. Project team members noted the structured approach of the study and a well-planned and executed pilot study. They also felt that the preparation of the decision-making process was well done and illustrated all the different impacts of the selected solution on the system performance. Suggestions for improvement regarding the coordination mechanisms employed, focused on relationship-building. Notably, no common understanding of the problem, let alone agreement on a solution, was reached among the various project stakeholders, even after the decision had already been made. For example, the individual responsible for advising on the relationship between planning & safety of the rolling stock company stated:

“My opinion is that it was the wrong decision […] Ultimately, the solution isn’t impactful enough to fully reduce the risk.”

The safety advisor from the ministry, on the other hand, elaborated:

“Based on the numerous incidents alone, it became clear that something had to change. […] but the actual decision took a very long time, which I can’t understand.”

In the CAPACITY case, the project members employed targeted relational coordination. Emphasis was placed on creating mutual understanding between the different experts by means of facilitated discussions, particularly at the start of the project. Additionally, the focus on stakeholder management and establishing openness within the group was perceived positively. In the words of NS’s project manager:

“Stakeholder management was a key success factor throughout the preparation of the decision. Good stakeholder management facilitated discussion at the substantive level in a way that created more understanding of others’ perspectives.”

Coordination regarding flexibility was also highlighted as a positive aspect; by establishing a small core coordination group to prepare the work, it was made possible to respond to changes more quickly. This meant that the larger project team which included all experts was only called in when required.

In the NEW VEHICLE case, project members noted a high level of coordination by means of relationship-building. At the start of the project, emphasis was placed on informal activities such as team building and demonstrations of the solution to make it more tangible. Additionally, transparency within the group, and following up on concerns were seen as positive. The service and operations manager put it as follows:
“The general teamwork went particularly well. You can always discuss things with each other, we did team-building activities and structural participation.”

The project managers themselves emphasized flexible coordination by implementing a test-and-learn cycle, organizing joint “reality check” sessions, and having short lines of communication.

Finally, in the ERTMS case, the main mechanisms used to coordinate the project was planning & control. Two examples of this are the fact that project members were provided with organized and well-planned meetings, and that there was a strong focus on finding process agreements and following up on them. However, little attention was paid to attaining a shared understanding of the root cause of the divergent views regarding their responsibilities. One safety management representative explained this as follows:

“In terms of content, we’re pretty much on the same page. But when it comes to roles and mandate, the decision is questioned: Are we even allowed to make a decision here?”

3.4.2. Fit of coordination mechanisms in inter-organizational projects

In order to expand on the responses preferred by Maylor & Turner (Maylor & Turner, 2017), the fit between the suggested and applied coordination mechanisms was evaluated. In addition to fit, this paragraph also addresses project members’ overall satisfaction with the coordination mechanisms applied. The levels of satisfaction were identified by comparing coordination mechanisms which were described as positive, to those that were described as needing improvement.

In the SAFETY case, project members experienced a high degree of socio-political complexity, benefitting from an emphasis on relational coordination. The project members focused strongly on planning- and control-based coordination. This suggests that a rather limited fit existed between the complexities encountered and the coordination mechanisms used, especially in the early stages of the project. This can also be observed based on project members’ reflections on project coordination in general. The project members experienced the project as rather slow, with not all of them being satisfied with the final result.

The CAPACITY case revealed a high degree of socio-political complexity, suggesting the use of coordination focused on relationship-building would be most useful. Within the project, the team experienced a high level of orientation towards relationship-building, especially at the start. As such, a higher level of fit between these two was observed, which was also reflected in the overall satisfaction of project participants. Most members were satisfied and willing to build on the developed relationship for a follow-up project.

Project members in the NEW VEHICLE case faced a mix of emergent and socio-political complexities, suggesting the use of coordination mechanisms of flexibility and relationship-building could be beneficial. This appropriately illustrates the focus set by the project members and shows a high degree of fit between the proposed and
applied coordination. Generally, the degree of satisfaction with the coordination process among project members was very high, although some expressed a desire for more planning & control mechanisms.

Lastly, project members in the ERTMS case encountered high levels of socio-political complexity during coordination, suggesting that attention should be focused on the development of relationships within the group. The project team used a planning & control-based approach to address these complexities. Consequently, the degree of fit between the proposed and applied coordination was lower. This was also reflected in the feedback provided by the group regarding the applied coordination. This was not perceived to be optimal, as members felt they repeatedly discussed the same topic without making much progress.

3.5. Discussion

When comparing the results of the four case studies, it can be observed that in those cases where the fit between the proposed and applied coordination mechanisms is high, more project members are satisfied with the chosen approach. Conversely, in the cases where this fit is lower, the satisfaction with the applied coordination mechanisms among the project members is lower as well. Building on the findings of Maylor & Turner (Maylor & Turner, 2017), who found that all three coordination mechanisms can be applied in order to address each of the three complexities, this study confirms this for certain cases (e.g., coordinate with planning for socio-political complexities). However, it is important to bear in mind that the success of the applied coordination mechanism depends on its fit with the experienced complexity. As such there appears to be a preferred way to coordinate a given complexity which results in a higher number of satisfied project participants. In the cases with a higher fit, project members were also more satisfied with the pace of the inter-organizational project. It follows that inter-organizational transportation projects can potentially benefit from identifying project complexities during coordination in order to more specifically coordinate the complexities experienced. This is likely to positively influence satisfaction and pace in inter-organizational projects.

Additionally, in the SAFETY and ERTMS cases, a tendency to focus on planning & control activities was observed, which may have resulted from using standard project management methods that are heavily influenced by planning & control mechanisms (Kapsali, 2013). Especially in technical environments, such as railway systems, a strong focus on planning & control coordination (Koppenjan et al., 2011) appears to exist. The cases presented in this paper indicate that when pressures or uncertainties arise, project members tend to resort to addressing complexity with planning & control responses. Although this may be the initial response, it does not necessarily lead to coordination satisfaction. For example, in the ERTMS case, project members noticed that the current way did not lead to desired levels of progress, which they wanted to change. Still, the authors observed a tendency towards planning & control mechanisms in their improvement efforts. This appears to indicate that the
required behavioral change is difficult to achieve, which is in line with the findings of change management (Kotter, 2007). Following Kotter (Kotter, 2007), promoting a sense of urgency is needed as a first step to change people’s behavior. Therefore, the authors of this paper suggest that raising awareness regarding the contingencies of project coordination may be a beneficial preliminary step in environments with high levels of socio-political complexity. This includes inter-organizational projects where shared decision-making activities take place (Van Marrewijk et al., 2016).

Although there is a strong focus on planning & control measures, satisfaction with project coordination appears to be higher when relational coordination is applied at an early stage of an inter-organizational project. From the case studies, it can be inferred that during the design phase of inter-organizational projects, socio-political complexities are particularly high. These complexities include differing perspectives and a lack of shared understanding which complicates project collaboration. As a result, members of projects which focus on relationship-building in an early project stage, appeared to be more satisfied with the approach. As such, more emphasis needs to be placed on coordination using relationship-building early in the process, as this can benefit the pace of the project and satisfaction with project coordination.

3.6. Conclusion

This study was started with the goal of investigating the fit between suggested coordination mechanisms based on experienced complexities and applied coordination mechanisms in mind. The setting of inter-organizational railway projects seemed particularly relevant because, there is a strong tendency to focus on planning & control responses in these engineering-driven environments. However, the parties in these environments, especially when it comes to project decisions, often have conflicting interests which are difficult to align, so planning & control may not always be the most appropriate mechanism for coordination. To investigate the fit between proposed and applied coordination mechanisms, a multiple case study in the Dutch railway system was conducted using Maylor & Turner’s complexity-response framework as an analytical framework (Maylor & Turner, 2017). It was observed that in cases with higher levels of alignment between the suggested and applied mechanisms, project members experienced higher degrees of satisfaction with the chosen approach and the pace of the project. Conversely, in inter-organizational projects which had a lower degree of fit between the two, project members appeared to be less satisfied with the coordination and pace of the project. Additionally, it appeared that in some cases there was a natural tendency to use planning & control-based coordination, even though the complexity experienced suggested otherwise. Especially in the earlier phases of inter-organizational projects, such as the design phase, the need for relational coordination is high. In summary, in the largely engineering-driven environments of inter-organizational transportation projects, more attention needs to be paid to understanding each other’s interests, and early relational coordination: together these factors appear to facilitate decision-making and system integration.
The theoretical contribution of this work is twofold. Firstly, it demonstrates that matching coordination mechanisms to the experienced complexity in the inter-organizational project contributes to project coordination effectiveness. This supports the findings of Maylor & Turner regarding a contingency approach to project management. Secondly, this paper demonstrates that in inter-organizational transportation projects there appears to be a strong focus on coordination by means of planning & control. Relationship-building as a coordination mechanism appears to be underutilized, particularly in the early project phases. In the discussion, a number of possible explanations for this are investigated. Nevertheless, more detailed research is needed regarding the reasons for such an undervaluation of relational coordination at the start of inter-organizational transportation projects.

3.6.1. Future research suggestions

This paper identifies two areas that would benefit from further research.

Firstly, this paper identifies a degree of high focus on planning & control mechanisms in railway system projects, which do not always match the complexities experienced. A stronger focus on relational coordination in such environments appears beneficial. Despite high levels of socio-political complexity, project teams often relied on planning & control mechanisms rather than relationship-building. A number of potential explanations for this are discussed in this paper, but further empirically grounded research is needed to explore the reasons why relational coordination is difficult to achieve in engineering-driven environments.

Secondly, this paper observes that relationship-building is often required in order to address the specific experienced complexities. However, the field of relational coordination is in a relatively early stage of development, and as such, cannot draw on as many tools and instruments as planning & control-based coordination. Therefore, the authors feel that future research that tests new techniques or instruments contributing to relational coordination will aid the field.
Publication history
This chapter is under review in the Project Management Journal.
Chapter 4: The Dynamics of Inter-Organizational Decision Process Coordination: A Multiple Case Study on Large Railway Projects

Abstract

Inter-organizational transportation projects are increasingly difficult to manage because of a need to coordinate complex interdependencies pertaining to railway infrastructures with increasing levels of utilization. Additionally, although the railway system stakeholders have limited power to dictate each other’s behavior, they nevertheless need to collaborate. In this paper, the dynamic behavior of coordination mechanisms in the decision-making processes of inter-organizational projects of the Dutch railway system is investigated. A multiple case study on large inter-organizational railway projects is conducted, utilizing the process perspective. In doing so, particular attention is paid to the period preceding the inter-organizational project as well as the project phase. The results of this study suggest that the effectiveness of inter-organizational decision-making can be positively impacted during the pre-project phase, by emphasizing relational coordination in safety- and capacity improvement projects. We find a reinforcing relationship between trust and mutual understanding among stakeholders by means of relational coordination mechanisms. The degree of mutual trust and the existing governance structures ultimately influence the efficiency of project coordination. The mix of qualitative research techniques combined with such a rich data set enriches our understanding of the dynamic behavior of coordination mechanisms, beyond just studying simple deterministic relations.
4.1. Introduction

Public transportation organizations have to coordinate increasingly complex interfaces in large inter-organizational projects. Previous literature has shown that projects demonstrate critical shortcomings at the interface of two or more collaborating and risk-sharing organizations, despite awareness of the inherent complexity of the project. These shortcomings can lead to failures, delayed implementation and increased costs (Flyvbjerg et al., 2003). An example of this is the failed implementation of the FYRA high-speed train, in the Netherlands, which resulted in the decommissioned train series after a brief period (van Silfhout & van den Berg, 2014). Two reasons for this failure were conflicting interests of stakeholders during shared decision-making processes and limited success in recognizing the need for coordination across organizations.

Large-scale projects, such as FYRA, typically feature decision-making processes in which interdependent and complex tasks must be executed at different times by various actors whose interests often conflict (Levitt & Scott, 2017; A. Pitsis et al., 2018). The operations research literature on complex inter-organizational business environments has focused on optimizing collaborative decision-making problems (Lu, Lau, & Yiu, 2012). However, since not all relevant information is readily available or quantifiable, this article adopted an organizational and management science perspective. When considering decision-making processes from a project management perspective, it was found that stakeholders have different risk appetites (Lehtiranta, 2014) and different value creation approaches (Morris, 2013), which may diminish the trust between project actors (Van Marrewijk et al., 2016) and pose a challenge for successful completion of large-scale projects. Given the difficulties in building consensus among various actors, who are often accustomed to different project management approaches, coordination mismatches in decision-making processes may occur at the inter-organizational level (Flyvbjerg, 2014; Van Marrewijk et al., 2016). Relational coordination appears to be important in such environments (Maylor & Turner, 2017) but is often undervalued in inter-organizational collaborations (Hammervoll, 2011). Hetemi et al. (2020) identify two important focal points for understanding project decisions: the consideration of the inter-organizational network of actors at the front-end of such projects, and the importance of investigating these projects from a process perspective. To this end, they acknowledge that much can still be gained from understanding coordination mechanisms of decision processes in large-scale project settings.

The core argument of this paper is that the inter-organizational context and its complexities are central to the effectiveness of coordination mechanisms (Maylor & Turner, 2017). Due to the realization that there is no ‘one-size-fits-all’ approach to project management, more nuanced project coordination has been called for (Söderlund et al., 2017). Additionally, the front-end of the project has a major impact on the effectiveness of the decision-making processes during the inter-organizational project as a whole (Hetemi et al., 2020). The effectiveness of the decision-making process is here understood in terms of the pace of the process and perceived success.
of the decision by its stakeholders. In this paper, the front-end of projects, when the network of actors starts to interact, but no project has been formally established, is referred to as the pre-project phase. We posit that the coordination efforts in the pre-project phase is highly relevant in the decision-making process because projects are still flexible and there is a lot of leverage at this stage. Another important point of attention to gain a more rigorous understanding of the dynamics of project coordination is the process perspective (Aaltonen, Ahola, & Artto, 2017). This is widely underestimated in project management research, since most research in project management uses methods focused only on one point in time. Perpetual decision-making processes in large-scale projects imply that project environments are dynamic and changing (Hetemi et al., 2020). Ultimately, this nature leads to variations in the functioning and effectiveness of coordination mechanisms in different phases of the project. Accordingly, coordination enablers and effects can be better understood from a process perspective, as they are contextualized over time.

Therefore, we pose the following research question:

**What coordination mechanisms are currently applied in decision processes in inter-organizational railway projects and how do these facilitate decision-making?**

As such, the primary aim of this study is to investigate the role of coordination mechanisms in facilitating decision-making in large inter-organizational projects of railway organizations. To do this, two large-scale projects within the Dutch railway system, namely the SAFETY project and the CAPACITY project, are empirically investigated. For the purposes of this paper, each case study has been divided into two phases: the pre-project phase and the project phase.

The Dutch railway system provides appropriate examples of situations in which vertical separation of the system can lead to conflict in the decision-making process (Broman, Eliasson, & Aronsson, 2022). The railway system can be considered to consist of various parts, which are linked and must be managed jointly (Smith, Majumdar, & Ochieng, 2012). System weaknesses must be addressed through cost-effective, multidisciplinary and innovative measures, which can only be achieved through strong governance and collaboration between stakeholders (Stamos, Myrovali, & Aifadopoulou, 2016). In order to prepare the Dutch railway system for the increased capacity demands of the future, several inter-organizational projects are currently running in parallel. Previous studies on the Dutch railway system and its projects have identified that their implementation was delayed due to insufficient knowledge of system integration, and a lack of collaboration between stakeholders (van Dongen et al., 2019). For the purposes of exploring how coordination mechanisms can facilitate decision-making in the two cases, a process model, which takes into account the complexity of the inter-organizational context, was used. This study also addresses possible enablers and implications of the coordination mechanisms presented. Coordination is understood as a way to organize the collaboration between the different railway stakeholders.
The remainder of this article proceeds as follows: firstly, the main theoretical implications of coordinating large inter-organizational projects are discussed. Secondly, the research design is presented, with an emphasis on the process perspective. Thirdly, the case studies are introduced, and the results of the individual case analyses are presented. Fourthly, the cross-case analysis findings are presented, discussed and reflected on, followed by addressing the limitations of this study. Finally, recommendations for future research are presented, as well as our conclusion.

4.2. Coordination of inter-organizational projects

This section discusses the state-of-the-art of coordination research in inter-organizational projects, in particular in relation to decision-making and system integration. Moreover, the dynamics of project coordination mechanisms are outlined, which altogether outlines the research need.

4.2.1. Large-scale projects in transportation

Large inter-organizational projects are “large-scale, complex ventures that typically cost US$1 billion or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people” (Flyvbjerg, 2017, p. 2). Although a clear trend towards more research on these projects can be observed in recent years, literature on these large-scale projects is rather lacking cohesion at this time. As such, the field of project management research currently lacks a solid understanding of why large-scale projects underperform (Lenfle & Loch, 2016). The need to understand such underperformance is particularly high in the transportation sector, since many large-scale projects take place in this field, and due to its direct impact on society (Flyvbjerg, 2017) and its contribution to the world’s increasing need for economic growth (Söderlund et al., 2017).

4.2.2. Coordination requirements in railway projects

Historically, the body of project management concepts has strongly reflected a predominately positivist worldview, corresponding to a ‘hard system’ and ‘best practice’ perspective (Maylor et al., 2018), while more recent research indicates the value of a contingency view in the management of highly complex projects (Dahlgren & Söderlund, 2010). Moreover, research on large-scale projects is often conducted using an outside perspective which limits the possibility for gaining an understanding of what happens within the ‘black box’ of projects. As such, understanding the dynamics inherent in complex projects is crucial to revealing the coordination performed in large-scale projects. Likewise, the dynamic complexities of the project context provide particular challenges, both in practice and theory, mostly due to their variable nature since they consist of structural (e.g. interdependencies), socio-political (e.g. people), and emergent (e.g. uncertainties) elements (Geraldi et al., 2011; Maylor et al., 2018). Therefore, the context of railway projects seems to be highly appropriate for investigating the functioning of coordination mechanisms, because it demonstrates particular complexities due to the influence of system integration and joint decision-making activities. When applying a contingency approach, the
types of complexities that arise from the unique elements of the context of inter-organizational projects can best be addressed by means of customized coordination responses (Maylor & Turner, 2017). As such, it can be stated that, the context appears to be an important aspect of understanding the role of organizational coordination mechanisms of railway projects.

4.2.3. Contingencies for railway system coordination

According to Söderlund et al. (2017), more information is needed on the dynamics of coordination mechanisms in large-scale projects to discover their ‘black box’ and discover the inner workings of large inter-organizational projects. Coordination mechanisms are particularly important at interfaces where several subprojects and stakeholders need to be organized, since these mechanisms aid in managing interdependencies and in gaining a mutual understanding regarding these interdependencies (Lilliesköld & Taxén, 2006). One of the fundamental works on linking interdependencies with coordination mechanisms has been authored by Thompson (2017), who identified three types of interdependencies with increasing complexity, which are addressed by means of corresponding coordination mechanisms. The work of Maylor and Turner (2017), who have developed a contingency approach to the coordination of project complexities, is specifically focused on project management. They distinguish between three different forms of coordination, namely planning & control, relationship-development, and flexibility, each of which addresses distinct project complexities. Recent literature finds that in particular planning- and relational coordination efforts have a positive effect on project effectiveness and efficiency (Sicotte & Delerue, 2021). In the previous sections, it was noted that project complexity in the railway system context is influenced by system integration and shared decision-making activities. Additionally, the dynamic nature of inter-organizational projects is a crucial aspect which impacts the coordination efforts.

4.2.4. The role of system integration & decision-making in railway project coordination

According to Artto et al. (2016), system integration, which is a critical element of railway projects (Rajabalinejad, Frunt, Klinkers, & van Dongen, 2019), requires particular attention to coordination. System integration is complex because multiple interdependent organizations must work together to create operational value (Artto et al., 2016), while having individual interests (Levitt & Scott, 2017; A. Pitsis et al., 2018) and distinct value creation approaches (Morris, 2013). Often system integration is coordinated for too late, leading to significant higher costs and inflexible interface mechanisms (Tao, Zophy, & Wiegmann, 2000). In this context, Artto et al. (2016) note that establishing a coordinating body is an important integration mechanism at the beginning of the system lifecycle (i.e., the project phase). They consider the front-end of the system lifecycle to be the project phase and as such do not pay special attention to the pre-project phase. In line with this, Tao et al. (2000) find that proper project definition is crucial for system integration to prevent conflicting views on the business model.
Due to the organizational interdependencies and the often misaligned interests of the project participants, conflict and, ultimately, the failure of coordination within these decision-making processes can occur (Flyvbjerg, 2014; Van Marrewijk et al., 2016). One reason for this misalignment is differences between the parties’ risk appetites (Lehtiranta, 2014). Furthermore, conflict may also occur due to disagreements related to unclear roles and responsibilities, which, in turn, can decrease the level of trust between stakeholders (Van Marrewijk et al., 2016). Moreover, understanding the context of project decisions can facilitate recognition of the mechanisms that enable project success (Hetemi et al., 2020). According to these authors, especially the pre-project phase affects inter-organizational project decisions. While acknowledging the need to consider the inter-organizational context and the network of actors in decision-making, they do not explicitly address the existence of pre-project coordination and its impact on project decisions. Nevertheless, there is a need for coordination between parties in the pre-project phase due to the scale of the network of actors and their inherent interdependencies within the inter-organizational context (Flyvbjerg, 2014; Hetemi et al., 2020).

4.2.5. Dynamics of project coordination mechanisms

In recent years, research in the field of organizational studies has increased interest in understanding how and why (coordination) mechanisms evolve in an organizational setting (Sydow & Braun, 2018). Because of this, research on decision-making has progressed from considering a single point in time to a process perspective that captures the pattern of decision-making behavior which progressively constrains options for action over time (path dependence). More recently, this concept has also been observed in project management (Aaltonen et al., 2017), where the complexity of decision processes can be understood through investigating (coordination) mechanisms and their effects. A technique based on understanding the relation between context, mechanisms and effects is so-called CIMO-logic (Context, Intervention, Mechanism, Outcome). Denyer et al. (2008) use CIMO-logic in an organizational setting to gain an understanding of how mechanisms work by examining context, interventions, and outcomes. This concept can also be applied in the context of large-scale projects to gain an understanding of the effects of coordination mechanisms on decision-making.

Furthermore, by understanding coordination mechanisms, processes and their interdependencies can be illuminated, providing explanations for contexts and outcomes (Pajunen, 2008). This is particularly important for gaining an understanding of the inner workings of projects, which is currently lacking. The process perspective views the context as dynamic, generating unexpected and largely uncontrollable chains of activities over time (Langley, Smallman, Tsoukas, & Van de Ven, 2013). Therefore, a process perspective appropriately captures the differences in the coordination mechanisms underlying the activities performed in the pre-project phase and the project phase itself. In summary, it is necessary to understand the inner workings of projects in the context of the railway system, where interdependencies between organizations are high and where joint decisions must
be made even though interests are not perfectly aligned. This highlights the need for coordination, to allow for system integration. There is interest in understanding the dynamics of coordination mechanisms in large projects (Söderlund et al., 2017). This can be achieved by studying the changes in the use of mechanisms between project phases, as well as their enablers and effects, which provides a more accurate understanding of the inner workings of large inter-organizational projects.

4.3. Methodology

The methodology section introduces to the research design and case selection. Particular attention is paid to the data collection and analysis to stress the quality and rigor of this qualitative case study.

4.3.1. Research design

To understand the dynamics of coordination mechanisms in large inter-organizational projects, especially during the pre-project phase, an explorative comparative case study design was adopted (Yin, 2003). This paper employs a mixed-method approach, combining a number of qualitative research techniques. This approach allows for a more accurate investigation of the inner workings of project decision processes. Yin (2003) considers the case study method to be most appropriate when the context is strongly relevant to the subject. As discussed in the review of the literature, this also holds for large inter-organizational projects (Maylor et al., 2018). Furthermore, employing a process perspective aids in understanding how and why events develop (Langley, 1999), which assists in uncovering the ‘black box’ of large projects (Maylor & Turner, 2017), and also provides insight into the dynamics of the decision-making process. The use of the process perspective is particularly prominent in research on organizational decision-making (Mintzberg, Raisinghani, & Theoret, 1976). Therefore, a case study approach, employing a process perspective, is well suited to identifying the dynamics of coordination mechanisms in inter-organizational decision-making processes. Langley (1999) further outlines that a combination of several methods can be used to meet the objectives of a study, as different steps of the methodology may address distinct aspects of the case. This is why several different data analysis methods were combined, thus enhancing data triangulation and the rigor of the study. The unit of analysis of this case study is a large inter-organizational project, whereas the unit of observation is an inter-organizational project team working within the larger project.

4.3.2. Case selection

The embedded cases were selected based on their distinct characteristics regarding the involvement of actors, timeframes and themes, while simultaneously being sufficiently similar in their technical aspects to enable comparative analysis. Inter-organizational projects within the context of the Dutch railway system constitute a suitable research context because of several (parallel) initiatives to prepare the railway system for future demands, resulting in large infrastructure projects. These projects are needed since the Dutch railway network is one of the
most congested networks of Europe and demand is still expected to grow (Schipper & Gerrits, 2018). To facilitate data access, the authors set up a multi-year research project with the two main stakeholders of the Dutch railway system, in this paper referred to as railway undertaking (RU)\(^3\) and infrastructure manager (IM)\(^4\), to answer the queries examined in this paper.

Two embedded project initiatives within the larger inter-organizational projects were selected as cases to be analyzed. Namely: the improvement of the train safety system braking criterion, as part of the inter-organizational SAFETY project, and the design of a new train type as part of the CAPACITY inter-organizational project. Both cases align with the purpose of this study since effective coordination facilitated a decision that was accepted by all participating parties. The cases differ in various aspects, such as the time frame, the involvement of stakeholders, political pressure, and the value placed on different decision criteria. The two embedded cases facilitate analysis of reoccurring patterns of emerging coordination mechanisms across cases, allowing rich and detailed analysis. A summary of the case characteristics can be found in Table 4.1.

Table 4.1. Case characteristics of the studied decision-making process based on van der Mark, Das, Metzlar, and Oudshoorn (2018), Ministerie van Infrastructuur en Waterstaat (2020a), and internal project documentation.

<table>
<thead>
<tr>
<th>Case characteristics</th>
<th>Case study 1: SAFETY</th>
<th>Case study 2: CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeframe</td>
<td>2012-2021</td>
<td>2013-2028</td>
</tr>
<tr>
<td>Budget</td>
<td>160 million euros + extra costs covered by the responsible railway organization</td>
<td>450 million euros</td>
</tr>
<tr>
<td>Main actors</td>
<td>RU, IM, Ministry of Infrastructure- and Water Management (GOVT)(^5), inspection</td>
<td>RU, IM, GOVT, IB</td>
</tr>
<tr>
<td></td>
<td>body (IB)(^6)</td>
<td></td>
</tr>
<tr>
<td>Decision criteria of sub-project</td>
<td>Safety improvement, operational impacts, capacity impacts, driver autonomy, energy efficiency, public perception</td>
<td>Degradation of track stability, operational impacts, capacity impacts, complexity &amp; robustness of the system, market risks</td>
</tr>
<tr>
<td>Divergent interests of sub-project</td>
<td>Minimize operational impact (RU) vs. improve safety level (IM, GOVT, IB)</td>
<td>Passenger growth (RU) vs. track stability (IM)</td>
</tr>
<tr>
<td>Objective of sub-project</td>
<td>Improve system safety</td>
<td>Improve transport capacity</td>
</tr>
<tr>
<td>Decision responsibility of sub-project</td>
<td>RU</td>
<td>RU, IM &amp; GOVT</td>
</tr>
</tbody>
</table>

\(^3\) Also known as NS  
\(^4\) Also known as ProRail  
\(^5\) Also known as IENW  
\(^6\) Also known as ILT
4.3.3. Data collection and analysis

Data collection was carried out through semi-structured interviews and internal case documentation. The semi-structured interviews were transcribed and verified with the interview partners. As described by Langley (1999), a combination of several data analysis strategies can be combined to aid in learning from process data. Information about the data sources and the interview guide can be found in the appendix (Table A1.1-A1.4 and A4). During the data analysis period, this study used thematic analysis to learn from the collected data (Braun & Clarke, 2006). Methodologically, this combination of data analysis steps is especially suited to learn from rich and holistic data. Figure 4.1 shows an overview of the conducted data analysis steps.

Figure 4.1. The data analysis process.

4.3.3.1. Within-case analysis using CIMO-logic

A chronology of events has been established by studying the available documentation (i.e., presentations, reports, government documents, letters, and other communications) and observing relevant outcomes of meetings. Subsequently, the chronology of events was divided into two distinct time intervals using temporal bracketing (T1 and T2) (Langley, 1999), with T1 being the pre-project phase and T2 being the joint project/working group phase. This is in line with the introduction, where the conceptual differences of the two phases are outlined. Temporal classification is a strategy used in process research to sort descriptions of events (Langley, 1999). Typically, the basis on which each period is determined depends on some continuity in activities, in this case, the pre-project phase and the project phase. This provides the added advantage of allowing the comparison of units of analysis more easily (Langley, 1999). Temporal bracketing was recently successfully applied in a study concerning project management and decision-making to determine the occurrence of lock-in effects (Hetemi et al., 2020), further emphasizing the possible fit for this study.

For each time interval (T1 and T2), interview partners who were active in the project at that time were selected. Some interviewees were active in the project during both time intervals, which meant that special care had to be taken during
the coding step. For each time interval, the so-called CIMO-logic was applied, in order to understand the functioning of the project, and to identify the role of the predominant coordination mechanisms. CIMO-logic deals with the development and understanding of the mechanism, as well as the results of the implementation of the design proposals once field-tested. Applying CIMO-logic requires a strong focus on the context in which the design proposals are applied, which provides a comprehensive learning process (Denyer et al., 2008). The rich data this yields helps to improve understanding of the inner workings of the project. This approach employs the following logic: “in this class of problematic Contexts, use this Intervention type to invoke these generative Mechanism(s), to deliver these Outcome(s)” (Denyer et al., 2008, pp. 395-396). Akkermans, Van Oppen, Wynstra, and Voss (2019) also used the CIMO-logic in their research design to develop collaborative key performance indicators in inter-organizational partnerships, and as such, its fit for the inter-organizational context was demonstrated. Moreover, CIMO-logic has previously been used to identify mechanisms that have been triggered by interventions applied in a certain context (Mazzocato, Savage, Brommels, Aronsson, & Thor, 2010).

In order to apply CIMO-logic to the two cases, a thematic analysis with a hybrid approach was applied, using both inductive and deductive reasoning (Swain, 2018). This hybrid approach is a seven-step iterative process, inductively learning from the data as well as deductively incorporating theory in the coding scheme. For the inductive part, the semi-structured interviews were coded using open coding (Strauss, 1987) with AtlasTI software. Subsequently, the role of coordination mechanisms was explored through deductive reasoning, using the CIMO-logic as themes and the Complexity-Response Framework (Maylor & Turner, 2017) as main theoretical base for the codes. The resulting combined priori- and posteriori codes can be found in Figure 4.2.

To provide an example of the coding scheme based on thematic analysis, when an interviewee stated the following: “…irrespective of the various commercial interests, there are also safety interests to keep in mind. Finding a preference everyone agrees to is, therefore, a challenge…”, this statement was sub-coded as “conflicting priorities”, which fits into the code of “socio-political complexity”, which in turn is part of the theme “context” (see coding structure (Figure 4.2)). The CIMO-logic analysis resulted in a profile of the triggered inter-organizational coordination mechanisms in both time intervals of the two cases.
Figure 4.2. The coding structure employed in this study.

4.3.3.2. Cross-case analysis

The determined CIMO-logics of the two intervals are contrasted in a cross-case comparison. For this purpose, pattern matching is performed across cases, in order to relate the observed empirical patterns and draw conclusions about the functioning of coordination formation (Sinkovics, 2018). In this way, the drivers and effectiveness of the predicted coordination mechanisms in the specific context can be determined. The pattern as analyzed is presented in a causal loop.

4.3.4. Validity and reliability

This study uses several approaches to ensure validity and reliability of the cases; see Table 4.2 for more details.
Table 4.2. Approaches used to increase validity and reliability.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Approach</th>
<th>Research phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>Multiple sources of evidence: semi-structured interviews, internal project documentation, observations</td>
<td>Data collection</td>
</tr>
<tr>
<td></td>
<td>Project members review interview transcripts and results of analyses; key stakeholders review case study report</td>
<td>Composition</td>
</tr>
<tr>
<td>Internal validity</td>
<td>Focused coding using a predefined analytical framework</td>
<td>Data analysis</td>
</tr>
<tr>
<td></td>
<td>Pattern matching (cross-case comparison)</td>
<td></td>
</tr>
<tr>
<td>External validity</td>
<td>Literal replication logic: same system, same collaborating parties, different teams, different issues to solve</td>
<td>Research design</td>
</tr>
<tr>
<td>Reliability</td>
<td>Case study database: the chronology of events</td>
<td>Data collection</td>
</tr>
<tr>
<td></td>
<td>Data source tables: Appendix Table A1.1 - Table A1.4</td>
<td></td>
</tr>
</tbody>
</table>

4.4. Case analysis

As part of the case study analysis the railway system context is described first to get an understanding of the complexities that play a role in the Dutch railways. For both cases, first a within-case analysis is carried out looking into both time intervals T1 (pre-project phase) and T2 (project phase). In the cross-case analysis these two time intervals over the two cases are compared with each other outlining the differences in coordination mechanisms employed and its effects.

4.4.1. The railway system context

Train-track interface issues within large inter-organizational projects in the railway system are characterized by interdependent organizations working for their interests (Thanh, Madelin, Roberts, & Tobias, 2010). Darling (2004) previously identified that the splitting up of the British railway system into separate entities has led to individual authorities having overlapping responsibilities, which has caused ineffective decision-making, and conflicts. This is, for instance, because most of the employed approaches focus on optimizing the benefits for the infrastructure manager or railway undertaking, not taking into consideration the interests of other railway stakeholders (Prodan & Teixeira, 2018). Similarly, in the Dutch railway system, the responsibilities for train operations and infrastructure management are split (van Dongen, 2015), which affects the performance of shared projects. Although the need to integrate the railway system into a cohesive whole has been recognized by stakeholders, the piecemeal optimization of components, rather than focusing on the integral system, leads to inefficient and inconsequential decisions (Thanh et al., 2010; van Dongen et al., 2019).
As such, inter-organizational projects in the Dutch railway system provide a promising ‘black box’ to investigate, since they meet the main requirements for this study, namely: large transformational and long-lived projects; many stakeholders with distinct interests; overlapping roles & responsibilities; many inter-organizational interfaces that require coordination to facilitate decision-making.

4.4.2. Within-case findings

4.4.2.1. Case 1: Initiative to improve system safety

GOVT initiated the SAFETY project in 2012 to reduce the number of safety-related incidents (van der Mark et al., 2018), which are analyzed through the signals past danger (SPAD). To mitigate this, railway operators must consider whether additional safety measures should be taken. One such undertaking is the improvement of the braking criterion of the train safety system (case 1). Figure 4.3 shows a chronology of the main events, including the separation into T1 and T2 and their corresponding main coordination mechanisms. Figure 4.3 is used to familiarize researchers with the events and activities of the case and thus influence the thematic analysis.

Figure 4.3. The chronology of events for T1 of the SAFETY case.

T1: pre-project phase

The initial context of the SAFETY case is marked by a number of structural and emergent complexities, but primarily by socio-political issues. In instances of structural complexity, the level of organizational interdependency was high, and the scope was extensive, including many differing expert opinions. Concerning the socio-political complexities, three main aspects were observed, namely disagreements between the commissioned project staff and organizations, conflicting priorities, and politics. Regarding the disagreements between the commissioned project staff, there were cultural conflicts as the two organizations worked in different ways, one being more bureaucratic and the other more hands-on. Additionally, the experts involved in problem solving acted from different perspectives, as they had different safety-related backgrounds; some had worked with safety methods for a long time, while others were relatively new to the field. This resulted in divergent understandings of the problem, of how the risk of future safety incidents has to be comprehended, and therefore the need to mitigate this risk was judged differently.
As for conflicting priorities, it was mentioned that due to the different interests of the main stakeholders, disparate solution possibilities were preferred. IM focused on optimizing technology, while RU preferred a process solution that aligned with their goal of higher customer satisfaction. The disparate goals led them to take different levels of risk regarding the impact of appropriate solutions, which ultimately did not lead to a preference for the same options. As such, politics played a significant role in this case. One party attempted to put pressure on the other to make a decision in its favor, by including other key railway stakeholders. Additional safety incidents in the railway system made the issue more sensitive, which added emotional value to the matter. Finally, a number of emergent complexities were present, such as uncertainty about the impact of the proposed solutions, since not all information was available yet. This was due, in part, to the rotation of team members in the safety department.

To address these complexities, in the first 4.5 years (T1), no major interventions were made in the ‘normal functioning’ of the main participating organizations. The organizations formed their opinions on issues individually, within their respective departments. After coming to their conclusions, they tried to persuade the other party, for which a number of bilateral discussions were held.

These discussions resulted in a low level of shared problem understanding because divergent assumptions and principles were not clarified from the beginning. Due to the different goals of the stakeholders, different solutions were also favored. Due to the pressure exerted on the issue, there was a significant drop in the level of trust between the parties. Finally, in 2014 an impasse was reached, emphasizing the need for a different approach.

The most important mechanisms that resulted from the mode of operation was coordination by means of planning & control. Individual planning of how to proceed and what is in the individual best interest was conducted. Furthermore, pressure to decide in one’s favor was exerted, leading to decreasing levels of trust and increased uncertainty, and in turn, to more controlling behavior. Any other mechanisms employed were merely supportive and not very pronounced. An overview of these results can be found in Figure 4.4.

![Figure 4.4. The CIMO-logic of T1 of the SAFETY case.](image-url)
T2: Inter-organizational project phase of RU & IM

The context remained virtually unchanged from T1, since no significant progress was made with respect to the topics addressed; no shared understanding of the problem had yet been reached, and no agreement on the way to proceed existed. If anything, the duration of this matter made it even more complicated, as evidenced by the dwindling trust between the stakeholders.

To address the complexities discussed above, a joint project was set up to conduct a pilot study in order to investigate the consequences of the preferred solution. Several actions were taken as part of the joint project to ensure success. Firstly, the project team defined common agreements and criteria, including both process agreements and decision criteria, based on shared railway system interests. Additionally, engaging in this project improved collaboration levels between the organizations. More openness was created by making the process and decision criteria transparent, and cooperation between organizations was intensified. More holistic communication efforts were made to support the case. Informal activities were organized, and continuous inter-organizational communication channels were established, in order to include all key stakeholders. Joint awareness activities were introduced to create a better common understanding of the problem. For example, several integral stakeholder meetings were organized and the Dutch BOB-Model, which involves picture formation, judgement forming, and decision-making was applied to provide decision-makers with a common view of the situation. In general, the pilot study facilitated the formation of a shared understanding of the impacts of the decision.

Aided by the more properly aligned understanding of the problem, the identification of common goals, and the pilot study, a decision was arrived at, accepted and implemented by the participating organizations. The interventions resulted in improved relationships within the project group and between stakeholders. Efforts to create a shared view of the situation and a shared understanding of the problem, facilitated an improved relationship between project members and decision-makers. A shared planning & control approach was a supporting mechanism that was particularly effective in the implementation of the pilot study. Figure 4.5 presents an overview of these findings.
4.4.2.2. Case 2: Design of a new train type

The large-scale CAPACITY project is an initiative of GOVT and was initiated to prepare the railway system for growing passenger demand. The aim is to increase the capacity of the railway system in order to prepare it to meet the projections concerning the public transportation system in 2040. One of the CAPACITY projects was the design of a new train series (case 2). A chronology of the main events, including the separation into T1 and T2, and their corresponding main coordination mechanism, is shown in Figure 4.6. The researchers use Figure 4.6 to familiarize themselves with the events and activities of the case and therefore it has an influence on the thematic analysis.

Figure 4.6. The chronology of events for the CAPACITY case.

T1: pre-project phase

T1 is a relatively short time interval of only 6 months (January 2018 – July 2018), after which the decision was taken to start a shared working group. This indicated that the need for collaboration was recognized early into this process.

The context of the CAPACITY case is characterized by many socio-political issues, and some structural and emergent complexities. Where structural complexities
were concerned, organizational interdependencies made the decision more difficult, as responsibilities were divided across the organizations, and the decision of one party had far-reaching effects on the other. This made it difficult for both parties to accept all the risks of the decision. Regarding the socio-political complexities, the individuals involved from both organizations have different backgrounds (technical vs. commercial departments), and therefore had different perspectives on the problem. On the one hand, some project members argued that a problem regarding infrastructure congestion can be recognized based on local data. On the other hand, dissenting project members felt that there was insufficient data to assess the existence of a problem. Additionally, the two organizations had different goals: IM wanted to limit impacts on infrastructure stability and maintenance, while RU wanted to optimize the capacity of the railway system. As a result, it was difficult to get people to focus on common interests rather than advocate for their own party’s demands. Recent events related to infrastructure stability caused interests to diverge even further, which also affected the interpersonal behavior of participants. As far as emergent complexities were concerned, initially the exact consequences of the proposed decision could not be determined based on the available data, which led to uncertainties about the impacts. Additionally, new employees who did not yet have all the required knowledge were present in the departments.

Regarding interventions, RU was studying possible design choices for their new train series, which touched upon limits regulated by IM. This led to a customer request to increase the pre-set limit, and bilateral exchanges of viewpoints between the two main organizations were organized.

Due to strongly divergent viewpoints, this became a sensitive topic. This may be due to the long-running history of the issue, as it often comes up when new rolling stock is introduced. This, as well as a reduced willingness to compromise on the part of IM, led to lower levels of trust. Participants found it difficult to stick to fact-based arguments during bilateral viewpoint discussions. Ultimately, the awareness of the need for a different collaboration method, led to the establishment of a joint working group.

The main mechanism observed was planning & control-based coordination. RU designed the train based on their preferred features and requested that the other party relax the infrastructure limit. An overview of these findings can be found in Figure 4.7.

Figure 4.7. The CIMO-logic of T1 of the CAPACITY case.
T2: Inter-organizational project phase of RU & IM

The context of T2 is very similar to that of T1, except for the reduced level of trust between the parties.

To address the issue, RU approached a department of IM to set up a joint working group, which was tasked which reaching a consensus on this issue. In order to achieve this, the working group began by defining common goals and areas of focus, to align decision criteria, and prioritize problem areas. The project manager of IM phrased it as follows:

“They decided to prioritize two main issues relevant for the design phase of the overall RU project. [...] Together, they formulated a process goal, namely, to get agreement on hard decision criteria. [...] Finally, they achieved a compromise by showing experts what the interests and benefits for the railway system as a whole are, when choosing a certain type of material. Furthermore, the pressure from RU helped to make the interests of both parties explicit very early on to find commonalities.”

A governance model, which was specifically developed to address interface issues between IM and RU, was implemented to separate content from process, and to divide the working group accordingly. The person responsible for implementing the governance model stated:

“The idea was to split the project team into a relatively small process-related group, dealing with the problem and preparation of the decision, and a larger knowledge acquisition, and -sharing group, to establish a knowledge base around the issue. This ensured that no premature decision based on content alone was made.”

Additionally, cooperative interventions were used, such as open discussion of mutual expectations and the use of stakeholder management. Joint awareness activities were carried out, such as the regular exchange of viewpoints and the use of various communication channels to create a shared view of the situation. Another priority was starting from common interests. This was achieved by appointing a good facilitator, who coordinated between the different members to build consensus and create awareness of the externalities of the proposed solution. For example, the interface expert of IM identified a number of success criteria, namely:

“RU and IM together achieved a good overview of what each of them wanted: a [...] train that met the capacity requirements but at the same time limited the excess load, ensuring. Discussion of the high-level requirements helped the process of establishing a compromise. [...] Generally, the project manager did a great job in facilitating the discussion, considering the many conflicting interests.”

Using this group structure and communicating in sequence and not surprising the other party with made decisions, but involving them in the process, openness was achieved. Furthermore, information was followed up on before it was shared. Finally, insights about the possible solutions were used to learn from and adapt the proposed path.
As a result of the interventions, a compromise was established within the team and a consensus was reached among the decision-makers. Additionally, most members of the working group expressed trust in further cooperation with the other members.

In conclusion, the interventions made led to better relations in the working group, and ultimately also strengthened trust in the project team. These interventions included shared sensemaking activities, good facilitation and communication within and pertaining to the working group, and regular updating of the decision-makers. Moreover, the separation of content and process, and the associated communication structure, allowed for more flexibility. By merit of an early definition of joint goals, planning & control proved to be a successful supporting mechanism. Figure 4.8 presents an overview of these results.

Figure 4.8. The CIMO-logic of T2 of the CAPACITY case.

4.4.3. Cross-case findings

The results of the empirical analysis show that two main coordination mechanisms were used, namely, planning & control and relationship-development. In the following sections, the situation in which these mechanisms were employed, as well as and their effects are compared. Due to the fact that flexibility as a mechanism was barely recognized, this will not be extensively covered in the discussion.

4.4.3.1. Planning & control

Coordination through planning & control occurred in both cases, mainly in the pre-project phase (T1), during which joint activities were limited, and individual planning & control activities predominated. Possible reasons for the predominant focus on planning & control are the organizational culture, which has been built on such project management methods, and the distribution of power, which tends to be top-down focused, with GOVT having a supervisory and controlling role (van Dongen, 2015; van Dongen et al., 2019). The singular focus on planning & control coordination has led to trust issues between key parties, as well as low degrees of mutual understanding of the problem and disagreements regarding solution selection. Ultimately, this led to an impasse in decision-making. The projects differ
in the length of time that this approach has dominated them. In case 1, the pre-project phase lasted for 4.5 years, after which it was recognized that there may be more effective ways to coordinate. During the implementation of the pilot study, the actors started a shared project. In case 2, RU became aware of this issue early on in the project and intervened after several months of studying the issue by establishing a joint working group.

4.4.3.2. Relationship-development

The mechanism of relationship-development was set in motion by the actions taken after an impasse was reached. The organizations became aware of the need for a joint approach to solving the problem. Consequently, a joint project/working group was initiated in which both organizations collaborated. In both cases, this resulted in an accepted decision in a suitable amount of time. In particular, in the first case, the pace of the project increased once the joint project started. Moreover, in both cases, the measures chosen to address the situations are comparable, as shared sensemaking activities and calls to work on common interests were acted on, in order to improve the relationship, which ultimately led to increased levels of trust between the parties. There were also differences between the two cases: in case 1, the parties were able to jointly demonstrate that the chosen solution had a low degree of negative impact on their respective interests. Case 2, however, was about finding a compromise based on common interests.

4.4.4. Toward a generic understanding of railway project coordination

A summary of the facilitating and hindering factors of the two coordination mechanisms for the decision-making process can be found in Figure 4.9. In the figure, the four CIMO-logics (Figure 4.4, 4.5, 4.7, 4.8) are also synthesized using general knowledge about the system (i.e., the hierarchical power structure) for additional explanations. As illustrated in Figure 4.9, two factors are identified that influence the use and development of coordination mechanisms in two different ways.

![Figure 4.9. The causal loop diagram showing the behavior of the coordination mechanisms.](image)

4.5. Discussion

The following section discusses the important findings on the coordination of inter-organizational decision-making processes by outlining the implications that
were identified in both cases individually. The cross-case findings are then discussed and placed in the context of the existing literature.

4.5.1. The within-case findings

This type of in-depth case assessment, which looks at the development of decision-making processes in inter-organizational projects, is particularly useful for improving understanding of what happens in the “black box” of projects. As such, it has been shown that by using process methods, railway organizations are better equipped to understand the behavior of critical mechanisms in coordinating decision-making. By not limiting the investigation to a single point in time, but rather following the development of the decision-making process throughout the project (Sydow & Braun, 2018), preferred coordination mechanisms can be identified per time interval. The use of CIMO-logic also takes into account the context of inter-organizational networks and provides details about when interventions lead to specific outcomes. This seems to be particularly useful in contexts as complex as the railway system, where one has to deal with strong interdependencies and conflicting interests. To this end, the interventions applied in the two cases mainly revealed the use of the coordination mechanisms of planning & control in the pre-project phase and relationship-development during the project phase. Furthermore, previous research on coordination responses by Maylor and Turner (2017) is expanded by a detailed empirical investigation of the dynamics of planning & control and relationship-development coordination in the inter-organizational system. This reveals, in addition to the addressed complexities, the phase in which the mechanisms are frequently applied and factors that support its emergence. This is further elaborated on in the discussion of the cross-case findings.

4.5.2. The cross-case findings

The hierarchical power structure and organizational culture of the Dutch railway system appear to encourage planning & control responses, which are enhanced by existing trust issues and uncertainties that accumulate between the actors involved (Figure 4.9). A possible explanation is that planning & control responses are embedded in the organizational culture due to the use of standard project management approaches, such as PRINCE 2 (Meredith et al., 2017). Additionally, the culture of the entire railway system is characterized by a planning & control approach, especially for large projects or programs. This is likely due to the fact that the government, as the financier and supervisor in the trilateral relationship, still holds power over the other parties. The larger the inter-organizational railway project, the more coordination is based on planning & control measures imposed from the top, for all entities involved, as is evident in the reporting process of the ERTMS program (Ministerie van Infrastructuur en Waterstaat, 2020b). Literature on external control and the resource dependency view notes that power imbalance and resource dependency force the dependent organization to align its actions with the interests of more powerful organizations, which thus control the behavior of the dependent organization (Pfeffer & Salancik, 2003). By imposing more control, the level of trust decreases, as has already been demonstrated by other research.
on intra-organizational settings (Wells & Kipnis, 2001). These studies show that the greater the interdependence of actors, and the greater the distrust, the stronger the motivation to control the other becomes. The findings highlight that in cases where interdependencies between organizations are strong, the similarities to intra-organizational projects are significant. Similarly, Zand (1997) has identified this inverse relationship, namely, that distrust promotes the use of control. As such, it can be concluded that over-emphasizing planning & control has decreased the level of trust, and vice versa.

Awareness of a need for coordination and adaptation, and a joint project approach, seems to facilitate the development of relationships between the parties, which in turn increases the level of trust between them and leads to improved relationships (Figure 4.9) for the decision-making process. Existing literature illustrates the reinforcing link between relationship and trust is highlighted in established literature (Fang, 2019). This paper confirms these findings, with a particular focus on coordination behavior. Furthermore, the findings suggest that especially building mutual understanding promotes trust, which, once established, contributes to an even better relationship. Previous literature has found that trust is a facilitating factor in inter-organizational relationships that contributes to knowledge sharing (Li, 2005). In highly complex projects, such as inter-organizational projects, information has to be exchanged in various forms in order to manage complexity (Kennedy, McComb, & Vozdolska, 2011). Engaging in these relational activities that allow for knowledge exchange can also help address both structural and emergent complexities. This is because collaborative practices enable ambidextrous behavior by manifesting features of processes of exploitation and exploration (Faccin & Balestrin, 2018). Nevertheless, in case project partners value investing in the relationship asymmetric often a power imbalance emerges and communication efforts are not as effective anymore (Pemartín & Rodríguez-Escudero, 2017). Especially for complex system integration questions, conducting joint sensemaking activities and focusing on common interests of stakeholders in the pre-project phase of inter-organizational projects appear to be promising interventions which facilitate a trusting relationship. This in turn can have other positive implications with regard to project success.

4.6. Conclusion

This paper investigates how coordination mechanisms can facilitate decision-making in large inter-organizational projects. The results of this multiple-case study extend the front-end focus of the system lifecycle view of Artto et al. (2016) and support the contingency view of the complexity-response framework for large-scale projects by Maylor and Turner (2017). The process perspective used in this research serves to expand our understanding of coordination mechanisms. By means of our qualitative research, the findings revealed the dynamics of the two main coordination mechanisms in both T1 and T2, as well as the enablers and effects of these mechanisms. Hetemi et al. (2020) have previously emphasized the importance of understanding prior linkages, for example, interdependencies among different
actors, before the start of the inter-organizational project. This paper contributes to this body of knowledge by explicitly considering the time before the start of the inter-organizational project and the impact of individual coordination efforts on the problem-solving progress. In doing so, this study moved beyond the system lifecycle view as described by Artto et al. (2016), which starts with a shared project setting but does not include the pre-project phase. Especially in the context of system integration, where several interdependent organizations must work together to create operational value, shared coordination efforts before the start of the project seem to be important. In doing so, it possibly helps to identify misaligned interests from the start and implement appropriate coordination efforts to mitigate these for more efficient decision-making processes.

The results emphasize the importance of building relationships in an inter-organizational context as early as possible and having planning & control mechanisms in place as supporting elements. This is an interesting result in relation to the study of Sicotte and Delerue (2021), who found the effect of the two variables reversed. They show that planning efforts contribute to the effectiveness and efficiency of the project, with relational coordination having a mediating influence. Responding to the need for research to uncover the ‘black box’ of large inter-organizational projects (Maylor & Turner, 2017), this study observes promising theoretical foundations for the application of process perspectives (Langley, 1999) using CIMO-logic and temporal bracketing. The process perspective helps to reveal the inner workings of projects, by focusing on dynamic behavior within the project. Similar advances have been made by Hetemi et al. (2020), who have studied the emergence of lock-in, in inter-organizational projects. By means of applying a process perspective, this paper was able to identify salient coordination mechanisms of large-scale projects produced in an inter-organizational setting (Levitt & Scott, 2017; A. Pitsis et al., 2018). The most prominent coordination mechanism in the pre-project phase was planning & control, whereas during the shared project phase more emphasis was placed on relational coordination. Turning the coordination efforts around and using relational coordination at the start can possibly leverage the decision-making process in complex situations where system integration is required.

The unique combination of qualitative research techniques, such as CIMO-logic and temporal bracketing, enriches our understanding of the dynamic behavior of coordination mechanisms beyond just studying simple deterministic relations. Finally, our research contributes to the value-added elements of project-oriented front-end studies (Artto et al., 2016), while recognizing that the mechanisms are subject to the project context (Hetemi et al., 2020), as demonstrated by the application of CIMO-logic (Denyer et al., 2008).

4.6.1. Managerial implications

An important implication for managers is the critical nature of the contingencies of the inter-organizational project context when deciding on the use of coordination measures, and these should be considered key starting points for project management approaches. This supports the recommendation by Söderlund
et al. (2017) to depart from classic project management practices and best-practice approaches and instead use more nuanced approaches that adapt to the realities of inter-organizational projects.

Additionally, the study demonstrates the effectiveness of coordination by means of relational development in the decision-making process of inter-organizational projects with constitutional dependencies and unaligned interests. In these contexts, interventions based on shared awareness and a focus on common interests contributed to trust building and an accepted decision. Conversely, planning & control proved effective as an adjunct rather than as the main instrument of coordination, and was more successfully applied after initial relational coordination.

4.6.2. Limitations and recommendations for future research

One of the limitations of this study is the limited predictive power of our results, since generalizing the results of our study should be done with caution (Rowley, 2002), as it only involves two cases and is not subject to quantitative analysis. This exclusion can be considered a limitation, as its absence does not allow comparison to coordination mechanisms observed in other studies. However, since the goal of this study was to gain a better understanding of the dynamics of coordination mechanisms in inter-organizational projects, this limitation can be considered minor weighed against the comprehensive and rigorous understanding gained by means of the case studies (Yin, 2003). This study was also limited by the fact that a single researcher conducted both data collection and analysis. This issue was mitigated through data triangulation (semi-structured interviews and project documentation), methodological triangulation (temporal classification, CIMO-logic, pattern matching), and repeatedly switching between the data set and analysis steps.

This study provides numerous suggestions for future research. Though focused on findings from past projects, this study identifies significant opportunities for research on the design & testing of practical interventions in the inter-organizational context using CIMO-logic from the design science research field (Denyer et al., 2008). Developing an intervention that aids in recognizing the complexities of the decision-making process in inter-organizational projects, for example, could potentially lead to greater awareness regarding suitable coordination mechanisms. Another suggestion for future research lies in the examination of the effectiveness of planning & control measures in the context of inter-organizational projects. In this analysis, planning & control appear to be effective only as supporting activities, yet investigating the effective use of coordination through planning & control could contribute to this field, given its prominence in project management.
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Disclaimer

The article uses the notion of sustainable coordination. In this context, it emphasizes the need for encompassing stakeholder engagement and a system-based approach in coordination with the aim of improving social sustainability.
Chapter 5: Co-Designing Sustainable Coordination to support Inter-Organizational Decision-Making

Abstract

Processes in inter-organizational projects tend to be complex to coordinate. Within these projects, stakeholders have to make decisions together, despite a limited awareness of the other parties’ interests and views. Frequently, coordination in inter-organizational projects is ineffective and inadequately addressed, despite the investment of considerable effort, which often results in delays and/or unwanted project outcomes. The purpose of this study is to investigate how a shared problem understanding for inter-organizational decision-making can be achieved by means of sustainable coordination. In this study, CIMO-logic was used to explore the context of organizational change, followed by the application of design science research in order to develop an intervision process. The findings of this study are twofold. To manage the complex problem context, additional efforts were needed in order to create awareness of the team’s coordination activities. The application of the concept of co-designing resulted in a higher degree of sustainable relational coordination. The resulting intervision process aided the team in gaining a shared problem understanding of the decision-making process in the inter-organizational project. The use of the co-designed intervision process can potentially be employed for other complex systematic problems, such as those occurring in the construction industry.
5.1. Introduction

Inter-organizational projects are inherently complex due to their varying levels of structural, socio-political, and emergent elements (Geraldi et al., 2011; Ramasesh & Browning, 2014). Coordination within these complex projects is particularly challenging, due to the need for managers to respond adequately to emerging complexities (Maylor et al., 2018). As such, complexities in inter-organizational projects tend to lead to coordination challenges that can often slow down project execution, and therefore increase project costs (Fiedler & Wendler, 2015). Relevant factors for projects to achieve sustainable development, not only include time and cost, but also social aspects, such as the consideration of stakeholders and their interconnections (Missimer & Mesquita, 2022). As stated by Missimer and Mesquita (2022) (p.8), enabling social sustainability requires “more robust and encompassing stakeholder engagement”, using a high-level definition of success in order to achieve effective coordination. For the purposes of this paper, the notion of sustainability refers to social sustainability.

Large-scale inter-organizational projects are typically characterized by decision-making processes in which interdependent, complex tasks must be executed at different moments, by different actors, whose interests often conflict (Levitt & Scott, 2017; A. Pitsis et al., 2018). A large number of different stakeholders, where each has their respective goals and responsibilities within the system, work on optimizing their own part of the system, possibly unaware of the complex interdependencies between the actors in the system (Missimer & Mesquita, 2022). These differences in goals and perspectives are particularly significant during the problem identification stage of the decision-making process, where stakeholders may not understand the specific problem or each other’s perspectives (Daft & Lane, 2008). These decision-making problems are often ‘fuzzy’ as information is ambiguous and difficult to quantify (Ghadimi et al., 2017). Making decisions while having limited shared problem understanding can cause stakeholder dissatisfaction and delays in the decision-making process (Jakubeit, Braaksma, Rajabalinejad, & van Dongen, 2021). Current research that focuses on understanding the complexities of decision-making processes fails to make key considerations. For example, processes in inter-organizational projects are often studied from an outside perspective, without incorporating a thorough understanding of how processes inside the projects evolve (Söderlund et al., 2017). Studies which incorporate studying the internal processes of large-scale projects can reveal why projects are underperforming (Hetemi et al., 2020). As such, a change in perspective, so that more emphasis is placed on the inner workings of large-scale projects and their relevant mechanisms for coordination is essential (Söderlund et al., 2017). Moreover, research on complex inter-organizational projects has long demonstrated a tendency towards a ‘hard system’ view, building on the ‘best practice’ perspective (Maylor et al., 2018). However, to adequately deal with the contingencies of complex project dynamics (Dahlgren & Söderlund, 2010), it is often advantageous to have an understanding of the context in which project decisions are executed (Daft & Lane, 2008). Similarly, Climent and Haftor (2021) noted that the fit of the business concept with contextual factors is an
important driver of value creation. A complicating factor in the decision-making process is the need for stakeholders to connect with knowledge sources outside their own organization in order to gain a common understanding of the problem. Such strategic processes are creative, complex and highly subjective, and as such cannot be automated and made objective (Adamides & Karacapilidis, 2020). An understanding of the complexities of the context in which decisions are made, has been underemphasized in literature up to this point (Hetemi et al., 2020). In order to address this, progress toward establishing sustainable development of decision-making processes in inter-organizational projects should include proper diagnosis of the complex problem context (Litvaj, Poniscia, Stancekova, Svobodova, & Mrazik, 2022), and employ system-based approaches which involve all relevant stakeholders (Missimer & Mesquita, 2022).

Current research on advancing solutions for ‘fuzzy problems’ often focuses on the development of technological solutions (Aliev, Pedrycz, Huseynov, & Eyupoglu, 2016; Tang & Pedrycz, 2021), which means that the socio-technical perspective (Walker, Stanton, Salmon, & Jenkins, 2008) is often underexamined. To achieve this, any developed processes and support tools need to be thoroughly integrated into the organizations (Missimer & Mesquita, 2022). To ensure this, Litvaj et al. (2022) suggest using solutions focused on interaction and communication. Such relationship-building responses appear to be important in environments where dominant socio-political complexities are present (Maylor & Turner, 2017). These environments are tightly coupled and the information propagation is temporal dynamic (Hosseini, Yin, Zhang, Elovici, & Zhou, 2018). Relational coordination, as a concept which builds on shared goals, shared knowledge, and mutual respect, in order to enable timely, frequent, accurate, and problem-solving communication (Gittell, 2006), demonstrates advantages as a basis for solution development in the fuzzy problem contexts of decision-making processes in inter-organizational projects. However, up to this point, responses based on relational coordination have often been under-emphasized in inter-organizational collaborations (Bolton, Logan, & Gittell, 2021).

In outlining the benefits of relational coordination to sustainable decision-making processes for dealing with unclear problem contexts, the goal of this study is twofold. Firstly, this paper aims to understand the complexities of the problem context of inter-organizational decision-making processes, in order to identify coordination challenges and determine the path to a well-grounded coordination fit. Secondly, this paper aims to support practitioners in dealing with such problems by means of a co-developed design which builds on relational coordination. This study focuses on inter-organizational projects in the railway sector, since these provide a context where system integration is becoming increasingly important (van Dongen et al., 2019), and where coordination can benefit from further improvement.

This results in the following research question:

*How can the shared decision-making process of inter-organizational problem contexts be better designed and coordinated?*
The paper is structured as follows, firstly, previous literature on the potential of relational coordination for sustainable decision-making processes in inter-organizational projects is discussed. Secondly, CIMO-logic (Context, Intervention, Mechanism, Outcome) and the design science research (DSR) process steps are introduced. Specific attention is given to an in-depth analysis of the unclear problem context in order to gain awareness of urgent complexities. Particularly relating to DSR, the evaluation of the design propositions plays a fundamental role in understanding how the design works in the specific context. This is followed by a discussion on how the co-designed process aids in building relational coordination for inter-organizational railway decisions and lastly, a conclusion and suggestions for further research are provided.

5.2. Literature Review

Complexities in inter-organizational processes form challenges to the coordination in projects of this nature (Maylor & Turner, 2017). Often, complex projects are coordinated by means of planning & control responses, a tendency which largely results from Thompson (2017)’s theory of interdependencies and coordination mechanisms. Nevertheless, in order for firms to stay competitive in complex situations it is critical to focus on strategies besides planning & control, such as agility (Clauss et al., 2021). In order to deal with the dynamic demands of projects, Maylor and Turner (2017) developed the complexity-response framework, in which project complexities are linked to preferred response categories. The framework can aid in representing the complexity of the problem context by providing guidance in order to make sustainable decisions by outlining suitable responses (Litvaj et al., 2022). Previous research indicates that the complexities of the problem context are often associated with institutional differences among the large number of involved stakeholders, leading to disagreements (Aaltonen & Kujala, 2010; Scott, Levitt, & Orr, 2011; Van Marrewijk et al., 2016). These arise because the stakeholders do not thoroughly understand each other’s perspectives or the specific problem (Daft & Lane, 2008). As demonstrated in a previous study, this it can result in stakeholder dissatisfaction with the decision-making process, which slows down the process as a whole (Jakubeit et al., 2021). Nevertheless, when disagreement between stakeholders occurs, it is valuable to analyze all possible ideas, which requires paying close attention to interactions and communication between stakeholders in order to allow for sustainable decision-making processes (Litvaj et al., 2022). Therefore, the focus of responses to complexities, which build on communication and interaction, is in line with Maylor & Turner’s framework, which proposes the use of responses which build relationships between the participating stakeholders, especially when dealing with conflict, politics, and lack of mutual understanding (Bolton et al., 2021; Park & Lee, 2014). Despite these benefits, responses building on relational coordination are often under-emphasized in inter-organizational projects (Gittell, 2006).
5.2.1. State of the art: relational coordination

The theory of relational coordination states that shared goals, shared knowledge, and mutual respect, support timely and careful problem-solving communication, which facilitates effective coordination among stakeholders (Bolton et al., 2021). Shared goals motivate stakeholders to look beyond optimizing sub-goals and operate with the larger project in mind (March & Simon, 1958). Shared knowledge allows for systems thinking by informing stakeholders about how their contributions, and the contributions of others, add to the larger project (Weick & Roberts, 1993). Respect for the contributions of others encourages stakeholders to value the input of others, and to consider how their own actions impact other parties involved. This strengthens the inclination to act with the larger project in mind (Van Maanen & Barley, 1984). Relational coordination is more stable when opportunities are built into both programmed (e.g., shared information systems) and nonprogrammed (e.g., multi-disciplinary meetings) coordination mechanisms. This assists stakeholders in managing their interdependencies across boundaries (Gittell, 2002; Gittell & Weiss, 2004). According to Bolton et al. (2021, p. 308) (p.308), “relational coordination has begun to evolve into a dynamic theory of learning how to coordinate work by iteratively building structures and relationships across networks of roles, even redesigning the roles themselves when needed”. Learning is a crucial aspect of team-based interventions, which focus on building relationships between the interdependent and fragmented stakeholders (Abu-Rish Blakeney et al., 2019; Purdy et al., 2020).

5.2.2. Relational coordination mechanisms in sustainable inter-organizational decision processes

Relational coordination appears to be a good starting point for addressing issues pertaining to inter-organizational decision-making in projects. Inter-organizational projects in the railway sector are likely to encounter several challenges, as indicated in the literature on relational coordination. The literature on inter-organizational decision processes has been analyzed with respect to its impact on the three building blocks of relational coordination, namely shared goals, shared knowledge, and mutual respect.

A key consideration for inter-organizational decision processes is the role of shared goals. Stakeholders in these projects need to closely collaborate, but simultaneously have limited power to dictate each other’s behavior in the decision-making process. Accordingly, Sydow and Braun (2018) indicate that inter-organizational projects are coordinated through “shared governance”, where the network is rather dense but hardly centralized, and participating organizations cooperate on a consensus basis with a low power differential. In such settings, formal mechanisms are not sufficient to capture the complexities (Müller, Turner, Andersen, Shao, & Kvalnes, 2016), implying that relational mechanisms are also needed. In line with this, Caniëls, Gelderman, and Vermeulen (2012) identified that researchers have not agreed on how to properly integrate formal and informal mechanisms. Performance problems within inter-organizational projects
originate from organizational complexity, ambiguity, and conflict between project stakeholders (Clegg, Pitsis, Rura-Polley, & Marosszeky, 2002; T. S. Pitsis, Clegg, Marosszeky, & Rura-Polley, 2003; Van Marrewijk et al., 2008). A common issue for the complex problem context is misaligned interests, which results in coordination challenges for decision-making (Aaltonen & Kujala, 2010; Van Marrewijk et al., 2016). One reason for this misalignment is differences between the parties’ risk perceptions (Lehtiranta, 2014). Additionally, institutional differences may occur, which are differences in mindsets, goals, or work practices (Scott et al., 2011). According to Van Marrewijk et al. (2016), this can lead to conflict among stakeholders, which can be addressed through the establishment and maintenance of consensus and the resolving of institutional differences. Consensus-based approaches for dealing with institutional differences are especially appropriate in the problem identification stage of the decision-making process, when problems are still unclear (Daft & Lane, 2008). Diagnosing such complex problem contexts requires communication and interaction, Litvaj et al. (2022) suggest this can be achieved by using the “5 x why?” approach. This approach corresponds to what Maylor and Turner (2017) call the relationship-building response. Continuing this line of thinking, this paper hypothesizes that relational coordination activities are able to facilitate more sustainable decision-making processes.

Another point of concern in inter-organizational project coordination is the stakeholder’s need for shared knowledge (Caldwell, Roehrich, & George, 2017). A key aspect of organizational productivity is knowledge sharing as it promotes technological change (Gil-Alana, Škare, & Claudio-QUIROGA, 2020). Shared knowledge in inter-organizational contexts is critical because it increases the chances that communication will be understood, and enables individuals and organizations to behave as if they can anticipate the actions of others (Hoopes & Postrel, 1999; Puranam, Raveendran, & Knudsen, 2012). Often, an initial lack of shared knowledge between decision-makers can be observed when dealing with fuzzy problems (Daft & Lane, 2008), as there is a lack of shared language and experience on the basis of which to communicate in order to understand each other (Stühlinger, Schmutz, & Grote, 2019). The fuzziness of the complex problem context, where cause-effect relationships are hard to predict, requires specific attention in order to facilitate sustainable decision-making processes (Litvaj et al., 2022). Therefore, a lack of shared knowledge has a detrimental effect on working ties (Carlile, 2004). One way to address the lack of shared knowledge is suggested by Orr and Scott (2008) who demonstrate that project partners go through phases of ignorance, sensemaking, and response. Such shared sensemaking activities are good examples of relational coordination for addressing socio-political complexities (Maylor & Turner, 2017). Similarly, Litvaj et al. (2022) propose employing tools such as system engineering to create mutual understanding and to diagnose problems in sustainable decision-making processes.

Based on the previous, it can be concluded that two of the three aspects of relational coordination are important to problems occurring in inter-organizational decision-making, which highlights the need to include the concept of relational
coordination in the solution development for sustainable decision-making processes. However, studies on the concept of relational coordination have primarily focused on establishing the theory (Bolton et al., 2021), which means that the concept has not yet been operationalized for use by practitioners. Studies on the operationalization of frameworks are especially useful in fields where the connection between practice and science is reported to be lacking, such as in organizational studies (van Aken, 2007).

5.3. Methodology

The methodology section introduces the research design, which is based on design science research, with aspects of a strong problem investigation and co-designing the process. The developed approach is explained, paying attention to rigor and quality of this study.

5.3.1. Research Design

5.3.1.1. Design Science Research Methodology

As mentioned in the literature review, the context of inter-organizational projects can be described as fuzzy, which means it is characterized by ill-defined requirements, complex interactions, design flexibility, and dependence on social and cognitive abilities (Hevner et al., 2004). Moreover, the collaboration between two or more organizations makes for authentic problem contexts which require in-depth, complex negotiations, which set significant boundaries on the feasibility of potential solutions (Groop et al., 2017). As such, the effectiveness of building shared knowledge for relational coordination depends heavily on the ability to analyze and decipher complex inter-organizational contexts and develop solutions that are compatible with these socio-political contexts. DSR as a methodology is driven by problems encountered in a practical setting, and focuses on studying solutions which improve these (van Aken & Romme, 2009). Therefore, DSR can be used to create artifacts which solve decision-making problems in complex inter-organizational settings. Despite the recognition of the benefits of incorporating DSR in the field of organizational and management studies (Jelinek et al., 2008; van Aken, 2007; van Aken & Romme, 2009), it has only been applied in a few cases. One reason for this is that DSR is often approached from a positivist worldview and creates prescriptive knowledge (Denyer et al., 2008; Iivari & Venable, 2009), which is uncommon for organizational sciences which focus on understanding general patterns.

5.3.1.2. Organizational co-design

While DSR is often applied in technocratic environments and tends to focus on the effectiveness and design principles of the solution, the methodology can also be used to focus on improvement cycles of an iterative design (van Aken, 2007). van Aken (2007) argues that the focus of research should be placed on the actual learning and development taking place, shifting the focus from the ends (the design) to the means (how and why the design works). He also explicitly identifies the practitioners involved as co-designers, which means that participants engage in a co-
development process, gaining an in-depth understanding of the effects of the design choices by evaluating several iterations of the design together, utilizing feedback. This involvement fosters the learning and commitment of the practitioners by collectively considering the problem and the solution (Hocking et al., 2016). In doing so, it links co-designing directly to relational coordination, because the establishment of shared knowledge is a key consideration (Bolton et al., 2021). Likewise, co-designing is particularly relevant to enable sustainability as it promotes continuous stakeholder engagement (Missimer & Mesquita, 2022). Moreover, a co-designed process can empower the stakeholders to act based on the insights they gained from the interventions taking place. As such, employing a co-development-oriented form of DSR in the field of organizational and management studies helps to connect research more closely with practice, a link that is currently often missing. Moreover, when engaging in an organizationally dominant design process, this often involves challenging team members’ existing ideas and assumptions about the design, by iteratively evaluating the artifact and its design principles (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011, p. 44). By means of the focus on shared learning in DSR, it also promotes social values such as understanding, trust, and respect (van Aken, 2007). Since the creation of shared knowledge and mutual respect are important aspects of relational coordination (Bolton et al., 2021), DSR directly facilitates the emergence of relational coordination. Therefore, studying relational coordination through the lens of DSR may further aid in understanding the emergence of these mechanisms.

5.3.1.3. Designing for inter-organizational coordination

Viewing relational coordination in inter-organizational projects through the lens of DSR, gives rise to novel research opportunities concerning inter-organizational project dynamics, especially regarding relational coordination. Firstly, currently available instruments do not encourage relational coordination. One of the possible reasons for this is that traditionally, many projects focus on planning & control mechanisms (Morris, 2013), which are common in the coordination of complex projects, but may not be able to address all the socio-political complexities of inter-organizational decision-making processes (Maylor & Turner, 2017). For example, a study investigating the fit of coordination mechanisms in complex inter-organizational projects revealed that a focus on planning & control mechanisms at the start of the project, at which point problems were still unclear, led to delays and a lack of satisfaction among stakeholders (Jakubeit et al., 2021). A design science perspective, on the other hand, focuses on understanding which principles improve the situation for practitioners (van Aken, 2007). This form of collective learning enables relational coordination, since it builds shared knowledge (Bolton et al., 2021). Secondly, in organizational studies, such as when relational coordination mechanisms in inter-organizational projects are investigated, it is often noted that the connection between science and practice is lacking (van Aken & Romme, 2009). Employing DSR in this context can address this issue as it assists practitioners in adopting more of the suggested design propositions, as well as learning from them (van Aken, 2007). Incorporating the feedback of practitioners into the design
iterations thereby closes the loop and aids in bringing science and practice closer together. Additionally, DSR positively impacts the principal aim, since the design propositions provide practitioners with more ideas regarding instruments which facilitate establishing relational coordination. Thirdly, DSR addresses the need of inter-organizational projects to study coordination mechanisms from an inside perspective, focusing on how these projects develop (Söderlund et al., 2017).

5.3.1.4. Generalizing from case study design

van Aken and Romme (2009) propose to generalize the understanding of DSR by making use of design propositions to address problems in the field. Design propositions can be regarded as “a chunk of general knowledge, linking an intervention or artifact with an expected outcome or performance in a certain field of application” (van Aken, 2004, p. 228) (p.228), thus constituting generalizable solutions to types of problems. Denyer et al. (2008) link design propositions using CIMO-logic, which analyzes the action cycle employing four phases consisting of Context, Intervention, Mechanism, and Outcome. This not only aids in clarifying fuzzy problem contexts, but also aids in communicating the sequence of steps carried out during the research process (Coughlan & Coghlan, 2002). Because the generalization of design propositions depends on a thorough understanding of the problem context, CIMO-logic is used to analyze the inter-organizational problem context of the case study (see section 5.3.3).

5.3.2. Research Approach

The research design used in this paper is divided into two main phases (see Figure 5.1). The first phase is focused on understanding the inter-organizational context, the nature of the design problem, and the change desired by the organizations (section 5.4). During this phase CIMO-logic is employed to investigate a ‘what’ type question, which leads to the identification of design objectives and criteria. The aim of the second phase of the study is developing and evaluating a fitting design solution for the specific problem context. Its main purpose is investigating ‘how’ and ‘why’ the design propositions work (section 5.5), but also how they can be generalized (section 5.6). In order to achieve this, the design science research process of Peffers et al. (2007) has been modified. Figure 5.1 includes a sequential overview of the process steps of the proposed design and features a division into ‘what’ and ‘how’ phases.

The research approach is characterized by using established methodological steps as key ingredients for the framework. For the problem exploration, CIMO-logic based on Denyer et al. (2008) has been applied. The DSR process has been modified from Peffers et al. (2007). Finally, during the implementation of the designed process key principles of case study research have been employed (Yin, 2003). A simplified overview of the methodological steps can be found in Figure 5.2.
Figure 5.1. Overview of the methodology.

Action research
CIMO-logic: understand the change that has been triggered by the activities conducted in the group.
Phase 2

Design spin-off

Control

Co-development ➔ Selection & preparation ➔ Intervention workshop ➔ Evaluation

Design criteria ➔ Design propositions ➔ Design ➔ Implementation ➔ Evaluation

Design science research
Find a fitting solution to the problem of the specific context.

HOW?
5.3.3. Rigor and quality of the study

To ensure rigor and quality, this qualitative study employs several tests during different process steps (see Table 5.1). A key measure to establish validity in qualitative studies is triangulation, both regarding data and researchers (Golafshani, 2003). Moreover, several tests to ensure design science validity exist (Larsen et al., 2020), from which three validities were chosen. Data input validity ensures that the developed artifact is situated in the context. Theoretical validity ensures that the theory used is well-grounded in concepts from the relevant literature. Design validity ensures that the internal components are derived consistently and transparently.

Table 5.1. Tests to ensure rigor and quality of the study.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Approach</th>
<th>Process step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangulation</td>
<td>Multiple sources of evidence: semi-structured interviews, structured interviews, observations. (Information on the data sources can be found in appendix Table A1.5) Multiple research observers during the workshop.</td>
<td>Problem interviews Evaluation of workshop Design evaluation CIMO analysis Design propositions Design evaluation Design evaluation CIMO analysis Design evaluation DSR process</td>
</tr>
<tr>
<td>Data input validity</td>
<td>Open coding of semi-structured interview transcripts (Creswell &amp; Poth, 2016), followed by classifying into meaningful categories according to CIMO, to situate the developed artifact into context.</td>
<td>Data input validity Data input validity Data input validity Data input validity</td>
</tr>
<tr>
<td>Theoretical validity</td>
<td>Design propositions are grounded in literature and their outcomes are discussed and put into perspective.</td>
<td>Theoretical validity Theoretical validity Theoretical validity Theoretical validity</td>
</tr>
<tr>
<td>Design validity</td>
<td>The components of the design are well-supported and explainable (appendix A2).</td>
<td>Design validity Design validity Design validity Design validity</td>
</tr>
</tbody>
</table>

5.3.4. Case introduction

The designed process which enables relational coordination has been developed and evaluated for the specific problem context of an inter-organizational large-scale project in the Dutch railway system. The goal of this inter-organizational project
is the implementation of a Europe-wide interoperable traffic management system (ERTMS). The project has a span of 11 years and was initiated and is directed by the Dutch ministry of infrastructure and water management (GOVT). As part of this large-scale project, this study focuses on a board of safety representatives from the participating stakeholders, who are responsible for ensuring the safe implementation of the new ERTMS system into the operating railway system. Included on the board are stakeholders who represent: the program direction (PD), the infrastructure manager (IM), transport (TO) and freight operators (FO), and contractors (CO), all of whom collectively prepare decisions, and advise PD regarding safety-related issues. The board mirrors many other similar boards within the framework of the inter-organizational ERTMS project. This context was selected to reflect the main decision-making challenges in inter-organizational railway projects, in situations where interdependencies between stakeholders are high, and there is limited power to dictate each other’s behavior.

5.4. Problem Exploration

The fuzzy problem context of inter-organizational railway projects was initially investigated using eight semi-structured interviews with the representatives of the main stakeholders on the safety board (see appendix Table A1.5 for information on the data sources and appendix A4.3 for information on the interview guide). The interviews were transcribed and verified with the interviewees to avoid misinterpretation (Poortman & Schildkamp, 2012). The transcripts of the interviews were inductively coded into meaningful categories using the qualitative software Atlas TI, by means of open coding (Creswell & Poth, 2016).

5.4.1. CIMO-logic analysis

Using CIMO-logic is an approach that can be used to clarify fuzzy problem contexts as discussed in paragraph 5.3.1.4. In accordance with CIMO-logic, each meaningful category was classified based on the context theme and the intervention theme. For this analysis, the steps as outlined by Filius et al. (2018) have been followed. The context theme (5.4.1.1) as derived from the data, shows complexities that are specific to the situation, as was also mentioned by the respondents. The interventions (5.4.1.2) derived from separating the data into meaningful categories, show mechanisms (5.4.1.3) identified by respondents which are currently being used to clarify the problem context of the decision-making process. The mechanisms provide insight into why the interventions did not lead to the desired outcome (5.4.1.4) of reaching a decision.

5.4.1.1. Context

After these steps, each meaningful category was classified based on the context theme, and the intervention theme, in accordance with CIMO-logic, see Figure 5.3 for an overview.

7 Also known as IENW
8 Also known as ProRail
9 Also known as NS
Figure 5.3. Illustrating the meaningful categories classified according to context theme and intervention theme.

The context theme as derived from the data, shows the following. Firstly, different interests regarding the decision-making process within the safety board exist. Individual members are responsible for different parts of the system, and therefore have different preferences during decision-making. These varying interests lead to decision process inefficiency, since meeting time is spent on inefficient discussions, and decisions are re-evaluated several times. As such, the board lead from PD pointed out:

“The discussions during the safety board meeting are lengthy and have not resulted in many decisions. The representative of IM holds beliefs that I understand differently.”

Secondly, the stakeholders on the safety board have varying perspectives regarding the decision. The representatives on the safety board work for different organizations and have different backgrounds. Agreements in meetings have been achieved based on assumptions, since more detailed discussions led to the emergence of differences in opinion. This resulted in inaccurate interpretations of statements, which led to false agreements, ultimately prolonging the decision-making process as a whole. This is also stressed by a safety representative of IM, who mentioned:

“A representative of PD is very enthusiastic about the topic. However, his statements do not correlate to his actions. This can lead to relitigating the issue several times.”

Finally, since the meeting time was perceived to be used inefficiently due to repetitive discussions, several stakeholders of the safety board indicated frustration with the process, and a decreasing level of motivation to engage in problem-solving and decision-making processes. Conversely, others complained about certain board members not taking the work of the safety board seriously enough, by attending
without proper preparation and canceling meetings at the last minute. This lack of motivation was indicated by a representative of TO:

“Discipline during meetings is important. Sometimes participants fail to attend, arrive late, or fail to adequately prepare. Changing this is vital to make progress regarding decision-making.”

5.4.1.2. Interventions

In the following section, the interventions that have been implemented by the safety board so far are elaborated on. The primary aim of these interventions was to arrive at better supported and faster decision-making. In order to gain a more comprehensive understanding of the processes, the safety board has worked to improve the structure of the meetings, for example by using a standard form in which new information must be presented and using agendas to build consensus on the issues to be discussed. Another intervention already in place is creating an inventory of cases on which decisions need to be made, which they have organized by urgency. As such, the most urgent matters, where there is pressure to make decisions, are addressed first. Additionally, when working out solutions for the cases, these have to be clearly described, including the reasons why they are appropriate for solving the issue at hand. Finally, members realized that a potential problem in the decision-making process is the fact that roles and responsibilities were unclear. As a solution to address this problem, process agreements were formulated, including a clear delegation of roles, with which the board must comply.

5.4.1.3. Mechanisms

The analysis of the interviews revealed that, in the context of the safety board, several socio-political challenges, mainly related to the differences in opinion between the stakeholders, complicate the work within the team. The interventions employed to respond to these complexities primarily trigger more planning & control mechanisms, e.g., by establishing more structure during meetings. Also, by defining process agreements, the team wanted to create a document that could later be used in verifying that decisions were executed according to these agreements. However, by deciding to establish these in writing first, without having thoroughly examined the context of the problem and gaining clarity about it, a strong focus on solutions among the stakeholders is revealed.

5.4.1.4. Outcome

These planning & control-based interventions were perceived as not very effective, since they did not aid in arriving at better decision-making. This is exemplified by the lead of the safety board reflecting on one of the implemented solutions:

“During the previous meeting, the members defined their roles as part of the safety board and the goals of the safety board as a whole. During the meeting itself, everyone was in agreement, but by the next meeting a member had changed their mind, once again challenging this decision.”
Consequently, the implemented coordination mechanisms appear to not be effective in addressing the issues the safety board faces regarding decision-making. Planning & control appears inadequate in addressing the complexities of the inter-organizational railway context and as such, does not lead to the desired outcome of faster decision-making. Planning & control is a mechanism best suited to deal with structural complexities (Maylor & Turner, 2017), whereas the main complexities faced in the decision-making process are of a socio-political nature. Applying the planning & control mechanism in the specific context studied, resulted in failure due to continuous re-discussion and re-evaluation of decisions, and ultimately in ongoing frustration with the decision-making process. This is stressed by the safety representative of TO:

“I expect the safety board to act based on agreements that have been made. However, the agreements are not yet universally accepted. Despite good intentions, some parties slow down the functioning of the safety board.”

This intervention focused on defining agreements, however, there still seems to be a lack of consensus on the problem, indicating that the implemented interventions have not helped to increase understanding between the stakeholders. As such, the strong focus on solutions when working to solve the problem, rather than first getting clarity about it, does not lead to the desired outcome of reaching agreed-upon decisions either. Figure 5.4 summarizes the problem context of the decision-making process of the safety board using CIMO-logic.

![Figure 5.4. The problem context of the safety board explained using CIMO-logic.](image)

5.4.2. Awareness sessions

The results of the CIMO-logic analysis have been presented to the interviewees. During the awareness session, which is a result of phase one of the research (see Figure 5.1), specific attention has been paid to emphasizing the low coordination fit of the current approach. This resulted in a discussion among the team regarding more appropriate coordination responses for the situations faced by the safety board. The members of the safety board, as well as the researchers, contributed
to the idea generation of potential fitting responses to the identified, complex, problem. It was established that the interventions the board wants to implement should have the objective of building relationships in order to deal with the socio-political complexities, as suggested by Maylor and Turner (2017). Consensus in the team regarding this objective was established before work on a suitable solution was initiated. The goal of the second phase of this study is designing a solution based on relational coordination. Therefore, an essential requirement for developing the relationships in the safety board was co-designing the entire process. Essentially, the continuous stakeholder engagement during the co-design process enables shared understanding and ownership, which both contribute to relational coordination.

5.5. Co-designing a process for relational coordination

5.5.1. Design objective and criteria

As outlined in the previous sections, decision-making in inter-organizational contexts is often hampered by divergent views held by the participating stakeholders. Additionally, a tendency to focus on finding solutions without first completing a proper investigation of the problem has been observed. The divergent views of the safety board members contributed to a low level of mutual understanding regarding the problem. Moreover, stakeholders experience ongoing frustration with the current decision-making process, which has discouraged participants from addressing the issues they face.

These factors combined illustrate the need to find a better coordination fit between the complexities the safety board faces and the responses the board uses, by engaging in more relational coordination (Bolton et al., 2021; Maylor & Turner, 2017). Table 5.2 presents an overview of the design objective and the criteria.

Table 5.2. The design science research objective and the criteria.

<table>
<thead>
<tr>
<th>Objective and criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall objective</td>
</tr>
<tr>
<td>Criterion 1</td>
</tr>
<tr>
<td>Criterion 2</td>
</tr>
<tr>
<td>Criterion 3</td>
</tr>
</tbody>
</table>

To achieve the overall objective of building relational coordination three design criteria have been established. The first design criterion was intended to establish clarity regarding the problem for the decision-making process (Daft & Lane, 2008). The second criterion aimed to increase understanding regarding the different views of the stakeholders in the group (Kasl, Marsick, & Dechant, 1997). Lastly, the third criterion was established to ensure the designed process facilitates stakeholder ownership of the decision (Druskat & Pescosolido, 2002).
5.5.2. Design propositions

The design of the relational coordination process borrows from multiple design propositions. In the following sections, their origins and implementations into the process are briefly discussed.

5.5.2.1. Problem focus of decision-making process

One of the criteria of the design is that it needs to facilitate a higher degree of problem consensus during the decision-making process. According to Daft and Lane (2008, p. 452), “[inter-]organizational decision-making is formally defined as the process of identifying and solving problems.” As such, decision-making can be separated into two stages: the problem identification, and the problem solution stage. Responses focused on diagnosing the complex problem context are especially crucial when decision-making processes need to become sustainable (Litvaj et al., 2022). Exploring the problem and its interconnections aids in arriving at new insight and revealing its root causes. Ultimately, this process aids in choosing alternatives on the system level during the problem-solution stage (Missimer & Mesquita, 2022). When goals are ambiguous and/or inconsistent, and/or participants disagree on problem priorities, this leads to bargaining in order to gain support for the matter which is deemed most urgent. Moreover, participants may have differing viewpoints regarding the problem. By exchanging these perspectives, they gain more information, create mutual understanding, and reduce the ambiguity regarding the problem they face. To deal with such institutional differences, Cyert and March (1963) propose a problem-focused investigation in order to build a coalition between the stakeholders. As such, a focus on the problem identification stage of the decision-making process, rather than the problem-solution stage, is proposed as a key element of the design.

5.5.2.2. Collective learning through intervision

Relational coordination in inter-organizational projects can be established by creating mutual understanding between the stakeholders by promoting openness and collective learning. In order for processes to be sustainable, opportunities for continuous learning should be provided when engaging with processes of knowledge management (Armenia, Dangelico, Nonino, & Pompei, 2019). The learning aspect of sustainable processes enables the understanding and management of different stakeholder perceptions (Yu, Zhu, Yang, Wang, & Sun, 2018). According to Falcón-Cortés, Boyer, and Ramos-Fernández (2019, p. 2) “during collective learning, individuals with different experiences may acquire valuable information through interactions with others, possibly resulting in an increased foraging success compared to what isolated individuals would typically achieve”. Some of the benefits of collective learning include an improved capacity for sensing and making decisions. Openness is an important requirement for engaging in collective learning, especially when dealing with situations of conflict, where listening to others’ perspectives is vital (Kasl et al., 1997). In order to facilitate this, a conceptual outset for the design of the relational coordination process for inter-organizational projects is rooted in ‘intervision’, which
is a peer-led group reflection method often used in teaching environments (Staempfl & Fairtlough, 2019). The consultation process is carried out in a group, in which the participants discuss questions based on their professional experience according to a set procedure with assigned roles (Tietze, 2010). Participation in intervision results in improvements in communication and interpersonal skills (Tietze, 2010). It contributes to collegial exchange, fosters inter-professional understanding, and enhances a climate of mutual respect (Bailey, Bell, Kalle, & Pawar, 2014; Wagenaar, 2015). According to Staempfl and Fairtlough (2019), this can be achieved by means of non-judgmental communication. Openness and transparency, in particular, are improved by engaging in intervision sessions. Finally, intervision teaches participants how to learn from one’s experiences and actions by taking time to examine and review these. Reflection promotes awareness of the methods used, and decisions and judgments made during the process (Bellersen, 2009).

Using this line of thinking, intervision can be employed to promote collective learning and create openness regarding the perspectives expressed among the safety board. Through active listening and non-leading questions, participants are ‘forced’ to engage with the perspectives presented, without prematurely evaluating them.

5.5.2.3. Continuous stakeholder engagement

Another point of attention is the need to create more ownership of decisions. Therefore, the second leading design goal is the concept of continuous stakeholder engagement in order to create a sense of ownership of the team’s work processes and decisions (Druskat & Pescosolido, 2002). A sense of ownership is created through the collective understanding that all members are partial owners, and that the team’s actions and results are the team’s responsibility. It has been suggested that ownership of the decision increases efficiency by motivating employees to expand their knowledge and authority (Pierce, Kostova, & Dirks, 2001), in this case this means arriving at a mutually supported decision among the safety board. Ownership of decisions can be created through continuous stakeholder involvement (Patel, Kok, & Rothman, 2007), which is an important aspect of building social sustainability (Missimer & Mesquita, 2022). Therefore, Armeni et al. (2019) argue that sustainable project management should aim to attain proactive involvement and engagement of stakeholders. These interactive processes create room for discussions and negotiations which aid in building mutual understanding in order to manage the complexities of the process (Yu et al., 2018). Consequently, stakeholders participating in the study gain a feeling of ‘empowerment’, which supports them in expressing and analyzing their realities: it is a way to facilitate greater process, and outcome ownership among participants (Patel et al., 2007). Table 5.3 depicts how the design propositions connect to the design criteria and problem areas.
Table 5.3. Overview of connections between problem areas, design criteria, and design propositions.

<table>
<thead>
<tr>
<th>Problem area</th>
<th>Design criteria</th>
<th>Design propositions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fit between coordination and complexities of the situation</td>
<td>Design objective: Establish better coordination fit by working on the relationship (Maylor &amp; Turner, 2017).</td>
<td>Focus on the problem identification, not the solution (Daft &amp; Lane, 2008).</td>
</tr>
<tr>
<td>No consensus on the problem.</td>
<td>Establish more problem clarity.</td>
<td>Focus on the problem identification, not the solution (Daft &amp; Lane, 2008).</td>
</tr>
<tr>
<td>Little mutual understanding of the different views.</td>
<td>Create a mutual understanding of the views of the case to be discussed.</td>
<td>Engage in collective learning through intervision (Bailey et al., 2014).</td>
</tr>
<tr>
<td>Ongoing frustration with the process/decision.</td>
<td>Create ownership of the decision.</td>
<td>Enable continuous stakeholder engagement (Missimer &amp; Mesquita, 2022).</td>
</tr>
</tbody>
</table>

5.5.3. The process developed for the inter-organizational railway context

To develop the design, several iterations were created and used, working closely with the case study team (see appendix Table A1.5 for more information on the iterations). These iterations included design presentations, individual reflections involving the safety board team members, and preparing the intervision workshop with two experts, namely an intervision expert and the case owner. The process has been developed based on the previously mentioned design criteria and consists of three main phases: case selection & preparation, intervision workshop, and evaluation (Figure 5.5). The design propositions are concepts integrated into the design.

Figure 5.5. The co-designed artifact: the intervision process.

5.5.3.1. Selection & preparation

A decision issue in which different perspectives play a key role is selected. This can be based on urgency and/or relevance to decision-making. In order to gain maximum benefit from conducting the process, it is of great importance to select an issue that is currently impeding progress within the team. Once a topic has been selected for the intervision process, it must be prepared for the workshop. Part of
the preparation is an exploration of perspectives on the topic. This can be done by consulting with the team manager or by conducting individual interviews with team members concerning the case question. The individuals with the most strongly divergent perspectives are then asked to summarize these in the form of a slide, which is to be presented during the workshop.

5.5.3.2. Intervision workshop

During the intervision workshop, which is facilitated by one of the researchers, the selected views are discussed critically. The team which discusses the issue consists of stakeholders who are important to the decision-making process and who wish to arrive at a shared definition of the decision problem. In order to reach agreement, the different perspectives on the problem must be exchanged by means of a discussion. As such, the discussion component of the intervision workshop is a requirement for success.

The intervision workshop consists of four process steps. At the start of the workshop, the prepared perspectives are presented to the rest of the team. The explanations should be supported by information summarized on a slide, which should be kept concise to enhance the overview, in order to facilitate understanding and listening. Emphasizing the areas of conflict is important to the outlining of the differences. Visualization offers extensive potential for learning from each other’s points of view, and intervision (non-leading questions) can tap into this potential as well. In the sensemaking stage, the group familiarizes itself with the perspectives presented by asking open-ended questions that are non-leading, non-judgmental, and do not offer interpretations. The entire group actively listens to the explanations of the case facilitator. A secondary effect of this is that the case presenter is forced to critically reflect on their own perspectives, which encourages them to identify inconsistencies. After all the group’s questions have been addressed, sufficient learning should have taken place to understand the perspectives. The group then brainstorms about commonalities and differences between the perspectives presented. The similarities and differences are then discussed point by point. Once the group reaches consensus, it moves on to the next point. However, if there is no consensus on an item, there may not be enough mutual understanding to draw a conclusion, and the group returns to step two, where additional non-leading questions can be asked. Identified commonalities can be considered focus areas for resolving the issue. Differences require additional problem-solving initiatives that can either be addressed during the workshop or, if time is insufficient, tackled in follow-up tasks. Action items are shared to motivate the team and establish responsibilities. At the end of the workshop, a brief reflection on the process and outcomes of the workshop can help increase motivation and alignment.

5.5.3.3. Evaluation

After the workshop, a summarizing report is written, listing the questions and answers dealt with as outlined in step two, divided based on perspectives, the commonalities and differences identified in step three, and the specific action items
identified in step four. The report is then shared with the team so they can make decisions based on the results gathered during the workshop. It also provides the team members with an opportunity to verify that their input has been interpreted and processed correctly, which potentially leads to better mutual understanding and identification of additional comments.

5.5.4. Implementation into the safety board

The co-designed process was implemented in the ERTMS safety board. The implementation in a selected case serves to test the intervision process in practice. Within this context, the process was tested on a particularly protracted and sensitive issue that has been a recurring source of disruption over the past two years. Safety board members have discussed this issue at length without making much progress, which has also greatly influenced the decision-making process regarding other issues. The reason that no agreement could be reached so far was that the perspectives on this issue were too divergent, which is why it was selected for use with the relational coordination process for this particular issue. The workshop was conducted online, for which the visual collaboration platform, MIRO, was used. Using an online session allowed all the involved stakeholders to participate, which would have been difficult to realize in a face-to-face setting. Moreover, it contributed to the creation of an organizational sustainability identity by reducing emissions and supporting social interaction (Bouncken, Lapidus, & Qui, 2022). A description of the different phases, including the conducted activities, can be found in Table 5.4.

Table 5.4. The phases of the co-designed process.

<table>
<thead>
<tr>
<th>Nb.</th>
<th>Phase</th>
<th>Description</th>
<th>Main activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Selection &amp; preparation</td>
<td>Selecting the decision-making issue at the safety board and preparing the</td>
<td>Meeting to collect information and decide on the issue to be investigated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>different perspectives for the workshop.</td>
<td>(manager of safety board).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual meetings with members on their perspectives regarding the issue.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preparation meetings with members who will present their perspectives (2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>meetings).</td>
</tr>
<tr>
<td>2</td>
<td>Intervision workshop</td>
<td>Perform a workshop to deal with the different perspectives on a particular</td>
<td>A workshop to perform intervision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>issue.</td>
<td>lasting 2 hours (7 safety board members present, representing 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>different stakeholder groups)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Workshop is conducted using MIRO</td>
</tr>
</tbody>
</table>
5.5.5. Evaluation of the co-designed process

Several means were used to evaluate the design: using direct participant reflections and researcher observations during the intervision workshop, and structured interviews and researcher observations during the safety board meetings after the intervision workshop (for more information on the data sources in appendix Table A1.5. and information on the interview guide in A4.5). Finally, the results were summarized according to the design propositions.

5.5.5.1. During the intervision workshop

The application of the intervision process in an inter-organizational context demonstrated that participants accepted the implemented process. Initially,
participants resisted using the process when it came to managing complexities specific to them. However, once they became familiar with the concept of intervision, their initial resistance diminished, and they appreciated the usefulness of the concept for addressing their case question. One of the safety experts from PD reflected:

“Though I was initially hesitant, I soon realized the value of asking questions according to the principles of intervision. This helped me understand the perspectives of other participants more thoroughly, especially when aspects emerged that I had not previously considered.”

This is consistent with the observations of the researchers, who noted instances when the value of the methodology became apparent to participants. Participants noted that intervision benefited both parties, those who presented their perspective and those who listened and asked questions. The presenters learned to critically reflect on their perspectives from different angles, and the members who asked questions gained new insights related to the specific points of view of the presenters.

5.5.5.2. After the intervision workshop

After the initial evaluation, structured interviews with each participant in the co-designed process were conducted. Generally, the results of these interviews indicate that the introduced process was positively perceived. Active listening, and the asking of questions, encouraged mutual engagement. By thinking carefully about what to ask, depth was added to the discussions, and instances of learning were created, which ultimately led to a better mutual understanding of different perspectives. This also led to the board members gaining clarity on the nature of the problem by identifying its root causes. Additionally, the board members were more open to each other’s perspectives, as a direct result of the openness of the questioning style. The ability to empathize with other perspectives on the case question, allowed for an increased understanding of the initial institutional differences, and these were even reduced to some extent.

While evaluating the observations made during the safety board meetings, other positive results were noted. The intervision workshop was seen as a starting point for opening up to each other’s perspectives and as a way to implement more relational coordination activities in situations where planning & control measures had previously dominated, as well as leading to the respective points of view aligning more closely. In keeping with this, the safety representative of FO indicated:

“The meetings are more effective now; this is indicated by a higher degree of bilateral conversations: the group cohesion was increased.”

As such, it can be concluded that the process was effective in changing the team’s preferred approach by introducing more relational coordination activities. In particular, collective learning and understanding of the commonalities in the group were fostered. Some of the participants continued to ask questions in the form of intervision: in an open-ended and non-leading manner. These types of questions were used to gain an understanding of each other’s underlying assumptions and
interpretations. Thus, the intervision workshop and relational follow-up activities seemed to enhance mutual understanding within the group. Starting from a situation where misinterpretation was common, the frames of reference of the board members became more similar, which contributed to effective teamwork. Accordingly, the safety board lead from PD indicated:

“An increase in understanding of the other parties’ processes has led to an observable alignment of reference frameworks.”

Additional questions, on which there had previously been little consensus, were used to illustrate how the safety board now deals with such matters. When participants realized that they did not have an adequate understanding of a process, they drew on examples from their own experiences and asked the others to elaborate using their respective perspectives. This allowed board members to learn strategies for coping with such problems from each other, and also create a mutual understanding of why certain stakeholders held a particular viewpoint. Going forward, when problems arise, the board has the ability to discuss the issue openly and tackle it as a group. This has also been recognized by the safety manager of TO, who remarked after one of the last meetings:

“Today, many issues were discussed, and appropriate solutions were found, the meetings are more effective now.”

While this did not completely eliminate institutional differences during the problem identification phase, it did lead to a better understanding of those differences and to open discussions. However, after the relational coordination process was conducted, an important new focus was to highlight the commonalities between the perspectives, which helped board members to reach partial agreement on issues and how to approach them.

5.5.5.3. Results of the design propositions

During the application of the co-designed process in the inter-organizational context, both expected and unexpected outcomes were revealed. The outcomes were linked to the design propositions introduced earlier in this paper, in a condensed overview to indicate how these propositions function when applied practically (see Table 5.5). The table presents a summary of the qualitative evaluation performed through observations and interviews, which is a common strategy in design science research (Peffers, Rothenberger, Tuunanen, & Vaezi, 2012).
Table 5.5. Results of the design propositions after the evaluation.

<table>
<thead>
<tr>
<th>Design propositions</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem focus of decision-making process</td>
<td>Openly discussing commonalities and differences between the presented perspectives during the problem investigation stage and engaging in discussions facilitated decision-making. Commonalities became clearer, and a focal point for building consensus concerning problems. Over the course of the workshop, differences were understood better, and some seemed to diminish after the workshop, enabling increased problem understanding among the group. Other differences were defined during follow-up problem-solving activities.</td>
</tr>
<tr>
<td>Collective learning through intervision</td>
<td>Workshop participants kept an open mind regarding the perspectives of other members. The team learned from, and reflected on, the presented perspectives during the workshop as a group, by asking questions in a non-leading and non-judgmental manner. More mutual understanding was created in the group regarding their shared and individual perspectives on the system. Project members continued to work using many examples from their personal experience when presenting their perspectives on a topic and asking questions in an open and non-leading manner, even after the workshop.</td>
</tr>
<tr>
<td>Continuous stakeholder engagement</td>
<td>Co-development was employed during the design process in order to foster ownership of the design. Application of design: Participation in the intervision workshop was continuous and consistent. Follow-up actions were defined, and participants seemed motivated to engage further. Proposals for solving further issues by means of an intervision workshop were made. Continuous bilateral meetings between the members of the safety board were initiated in order to explore the differences and solve the associated problems. After six months, the manner in which the action points had been addressed was re-evaluated. Some members still did not take the meetings seriously, and canceled at the last minute, however, the increased levels of trust allowed members to address these concerns directly.</td>
</tr>
</tbody>
</table>

As such, the application of the proposed relational coordination process proved to be appropriate in the case of large inter-organizational railway decisions. Crucially, it facilitated improvement of mutual understanding by means of relational coordination. The relational coordination was subsequently organized by initiating
small team follow-ups, such as bilateral meetings in which opportunities were created for collective learning. Furthermore, the continuous stakeholder engagement which was encouraged by means of this process proved important to ensuring sufficient ownership of the decision-making process.

5.6. Discussing the design process - enhancing the three aspects of relational coordination by means of the co-designed process

The results of the DSR application in a large inter-organizational railway project demonstrate that out of the three aspects of relational coordination, (Bolton et al., 2021) especially the creation of shared knowledge has been addressed.

Shared knowledge has been created through collective learning, which was one of the main goals of the process. On the one hand, collective learning has been enabled through the intervision workshop to create a mutual understanding of the case question, thus supporting the safety board decision-making process. On the other hand, collective learning has been stimulated by the DSR process itself, by merit of improving understanding concerning the importance of relational aspects in the specific problem context. It has directly impacted the support for starting additional relational interventions, such as an increase in bilateral meetings, and asking for examples to clarify situations. Vitally, it demonstrated that the principles of intervision worked well in situations where differences between stakeholders play a role due to a lack of mutual understanding. The co-designed process, which built on the principles of intervision, also revealed some challenges. For example, it requires openness from the participants, which in this case has been generated by means of the co-development of the DSR process and its iterations. Moreover, it requires time and effort from the participants until long-term effects of the decision-making process emerge. The required resources, however, may not always be readily available. Furthermore, additional ingrained problems may emerge in the meantime, which can diminish or reinforce the effects of the co-designed process. Over the course of the case study, some safety board members changed functions, and thus new members entered the group. Therefore, as some of the gained mutual understanding may be lost, more attention should be paid to building relationships at all times. The long-term effects of the process can only be accounted for in the analysis to a limited extent and should therefore be viewed with caution.

The other two aspects, namely shared goals and mutual respect (Bolton et al., 2021), have only been addressed indirectly. For example, the openness required in order to engage in the co-designed process, and the willingness to work on the relationship within the group, indicate that a degree of mutual respect is required, which might be developed through the co-development aspect of the DSR process. Additionally, the continuous mutual engagement, and careful listening to each other’s opinions, demonstrates that mutual respect between the members of the safety board has increased. Nevertheless, some signs that mutual respect in the group was still lacking after the process has been conducted remained, such as one member repeatedly arriving to meetings late or unprepared. As for building shared
goals, initially after the awareness sessions, there was alignment in the group to work on relational coordination. Moreover, during the implementation of the co-designed process, there was a general trend towards reducing the differences among the group and focusing on the similarities when investigating the case question. In particular, when re-evaluating the identified similarities and differences after six months, the team members’ perspectives were clearly more similar. Therefore, the goals of the safety board seem to be more focused and aligned as well. However, deeper underlying issues could not be solved, since they were outside of the scope of authority of the safety board. These issues can mostly be characterized as differences in goals between the organizations represented by the participating stakeholders. As such, addressing these issues is crucial to the long-term success of the process.

As a whole, it can be observed that the three aspects of relational coordination as described by Bolton et al. (2021) are encouraged directly or indirectly by applying DSR and implementing the co-designed process, in an inter-organizational decision-making process in the railway system.

5.7. Conclusion
This paper posits that increased understanding of relational coordination in inter-organizational projects, in particular in three different ways, has been established.

Firstly, to accomplish the first objective of this study, a shared understanding of the fuzzy problem context of inter-organizational decisions was established using CIMO-logic. Moreover, the awareness sessions, which were the result of using CIMO-logic, facilitated alignment on how the safety board aimed to proceed in order to enable a good coordination fit, and contributed to establishing a shared goal. Additionally, they underlined the need to co-design a process to facilitate relational coordination. As such, they directly enabled a sustainable decision-making process through diagnosing the complex problem context by means of CIMO-logic.

Secondly, to connect the two different objectives of this study, during the problem exploration it was established that in order to facilitate relational coordination, co-designing the process is important. Therefore, the paper demonstrates that through continuous stakeholder engagement, increased understanding was fostered among the safety board members. The shared problem understanding contributed to establishing alignment on the goal of relational coordination. Practitioners are considered co-designers, who learn collectively through iterative design cycles. As such, these co-designers are involved in the problem exploration, as well as providing feedback during the design iterations, which leads to increased ownership of the implemented design. Encouraging relational coordination was established as a core problem during phase one of the research, therefore, by conducting design iterations, the group was able to collectively learn which propositions work well to establish relational coordination, when working on inter-organizational decision problems. Consequently, a sustainable decision-making process was established through continuous stakeholder engagement during the entire design process: this specifically impacted social sustainability.
Thirdly, in order to meet the second objective of this study, the DSR process facilitated the creation of shared knowledge of the design propositions. As outlined in the discussion of the methodology, in order to make use of DSR in the field of organizational studies design propositions were developed, which created knowledge on how the concepts operated within the studied context. The implemented design propositions, namely: a focus on the problem identification of the decision-making process (Daft & Lane, 2008), enabling collective learning in the team through intervision (Bailey et al., 2014), and continuous stakeholder engagement throughout the process (Missimer & Mesquita, 2022) facilitated relational coordination. The second design proposition in particular, demonstrated promising results within the railway setting. The intervision workshop fostered collective learning, thereby building mutual understanding among the group members regarding the problems concerning the decision-making process of the case which was selected for the implementation. Shared knowledge is a direct result of relational coordination (Bolton et al., 2021), stressing the concepts’ value for relational coordination. Fostering shared understanding decreases the uncertainty and ambiguity during the problem identification phase. As such, it can be considered the first step in building a coalition to reach alignment on goals for a sustainable decision-making process. Essentially, by considering the different perspectives on the problem and trying to align them, a system-based approach is chosen, which directly contributes to sustainable development (Missimer & Mesquita, 2022). Since this creates shared knowledge on the case question, relational coordination appears to be an important requirement for facilitating more sustainable decision-making processes. On the whole, applying DSR in the framework of organizational studies provided a new, inside, perspective on the field of inter-organizational projects, which has traditionally predominately been studied from the outside (Söderlund et al., 2017). As such, the understanding of the context which was gained by using this perspective, and the implemented process, can contribute to improving the performance of the decision-making processes within the project.

The combination of the three design propositions presented here is novel and shows promise for application in supporting relational coordination in complex inter-organizational decision-making. This study demonstrates that these propositions are particularly valuable in creating mutual understanding among key stakeholders to enable effective decision-making in a complex railway environment. Considering the individual design propositions, it can be observed that they have already been successfully implemented in other contexts. This is also illustrated in section 5.3.1.4, where it is outlined that they can be considered generalizable solutions. Collective learning, which originated in complexity research, for example, is a common approach in multi-agent systems, and it has been utilized successfully in ecosystem management research (Bousquet et al., 2002). Additionally, stakeholder engagement has been employed effectively in achieving sustainability in, for example, the construction sector, by assisting in decision-making processes with multiple stakeholders (Bal, Bryde, Fearon, & Ochieng, 2013). Therefore, the combination of implemented design propositions has the potential to be an effective solution for
related systematic decision-making problems, e.g., in the construction sector or related fields. Moreover, several steps have been taken to increase the knowledge of complex decision-making problems in the railway system and to develop a solution for dealing with this type of problem. The increased understanding of the working of relational coordination in inter-organizational decision-making provides a different, more rigorous understanding of how the organizational interventions reinforce each other in this complex setting. Moreover, it helps to decrease the fragmentation of the field, as suggested by van Aken and Romme (2009), by demonstrating how relational coordination works as a means to enable more sustainable decision-making processes inter-organizational contexts. By means of the continuous stakeholder engagement during the design process, the impact on social sustainability in particular, is increased as discussed by Missimer and Mesquita (2022). This paper expands on the methodologies commonly employed in the field, by stressing the benefits of using DSR in settings where collective learning is a central aspect of inter-organizational decision-making.

5.7.1. Limitations and future research

A limitation of this study is its lack of statistical generalizability (Rowley, 2002), since it only consists of a single, in-depth case. Nevertheless, there is no indication that the applicability of the developed process is limited to the railway sector. The individual design propositions have already been used in other fields, e.g., by Bousquet et al. (2002) and Bal et al. (2013). As such, the potential exists to apply the developed process in other related domains with complex inter-organizational decision-making problems, for example, the construction sector (Bal et al., 2013). Furthermore, the primary objective of this study was to improve the understanding of relational coordination in inter-organizational projects and to develop a suitable solution for sustainable decision-making processes. This type of study is usually done by means of case study research (Yin, 2003), the strength of which is increasing knowledge about a social phenomena, therefore, statistical generalizability is limited. Another limitation of this study is the limited impact on overall sustainability. The process developed was applied to only one decision-making problem faced by the safety board. In order to achieve a long-term and sustainable change in the way decision-making problems are addressed, the process has to be properly maintained and applied to different cases dealt with the safety board (Schneider, Brief, & Guzzo, 1996). Finally, this study only considered the impact on social sustainability, as discussed by Missimer and Mesquita (2022). However, in order to arrive at a more thorough overview of the sustainability impact of the designed process, environmental and economic sustainability factors must also be considered (Madureira et al., 2022). It is possible that the use of other design propositions is more relevant in these situations, which means that currently, only limited predictive conclusions can be drawn.

This study provides numerous opportunities for future research. Firstly, this study identifies an opportunity for studying external factors, and their effect on relational coordination. By doing so, the functioning of the design propositions
can be supported more thoroughly, and additional understanding on relational coordination in inter-organizational projects can be gained. Secondly, the impact of the applied design propositions on environmental and economic sustainability can be explored to provide a comprehensive overview of the impact of the designed process on sustainability in general. In doing so, this study has the opportunity to contribute to a broader discussion on sustainable decision-making processes. Thirdly, the examination of other coordination mechanisms: depending on the results of the problem exploration conducted using CIMO-logic, one of the other two coordination mechanisms in Maylor and Turner (2017)'s framework might have proved more appropriate. In that case, the design goal would be different, resulting in a different design to be implemented. Therefore, the authors propose applying the developed methodology with a strong focus on problem exploration using CIMO-logic in another complex environment with significantly different complexities, in order to determine its usability for other coordination mechanisms.
Publication history

A version of this chapter is intended to be submitted to the Engineering Management Journal.
Chapter 6: COMPASS – Design of a Coordination Mechanism Preference Assessment

Abstract

Project methodologies seem to show a preference for a coordination style centered around planning & control, especially in technocratic environments. Often the style is chosen according to what the project team knows (i.e., frozen habits) and the individual preferences of team members. Managers that are aware of other coordination mechanisms (e.g., relational and flexibility), are better able to match their coordination styles and the styles of teams to specific project contexts.

The purpose of this study is to help the project team members in identifying their individual and team coordination preferences and enable and stimulate reflection on their preference and usage of effective coordination mechanisms.

We use design science research methodology to design a preference assessment tool inspired on the Thomas-Klimann conflict mode instrument that determines the team member’s individual coordination preferences and test the tool with railway system professionals.

The findings show that the coordination preference indeed assesses an individual’s and team’s preference for coordination styles. It helps in creating awareness of personal preference and gives insights into other options available for coordination needs for their projects which can aid in a better fitting coordination mechanisms choice in their collaborative projects. Moreover, by comparing the individual results together in a team or with other stakeholders, further reflection and personal development can be stimulated.

The coordination mechanism preference assessment can be seen as a steppingstone towards creating awareness in the organization on the importance of coordination and more effective coordination mechanisms in inter-organizational project contexts.

The designed coordination mechanism preference assessment enhances exaptation, since the known design principles of complexity-response framework, personal assessment tests, and team-based assessment have been successfully applied to problems centered around coordination mechanism fit. Within a team of railway professionals, it draws attention to coordination mechanisms, which are needed for system integration and other organizational settings.
6.1. Introduction

The body of knowledge of project management literature is widely shaped by methodologies that focus on the concept of planning & control (Morris, 2013). For example, the project management body of knowledge (PMBOK) (Project Management Institute, 2017) provides project professionals with a view of how projects should be managed with a focus on prescriptive techniques and procedures. This line of thinking is largely based on “system management practices” which originated in the 1960s (Morris, 1994). While these techniques are effective in coordinating simple projects, especially in complex, uncertain, and time-sensitive contexts, newer methodologies in which the project “emerges” rather than being pre-planned are more appropriate (Williams, 2005). Additionally, more recent work advocates for a more nuanced approach to managing complex projects because of the variable nature of complexities, which are usually also dynamic (Geraldi et al., 2011; Maylor et al., 2018). All this clearly indicates a trend away from the unilateral use of planning & control-focused coordination mechanisms. As such, Maylor and Turner (2017) developed the project contingency approach, in which the contextual complexities determine the most appropriate responses for coordinating these. They identify three coordination responses: planning & control, relationship-development, and flexibility, which are each best suited to deal with specific kinds of situations. Previous research has shown that a high degree of fit between the inherent complexities of projects and the chosen coordination responses of the project team to address these, leads to more effective project coordination, when measured based on both stakeholder satisfaction and completion time (Jakubeit et al., 2021). Managers who are aware of other project contingencies are better able to match their coordination styles and the styles of teams to specific project contexts (Shenhar, 2001). This can promote more effective use of management styles in projects because there is a fit for each level of contingency, with a higher fit leading to more effectiveness. (Donaldson, 2001). Unless this matching is encouraged in some form, the fit between contingencies and coordination mechanisms may remain low in some cases, affecting the effectiveness of the coordination mechanisms and ultimately the projects.

To promote coordination fit and coordination mechanism effectiveness, this study poses the following research question:

*How can more awareness regarding personal coordination mechanism choices and fit with the project context be created among railway professionals?*

The paper is structured as follows: firstly, background on the usage of coordination mechanisms and preference assessment tools is provided. Secondly, the employed methodology: design science research, is introduced, after which the design is presented. Thirdly, the results of the implemented design in its context are discussed, including outlining to what extent it created awareness and enabled a more effective use of coordination mechanisms. Finally, a conclusion, limitations of this study and suggestions for future research are provided.
6.2. Background

Previous research on coordination mechanisms has revealed that not all coordination mechanisms are equally well represented in project team coordination. Moreover, the fit between applied coordination mechanisms and the requirements of the situation does not always match, which leads to coordination ineffectiveness (Jakubeit et al., 2021). The ineffectiveness in coordination mechanism usage can stem, among other things, from a personal preference for the use of one coordination mechanism over others. Various factors may cause this preference, such as cultural aspects and personal competences (Turner & Müller, 2005). A strong focus on planning & control, for example, may be inspired by the use of conventional project management methodology (i.e. PRINCE 2) (Kapsali, 2013). Similarly, people-oriented leadership styles for managing cross-functional teams are an example of relational coordination (Bolton et al., 2021). Furthermore, the use of SCRUM-based tools by professionals in the IT sector reveals traits of flexibility (Highsmith, 2009). The manager’s personality may have a major impact on choosing a specific coordination mechanism, however, investigating the root causes of these preferences falls outside the scope of this study. Nevertheless, knowing one’s preferences can aid in creating awareness regarding coordination mechanism choices to encourage a more effective use of coordination mechanisms. The following paragraphs investigate the differences in the usage of coordination mechanisms, after which the role of preference assessment tools is discussed. Finally, literature on how to arrive at a more effective use of coordination mechanisms is investigated.

6.2.1. Differences in the usage of coordination mechanisms

To study differences in the usage of coordination mechanisms this paper examines the literature on coordination mechanisms and outlines their differences, before exploring these differences on both an individual and team level. There are various coordination mechanisms which aid project teams in dealing with interdependencies between the various parts and work packages (Thompson, 2017). Often, a desire exists to address complexity in projects by employing planning & control responses, which are inspired by Thompson (2017) fundamental work on coordination mechanisms. Johnson (2013), for example, argues that technical complexity and novelty were important drivers for the establishment of project management as an activity in the twentieth century, one which heavily relies on the coordination mechanism of planning & control. Furthermore, Koppenjan et al. (2011) demonstrate that when addressing coordination in projects, a strong focus is often placed on planning & control mechanisms, especially when it comes to managing risks. Maylor and Turner (2017) see project management tools as a good response to structural complexities, which are characterized by scope, interdependence, and speed. Such responses, shaped by project management tools, can be described as “planning & control” responses (Meredith et al., 2017). Although empirically, there is a strong focus on planning & control activities, there are also arguments in favor of a more nuanced view of project coordination (Geraldi et al., 2011; Maylor et al., 2018). For instance, Koppenjan et al. (2011) demonstrate that in large technocratic
projects, tension exists between the desired focus on planning & control, and the requirement to remain flexible in the face of task uncertainty. In light of this, Liu and Leitner find that managers respond to complexity by being ambidextrous in their coordination mechanism choices, employing both strategies of exploitation and exploration (L. Liu & Leitner, 2012). As such, ambidexterity shows characteristics of planning & control (exploitation) and of dealing with uncertainty (exploration). Maylor and Turner (2017) argue that emergent complexity, characterized by elements of novelty, uncertainty, and lack of experience, can be addressed with flexibility. Examples of flexibility include the agile project management mindset, as well as using the SCRUM framework (Highsmith, 2009). In addition, test- and learning-based approaches to learning from mistakes are another example of the increased flexibility often used in tightly coordinated teams (Edmondson, 2004). Finally, an additional complexity exists, namely that of dealing with the differences between the individuals involved. As such, Staadt (2012) addresses the complexity related to reciprocal incomprehension in projects with the soft systems methodology. This is an example of relational coordination, which builds on the concepts of shared knowledge, shared goals, and mutual respect (Bolton et al., 2021). Maylor and Turner (2017) view relationship-building as an appropriate response to socio-political complexity, which is defined by conflict, politics, and lack of mutual understanding. Especially in knowledge-intensive organizations, relationship-development is important to meet the dual requirement of building centralized and strategic as well as diversified and local collaboration capacity (Barker Scott & Manning, 2022).

6.2.2. The role of preference assessment tools

Preference assessment tools are often used in the form of personal assessment tools in order to investigate self-reported personal traits, and their influence on behavior within a team setting (Ones, Dilchert, Viswesvaran, & Judge, 2007). There are numerous examples of these tests, such as, the Myers-Briggs type indicator (Myers, 1962), the Belbin’s team role model (Aritzeta, Swailes, & Senior, 2007), or the Thomas-Klimann conflict mode Instrument (TKI) (K. W. Thomas, 2008). In the literature on negotiation and bargaining, a personal assessment based on the TKI principles has been found useful in order to ascertain awareness of various topics and the different styles that exist (Shell, 2001). As such, the TKI principles appear to be valuable and reliable for the purpose of ascertaining coordination mechanism style awareness. Moreover, TKI is a valuable tool for identifying personal style choices, as proven by the fact that TKI revealed a high consensus between the test results and the individual’s own perception of their behavior (Shell, 2001). As such, the results of using personal assessment tools can help professionals in making choices based on their scores. In line with this, Ones et al. (2007) found that self-reported personality tests can be used in organizational decision-making including personnel selection. Nevertheless, there are risks related to employing personal assessment tools in a team setting. Schmitt and Oswald (2006) suggest cautious use of personal
assessment tools and argue for only using them when they are directly linked to some outcome. As such, they only see potential in using these tools when the preference assessment measures are directly linked to job tasks in a valid and relevant way. Since the identified coordination mechanisms according to the framework of Maylor and Turner (2017) are directly matched to the complexity of the work task, this approach can be incorporated into the preference assessment tool. Therefore, a preference assessment tool, when used for determining a professional’s preference for coordination mechanisms, can be a useful way to improve the awareness of coordination mechanisms and facilitate coordination mechanism effectiveness. As has been discussed in the previous section, the effectiveness of coordination mechanisms is enhanced through a good fit between experienced complexities and chosen responses. This is the case since for each level of contingency there is a fit that can be established, with a high fit leading to effectiveness (Donaldson, 2001).

6.2.3. Towards a more effective use of coordination mechanisms

According to Maylor and Turner (2017) all three coordination mechanisms: planning & control, relationship-building, and flexibility are important in projects. As mentioned above, coordination mechanism choice may be influenced by cultural aspects and personal competences, and may be biased towards a certain mechanism. Nevertheless, the effective use of coordination mechanisms, while simultaneously focusing on topics such as fostering continuous change, cross-cultural communication, and coping with uncertainty and varying frames of reference, is crucial to addressing the majority of complexities (J. Thomas & Mengel, 2008). There are multiple options for enabling professionals to use more effective coordination mechanisms in projects, such as by addressing the root of the problem: changing the organizational culture. This involves an extensive change, requires much time and effort, and often leads to identity problems (Alvesson & Sveningsson, 2015). Another approach to creating a more effective coordination style usage is by selecting employees with more diverse personalities, whose individual preferences in using coordination mechanisms vary (Ones et al., 2007). In this case, the person can be matched with the fitting project (complexity). However, structuring a team around diverse individuals is time consuming and involves many other issues, such as employing the correct model for the job and organizational context (Hollenbeck, 2009). Finally, an easier to implement, and more expedient solution is creating awareness of the different coordination styles and the preferred way of working of the individuals involved. According to Shell (2001), creating awareness of the topic and the different styles can be achieved by using preference assessment instruments. It ultimately stimulates the individual in changing their usual behavior concerning coordination mechanism usage.

6.3. Methodology

The methodology section introduces the design science research approach that has been followed to arrive at a solution design. Particular attention has been paid to its fit with organizational studies and measures to ensure rigor and quality of this qualitative study.
6.3.1. Design science research methodology

As discussed in the literature review, project environments with many different stakeholders, such as is the case in the railway system, make for authentic problem contexts which require in-depth, complex negotiations, which in turn set boundaries on the feasibility of potential solutions (Groop et al., 2017). That is why we need to develop solutions that are compatible with the complex context. Furthermore, the project management methodologies, such as PMBOK, reveal a unilateral coordination mechanisms focus in project environments (Morris, 2013), whereas complexities experienced are often more diverse (Geraldi et al., 2011). To establish a better fit of coordination mechanisms applied, it is necessary to start creating awareness on the different options available to project managers. Therefore, a good understanding of why a particular solution works in a given context is helpful.

Design Science Research (DSR) as a methodology is driven by practical problems and focuses on studying solutions that address these problems encountered in the field (van Aken & Romme, 2009). It is useful in situations where practitioners want to identify which solutions work and do not work in particular instances (van Aken & Rommê, 2009). Therefore, DSR can be used to create artifacts that solve important organizational problems. Despite the recognition of the benefits of incorporating DSR into the field of organizational and management studies (Jelinek et al., 2008; van Aken, 2007; van Aken & Romme, 2009), and in particular for this studies context, it has only been applied in a few cases. As such, DSR appears appropriate to develop a test for assessing professionals’ coordination mechanism preferences in order to create awareness of suitable coordination mechanisms and the importance of effective coordination mechanism usage. DSR is often applied in technocratic and engineering-driven environments and tends to focus on the effectiveness of the designed solution in terms of meeting the design criteria. Nevertheless, especially in organizational studies employing DSR can assist practitioners in identifying and adopting design principles, as well as learning from these (van Aken, 2007). Within DSR, design principles are understood as knowledge about creating artifacts which in turn can be used as rules for creating similar instances of artifacts (Markus et al., 2002). Identifying and evaluating such design principles will be a major part of this study, allowing for the use of generalizable principles from other organizational settings.

Employing DSR in project coordination gives rise to many novel research opportunities. Firstly, the available instruments for project coordination often focus on one specific coordination mechanism, namely planning & control (Morris, 2013). Nevertheless, the nature of complexities experienced in projects is often more diverse than what can be addressed with a one-size-fits-all approach (Williams, 2005). A DSR process that identifies design principles can be helpful in this context because it suggests principles that can work in a particular situation without being too prescriptive about the exact solution (van Aken, 2007). Secondly, in organizational and management studies it is often noted that the connection between science and practice is missing (van Aken & Romme, 2009). DSR strengthens this connection by
encouraging practitioners to apply more of the principles identified in their own contexts and thus learn from science. Thirdly, another major focal point of research on complex projects is gaining a better understanding of their functioning using an inside perspective (Söderlund et al., 2017). The results of the design will shed light on the coordination mechanism preferences of professionals working in complex project environments, thereby also contributing to a better understanding of the internal workings and their influence on project performance.

This study aims to develop and evaluate an appropriate design solution for the specific problem context of underutilization of fitting coordination mechanisms. Therefore, it will follow the DSR process steps as described in Figure 6.1. The steps are further described in section 4 of this chapter.

Figure 6.1. The design science research process emended from Peffers et al. (2007)

6.3.2. Rigor and quality of the study

To ensure rigor and quality, this qualitative study employs several tests during the various DSR steps (see Table 6.1). A key measure for establishing validity in qualitative studies is data triangulation (Golafshani, 2003). Moreover, several tests for ensuring design science validity exist (Larsen et al., 2020), and this study focuses on three of these validities. Data input validity ensures that the data used as input for the artifact is suitable for use. Theoretical validity ensures that the theory used is grounded in concepts from relevant literature. Internal design validity ensures that the components employed in the design are consistent and explainable. Finally, reliability of the results is encouraged by providing transparent information on the data sources.
Table 6.1. Tests to ensure rigor and quality of the study.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Approach</th>
<th>Process step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangulation</td>
<td>Multiple sources of evidence: semi-structured interviews, document analysis.</td>
<td>Problem exploration</td>
</tr>
<tr>
<td>Data input validity</td>
<td>Classifying the input statements of the test according to the three coordination mechanisms, performed by three fellow researchers.</td>
<td>Building the artifact</td>
</tr>
<tr>
<td>Theoretical validity</td>
<td>Design principles are derived from literature and their use is evaluated.</td>
<td>Design principles</td>
</tr>
<tr>
<td>Internal design validity</td>
<td>The components of the design are derived from, and supported by, the DSR process (Figure 6.1).</td>
<td>DSR process</td>
</tr>
<tr>
<td>Reliability</td>
<td>Data source tables for more transparency on the collected data (appendix A1.8 and A1.9)</td>
<td>Data collection</td>
</tr>
</tbody>
</table>

6.3.3. Case introduction

Developing a solution to a problem with practical relevance in the field, and testing the application of designed artifacts in the real world, comprises an essential step in DSR (van Aken & Romme, 2009; Wieringa, 2014). The Coordination Mechanism Preference Assessment (COMPASS) artifact has been developed and implemented by the process and implementation management team of NS. NS is the primary railway passenger operator in the Netherlands, and when integrating and improving crucial system parts, closely collaborates with ProRail, the railway infrastructure manager, contractors, suppliers, and/or the governmental body for railway transportation, acting as system integrator. As such, the process and implementation management team is continuously working on system integration matters, learning from past implementations, and improving the quality of integration processes for the railway system. The team consists of 15 people, of whom nine work on implementation tasks, five work on process quality tasks, and one is responsible for administrative work. Each of the team members has a variety of responsibilities and are involved in inter-organizational projects, such as the ERTMS project, where they work together with project members from a wide range of different stakeholders and backgrounds. The team has recently been merged, currently consisting of the previously separate implementation management and process management teams. As such, not all members are equally familiar with the individuals involved, and the work processes and methods employed.
6.4. Designing a Coordination Mechanism Preference Assessment Tool

For the design process of the COMPASS tool the steps of the DSR methodology are applied, starting with problem exploration in terms of coordination needs, establishing design criteria, from which design principles are derived. Afterward, the design has been developed, and implemented and tested with the implementation management team. Finally, the tested design has been evaluated with the group.

6.4.1. Problem exploration

As an initial exploration, documents, such as summaries of workshops conducted with the help of virtual collaborative brainstorming environments, have been analyzed (see appendix Table A1.8 for more information on the documents). Such documents list the activities which the process and implementation management team has defined to be carried out in the next year to encourage team cohesion. Therefore, these activities pertain to the functioning of the team, rather than their regular output. The activities have been categorized into topics which the team is currently addressing, as depicted in the left column of Table 6.2. Subsequently, all the identified activities per category were classified according to the three different coordination mechanisms: planning & control, relationship-building, and flexibility. For example, the team indicated a desire to “optimize the systems by carrying out cross-fertilization”, which has been classified as a measure to strengthen their internal relationships, since it enables shared knowledge through interaction (Bolton et al., 2021). The results of this first classification step can be found in Table 6.2. After conducting the analysis, the results have been verified by one of the implementation managers.

Table 6.2. Summary of the categorized activities the team is addressing.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Planning &amp; control</th>
<th>Relationship-development</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work-processes, tasks</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Staff competencies, training, instructions</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Systems</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Existing key performance indicators</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Chain Process</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Guidelines, policies, laws and regulations</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Communication</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Participation council</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td><strong>26</strong></td>
<td><strong>24</strong></td>
<td><strong>6</strong></td>
</tr>
</tbody>
</table>
The findings of the problem analysis step, represented in Table 6.2, reveal two important issues. Firstly, there is no clearly identifiable trend for each pinpointed activity type. For example, for activities such as “communication”, one would expect a clear tendency toward relationship-building coordination mechanisms, since communication is a major input variable when building relationships in the team. However, the usage of coordination mechanisms in the area of communication is relatively balanced. Similar observations can also be made for the activity type “work-processes, tasks”, which is expected to be coordinated mainly by means of planning & control, whereas currently, coordination is primarily handled through relationship-development. Secondly, by reviewing the overall coordination mechanisms identified across all activities, there is a clearly visible trend toward planning & control and relationship-development, and a lack of application of flexibility. As such, the analysis does not reveal a balanced use of coordination mechanisms. Thirdly, as a newly formed team there are still a lot of unknowns that have to be investigated and defined. For example, as has been outlined in the case introduction, the team members are not yet familiar with other individuals involved and the work processes and methods employed in the team. This indicates a high degree of emergent complexity, which, according to Maylor and Turner (2017), requires more flexibility when the fit between experienced complexities and chosen responses should remain high. As revealed in the literature review, a low fit can have a negative impact on the effectiveness of coordination mechanisms.

In addition to analyzing the documentation of identified activities, semi-structured interviews with all 15 implementation- and process quality managers have been conducted (see appendix, table A1.9 for information on the interviews and appendix A4. on the interview guide). In these interviews particular focus has been placed on the regular activities of day-to-day operations (see appendix A4.8 for the interview guide). The execution of the discussed activities the team engages in as part of day-to-day operations demonstrates a preference for relational coordination, since these activities enabled a more continuous and informal exchange between the participants. For example, every two weeks a “team-up” is organized, which is a form of a stand-up meeting in which emphasis is placed on getting to know the other railway professionals and their work. Additionally, a moment of contact is scheduled each morning to ensure informal exchanges between individuals. Finally, implementation managers are encouraged to collaborate on assignments with other implementation managers in order to learn about each other’s work and the methods they employ. All of these activities vary in level of popularity and usage, some railway professionals are enthusiastic about them, while others see them as less useful and participate only occasionally. By judging a coordination mechanism’s usefulness, the professionals reveal an implicit preference for certain coordination mechanisms. Nevertheless, they may be unaware of this preference, and consider the activities that enable such coordination mechanisms to be less useful instead of identifying activities they may consider more useful.
6.4.2. Design criteria

As outlined in the problem exploration, proper coordination within teams is vital, yet team members may be unaware of the coordination mechanisms available to them. Additionally, the coordination mechanisms applied in the team are not always fitting. This study aims to design a coordination mechanism preference instrument to serve as a first step toward encouraging a more effective use of coordination mechanisms in the team. Table 6.3 presents an overview of the DSR objective and design criteria.

Table 6.3. Summary of design criteria.

<table>
<thead>
<tr>
<th>Objective and criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall objective</td>
</tr>
<tr>
<td>Criterion 1</td>
</tr>
<tr>
<td>Criterion 2</td>
</tr>
<tr>
<td>Criterion 3</td>
</tr>
<tr>
<td>Criterion 4</td>
</tr>
<tr>
<td>Criterion 5</td>
</tr>
</tbody>
</table>

In order to achieve the overall objective, a design that fits the five design criteria needs to be established, after which more emphasis can be placed on facilitating more effective use of coordination mechanisms. This entails first identifying each professional’s preferences followed by the average group preference for specific coordination mechanisms. After this, awareness of the coordination mechanisms available to the railway professional needs to be created. Finally, making it possible to discuss the coordination mechanisms and thereby also encouraging people to improve their coordination behavior.

6.4.3. Design principles

The design of the COMPASS tool borrows from multiple design principles. As such, these exapted strategies reveal that design knowledge previously created in one field can also aid in solving problems in new application areas (Gregor & Hevner, 2013). In the following paragraphs, the design principle’s origin and usefulness for COMPASS are briefly discussed.
6.4.3.1. The Coordination mechanisms according to the responses used by Mayor & Turner

As explained above, Maylor and Turner (2017) defined three different coordination mechanisms that aid in dealing with different forms of complexity. These dynamic complexities pose unique challenges due to their variable nature, as they can consist of structural (e.g., interdependencies), socio-political (e.g., people), and emergent (e.g., uncertainties) elements (Geraldi et al., 2011; Maylor et al., 2018). Each complexity can be best addressed by means of a specific coordination response. Responses to structural challenges are informed by planning & control, whereas responses focused on solving socio-political issues are rooted in relationship-development. Lastly, emergent complexities call for a response based on flexibility. For more information on the complexities and how to coordinate these, see Figure 6.2. The complexity categories can be used in the preference assessment as examples of representative situations. Furthermore, the coordination mechanism categories and their associated responses can be incorporated into the preference assessment as examples of representative statements about possible reactions to the given situation. As such, the framework of Maylor and Turner (2017) provides a key design principle which was integrated into the preference assessment tool.

Figure 6.2. The CRF showing the preferred coordination response to the experienced complexities.

6.4.3.2. The preference assessment tool inspired by the Thomas-Klimann Conflict Mode instrument

To develop a coordination mechanism preference assessment tool, the Thomas-Klimann Conflict Mode Instrument (K. W. Thomas, 2008) has been used as a guideline. While developing TKI, Thomas and Klimann looked for a measurement tool to test the validity and independence of the five modes of conflict posited by Blake and Mouton (1982). In order to do this, they defined statements that represented each of the five conflict modes. These statements were designed in such a way that they were simple to understand, repeated several times, and formed in such a way that respondents would select them over other equally compelling statements.
(Shell, 2001), these statements were paired into 30 combinations. By scoring the TKI statements one over the other the instrument measures self-reported preferences for using the five conflict modes: an example of this is provided in Figure 6.3. K. W. Thomas (2008) chose to present the 30 pairs of statements to each respondent situation-independently, in order to decrease bias in the answers.

*Circle the letters below corresponding to the statement that is most characteristic of your behavior*

<table>
<thead>
<tr>
<th>Competing</th>
<th>Collaborating</th>
<th>Compromising</th>
<th>Avoiding</th>
<th>Accommodating</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>A</td>
<td></td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>B</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>25</td>
<td>A</td>
<td></td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>26</td>
<td>B</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>A</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>28</td>
<td>A</td>
<td></td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>B</td>
<td></td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.3. Based on an example from the Thomas-Klimann Conflict Mode Instrument – scoring method (K. W. Thomas, 2008).

Afterwards, the raw score can be calculated by summing up the preferences per conflict mode. This indicates the individual’s preference and helps to uncover individual differences. The TKI scores are graphed, and the raw scores are compared to normalized scores (based on a sample size of at least 8000 entries) to indicate preferences compared to others (see Figure 6.4).
Graphing your TKI-Score

<table>
<thead>
<tr>
<th></th>
<th>Competing</th>
<th>Collaborating</th>
<th>Compromising</th>
<th>Avoiding</th>
<th>Accommodating</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>100%</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11, 12</td>
</tr>
<tr>
<td>25%</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>90%</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80%</td>
<td>7</td>
<td>7</td>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>70%</td>
<td>6</td>
<td></td>
<td></td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Figure 6.4. Normalized scores of the Thomas-Klimann Conflict Mode Instrument – can be used for comparison with individual scores (K. W. Thomas, 2008).

TKI is a tool which is easy to use and takes roughly 10 minutes to complete, provides relative independence from social desirability bias, represents conflict styles that are widely used, and appears to represent the individual’s own behavior well (Shell, 2001). This has also been remarked on by Womack (1988), who finds that teachers who use it rate the ease of use and effectiveness in uncovering individual differences highly. As such, using the principles of pairing simple statements that represent the three different coordination mechanisms and scoring an individual’s preferences for coordination mechanisms seems to be well suited to the design of a coordination mechanism preference assessment tool. Nevertheless, since each coordination mechanism best addresses a complexity in a certain context, it was decided to incorporate situational-dependence in the test in order to represent all three complexities of Maylor and Turner (2017) to an equal extent.

6.4.3.3. The team-based assessment

As described in the previous paragraph, after receiving the individual’s raw scores, these are compared against normalized scores in TKI, which were established by means of conducting the test with a sample of roughly 8000 participants (K. W. Thomas, 2008). Since the scope of this study is not as expansive, and this study aims to facilitate the effective use of coordination mechanisms, it was decided to include a team-based assessment of the coordination mechanisms instead. Team-based assessment is often used in education, and its reported benefits are (Brown & Malenfant, 2016):

- a shared understanding between the team members,
- discussion of important elements leading to increased agreement on important attributes,
- the development of competencies that contribute to the team’s success.
The team-based assessment builds on team-based learning, a strategy that engages individuals’ knowledge through individual testing and group collaboration (Cestone, Levine, & Lane, 2008). Following the collection of individual answers, these are discussed within the team to enable immediate feedback and clarification (Cestone et al., 2008). This, as well as comparing their own scores to that of other team members, who work on similar tasks, can aid the professionals in understanding their own scores better. Moreover, within the team setting, one can identify leading and lacking coordination mechanisms in order to identify which still need to be developed. Finally, the discussion of coordination mechanisms applied in certain contexts can encourage more effective use of coordination mechanisms.

6.4.4. COMPASS – Coordination Mechanism Preference Assessment

The designed COMPASS tool consists of two components: a personal assessment test which each team member can fill out individually within 10 minutes, and a team-based assessment where the professionals can discuss their scores collaboratively. There are four phases to undergo, into which these two components fall (see Figure 6.5).

Figure 6.5. The COMPASS process.

The first component consists of the coordination mechanism preference assessment test each professional has to fill out individually. The test consists of 36 pairs of statements, sub-divided into three categories. Each of the categories reflects one of the complexities that the coordination mechanisms address: structural, socio-political, and emergent. The three coordination mechanisms: planning & control, relationship-development, and flexibility, are incorporated into the coordination mechanisms preference assessment tool using statements that reflect an activity that contributes to one of these mechanisms. Per situation category, each statement representing a certain coordination mechanism is matched with a statement linked to one of the other two coordination mechanisms. For example, the test poses the question “In case of disagreements within the team, how would you most likely respond?” representing a socio-political complexity. For each of the coordination mechanisms, four coordination responses were provided, the statement “I immediately write down the different points of view and make agreements on how to proceed”, for example, is a planning & control-based response. This results in 36 pairs of coordination mechanism statements (3 situations x 3 coordination mechanisms x 4 responses). Based on this, the maximum score per coordination mechanism
that can be achieved is 24, which represents a 100% preference. After each railway professional has completed the test by choosing one of the statements in a pair that reflects their preferred coordination approach, the test scores of this professional and the average score of the team members which have similar job functions, are provided to the group as feedback. The designed COMPASS test is depicted in the appendix A3.

The second component is a team-based assessment of the professionals who conducted the COMPASS test. The team-based assessment can be used for the railway professional to reflect on their own score and how they score compared to individuals who perform similar tasks. Moreover, in the discussion, the professionals can identify coordination mechanisms that are not well developed and identify possible actions for addressing this. This will be encouraged by asking the team targeted questions, enabling reflection and encouraging action.

When applied to a practical case, these two components are conducted in four phases as depicted in Figure 6.5. The contents of the various phases of the COMPASS tool are described in Table 6.4.

Table 6.4. The phases of the COMPASS implementation.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
<th>Main activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Case selection</td>
<td>Choose a project team that aims to create more insight into their preferred way of coordinating.</td>
<td>Choose a project team. Understand the context the team is operating in. Become familiar with the team and its members (introductory meeting).</td>
</tr>
<tr>
<td>II Individually fill out the COMPASS test</td>
<td>Conduct the preference assessment test with the project group.</td>
<td>Provide the questionnaire to each team member and ask them to fill it in quickly (max. 10 min). Do not overprepare the team regarding the topic of coordination differences. Emphasize that test results will only be shared anonymously within the group.</td>
</tr>
<tr>
<td>III Analysis of the COMPASS test</td>
<td>Analyze the answers with the help of the answer sheet.</td>
<td>Establish the preferred project coordination approach per individual by means of the answer sheet. Summarize the average group results of people with similar job functions and write these on the score sheet, along with the individual scores.</td>
</tr>
</tbody>
</table>
4.5. Implementation of COMPASS

The designed COMPASS tool was put into practice within the process and implementation management team of NS, the members of which all work on large inter-organizational projects. Additionally, this use-case team cooperates with many different departments, including some outside of NS. As such, outlining the individuals’ preferences concerning coordination mechanisms and how these might differ within the team, can aid each professional in navigating their complex inter-organizational work environment better. An example of test scores is provided in Table 6.5. Such a filled out score sheet is provided to the professionals before the team-based assessment takes place. It shows how the individual scores compares to the scores of professionals that work on similar tasks, and thereby provides a foundation for the discussion taking place in the team-based assessment.
Table 6.5. Example of COMPASS test score sheet supplied to professionals. The left side depicting the group average of the coordination preference and the right side depicting the professional’s own coordination preference score.

<table>
<thead>
<tr>
<th>Group average</th>
<th>My score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning &amp; control</td>
<td>Relationship-development</td>
</tr>
<tr>
<td>100%</td>
<td>24</td>
</tr>
<tr>
<td>75%</td>
<td>17</td>
</tr>
<tr>
<td>50%</td>
<td>13</td>
</tr>
<tr>
<td>25%</td>
<td>9</td>
</tr>
<tr>
<td>0%</td>
<td>6</td>
</tr>
</tbody>
</table>

6.4.6. Evaluation of the design principles

The application of COMPASS within the process and implementation management team of NS revealed both expected and unexpected results. Using observations and an evaluation session after the application (see appendix Table A1.9 for more information on the data collection for the evaluation and appendix A4.9 for more information on the interview guide), the results were linked to the design principles, see Table 6.6. The design principles are based on concepts that have been applied successfully in other contexts. Therefore, the outcomes listed in the table increase the understanding of these theories when applied to new fields. This table presents an overview of how COMPASS functioned in the case study.
Table 6.6. Design principles of the COMPASS tool.

<table>
<thead>
<tr>
<th>Design principles</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The coordination mechanisms</td>
<td>Focuses attention on the different ways teams can coordinate their tasks. Creates awareness of the benefits and drawbacks of using the different coordination mechanisms. Creates awareness of which situation a certain coordination mechanism is most useful for.</td>
</tr>
<tr>
<td>The preference assessment tool</td>
<td>Identifying the individual preferences concerning coordination mechanisms, including an average score of the group of professionals with similar job requirements.</td>
</tr>
<tr>
<td>The team-based assessment</td>
<td>Enables the comparison of individual scores to each other’s. Enables comparing individual scores to the average group score. Makes the individual and team scores discussable. Provides the opportunity to implement the concept of coordination fit into daily processes to ensure more effectiveness.</td>
</tr>
</tbody>
</table>

Generally, the COMPASS tool appears well-suited to encourage the effective use of coordination mechanisms. Conducting the COMPASS test individually and afterward comparing the individual and average group scores was perceived as valuable and invigorated the team. When the professionals received their scores regarding the coordination preferences, as well as the average scores of a group of professionals with similar tasks, most indicated seeing their own behavior reflected in the scores they received. The team manager phrased it as follows:

“When we received the scores, we started talking to each other about them. It was very nice to see the differences between individuals. Overall, most implementation and process managers could recognize their behavior in the scores.”

This indicates that the COMPASS tool identifies the individual and average group coordination mechanism preferences well (design criteria 1 and 2). Furthermore, an explanation of the three different coordination mechanisms is provided in the scoring document, explaining common behavior and when such coordination mechanisms are often used. During the evaluation session, team members further indicated recognizing the three different coordination mechanisms in the activities and tasks they conduct. For example, one of the implementation managers mentioned:

“I am someone who focuses a lot on relationship-building and finds this very important. I can see this reflected in the scores.”

As such, the COMPASS tool created awareness regarding the three different coordination mechanisms: planning & control, relationship-building, and flexibility.
(design criterion 3). During the team-based evaluation, discussions were facilitated, and questions were asked of the facilitator. One of the railway professionals mentioned:

“We, as the process and implementation management team, are very much focused on relationship-building. This is mainly due to the activities that we currently conduct considering our recent team merger. We realize the importance of first establishing a proper foundation, after which we can focus on other activities which build on one of the other two coordination mechanisms.”

Similarly, one of the implementation managers noted:

“I feel you can react differently in different situations, and this is reflected in my scores.”

This indicates that awareness of the three coordination mechanisms has also increased, and that the usage of coordination mechanisms depends on the situation. As such, the situational dependence that was incorporated in the COMPASS test can be used in order to create awareness regarding the context dependence of suitable coordination mechanisms. Moreover, the results indicate that participants discussed several factors which may explain their preferences. As such, the team-based assessment made it possible to discuss coordination preferences and its implications (design criterion 4). Finally, during the team-based assessment, possible uses of the results of the preference assessment were discussed, as well as how the three coordination mechanisms can be implemented in their daily work processes as part of the complex projects they participate in. One of the implementation managers identified a direct connection to the implementation tools the team employs in projects:

“When we are working on implementation processes, we can use the framework to classify the impacts into complexities and determine the most adequate response. In the case of implementation management, it is useful to use this kind of thinking in our daily work.”

Similar connections were made by the process management part of the team, which shows that using the COMPASS tool can directly improve the coordination behavior of professionals in order to encourage the consistent inclusion of the different coordination responses into their daily work in complex projects (design criterion 5). To summarize, the COMPASS tool encourages a more effective use of coordination mechanisms that are aligned with the demands of the situation and can be institutionalized into the professional’s work tasks.

6.5. Discussion

The results of the COMPASS application have revealed implications for the differences between coordination mechanisms, the usage of preference assessment tools, and the effective use of coordination mechanisms as discussed in section 6.2.
Firstly, in the literature review we have outlined that the three different coordination mechanisms are best suited for different contexts. Therefore, this context-dependence of coordination mechanisms is reflected in the statements incorporated into the preference assessment tool. The original TKI assessment eliminates the situational dependence by using situation-independent statements. As previously discussed, the authors of this study chose to incorporate a situation dependence into the COMPASS tool, since all three coordination mechanisms have different complexities which are addressed better by each. As such, these contextual complexities should be equally represented in the statements. Another reference point for the contextuality of the coordination mechanisms is the situation in which the professionals implementing the COMPASS tool currently find themselves. The process and implementation management team was in the process of merging two previously separate teams, during which they prioritized building relations within the team in order to increase their familiarity with the new members. This may have influenced the results and caused them to focus more on relational coordination when providing their answers, which provides a possible explanation for why the average group scores this highly on relational coordination. Both these aspects demonstrate that, on the one hand, context dependence is needed in the COMPASS tool in order to represent all coordination mechanisms equally well, and on the other hand, context dependence can influence the results, depending on the context the professionals currently operate in.

Secondly, we have outlined that preference assessment tools are often used to investigate self-reported personality traits and their influence on behavior. Since the scope of this study has been limited to identifying both the individuals’ and the average group coordination preferences, in order to improve a railway professional’s coordination efforts by enabling them to use more effective coordination mechanisms, no effort has been made to determine where such preferences have originated. In addition to an individual’s personality, their coordination preferences may also be influenced by their environment, the technical system they are working on, the type of tasks they perform, or the organizational culture they operate in. For example, the process and implementation management team uses many methods and tools that build on the concept of relational coordination in their daily tasks in order to deal with the complex context of working with many different system stakeholders. This may be a possible explanation for their high scores on relational coordination. Another possible explanation of the unequal scores may be the unit of analysis showing a homogenous team that has been chosen for this case. The COMPASS tool has been applied in an intra-organizational setting where the group of professionals who conducted the assessment work in the same team and are part of the same organizational culture. This may explain why the preferences of the team members were fairly similar; most of them preferred relational coordination activities. Nevertheless, the team members all work in inter-organizational settings, where they are exposed to different external influences. When utilizing the COMPASS tool in a more diverse setting, with stakeholders from different organizations and different parts of the system, more differences in terms of coordination preference
results could be expected. In summary, all these factors may potentially play a role in choosing a certain coordination mechanism over another one. Even though identifying the reasons behind a person’s preferences was outside of the scope of this study, this tool is a first step in answering these questions since it makes professionals aware of their preferences.

Thirdly, we have discussed that creating awareness of individual preferences and coordination fit is advantageous in order to encourage effective use of coordination mechanisms. For this, the team-based assessment part of the COMPASS tool is essential. The team-based assessment took place within the group, with 12 team members present. The average group scores were presented and discussion among the professionals was encouraged. This has aided in accomplishing the study’s goal of creating awareness of coordination mechanisms and encouraging an effective use of coordination mechanisms, because coordination mechanisms and professional’s preferences were elaborated on. Several team members indicated that they could use the three different coordination mechanisms in their daily work, indicating a willingness to use more effective coordination mechanisms. Using more targeted coordination mechanisms which fit the complexities the professionals experience in complex projects, can strengthen the effectiveness of the coordination mechanisms employed. As such, the COMPASS tool can be a steppingstone in addressing issues of project performance, by contributing to relevant aspects of effectiveness such as time constraints and stakeholder satisfaction.

In summary, the discussion of the COMPASS tool demonstrates that it aided in identifying individuals’ and the teams’ coordination preferences, as well as creating awareness of the three different coordination mechanisms. Moreover, it can be regarded as a steppingstone towards more effective coordination mechanism usage.

6.6. Conclusion

The goal of the designed COMPASS tool was to create awareness of coordination choices and aid in effective use of coordination mechanisms. The tool design is based on the premise that project management methodologies reflect a focus on planning & control mechanisms, whereas other coordination mechanisms may be equally important, but are often undervalued. Addressing the experienced complexities with fitting responses leads to more effective coordination mechanism usage.

In order to accomplish the main goal of this study, the design is based on three design principles. Firstly, the three coordination mechanisms based on Maylor and Turner (2017) are used in order to create awareness of these, and when the use of each is most appropriate. Secondly, the preference assessment tool based on TKI (K. W. Thomas, 2008) was implemented to establish the preference scores of both the individual professional and the group. This helped to create awareness of underutilized coordination mechanisms. Thirdly, team-based assessment was employed in order to encourage the discussion and implementation of the assessment results into the professional’s work processes, which serves as a first step towards improving coordination mechanism usage.
Previously, no single tool existed which focuses on assessing the preference for coordination mechanisms in order to enable a more effective use of these. The employed design principles of TKI and the team-based assessment are adapted to the problem context of coordination mechanism effectiveness. As such, the COMPASS tool shows potential for expanding the knowledge created in negotiation literature to the field of coordination mechanisms, thereby revealing new areas of application.

6.6.1. Limitations and future research

One of the limitations of this study is the lack of statistical generalizability (Rowley, 2002) since the COMPASS tool has only been implemented in one case. Though most of the team members indicated that the scores reflect their coordination efforts well, only a limited amount of preference assessments have been conducted. In order to draw more generalizable conclusions regarding the representability of the preference assessment scores, the implementation of the COMPASS tool should be repeated. Another limitation of this study is the homogenous unit of analysis. The team members which have conducted the preference assessment all work in the same department. As such, both the organizational culture, as well as the methodologies they use in their daily tasks are very similar, which may explain their preference for relational coordination. Testing the COMPASS tool with another group that has more diverse members, such as in a complex inter-organizational project, where team members have different backgrounds and work for different organizations, will provide better insight into the tool’s validity. Nevertheless, other tests to ensure the validity of the design have been employed, for instance the internal data validity was ensured by categorizing the statements of the test according to the three coordination mechanisms, performed by three fellow researchers.

The study provides several opportunities for future research. Firstly, the study identifies an opportunity for research by modifying the design to be situation independent. This follows from the logic of K. W. Thomas (2008), who developed the Thomas-Klimann Instrument to be situation-independent in order to prevent biases. The statements used in the COMPASS tool can also be used situation-independently in a future study, which would possibly decrease biases that may be introduced by providing context to the participants. In this study, the context dependence was useful since it aided in representing all three complexity categories equally well. Secondly, studying the improvement aimed at during the team-based assessment step can be conducted in smaller groups in order to encourage peer feedback. This can potentially enable more reflection and openness during the discussion and could lead to participants improving their coordination behavior even further. Finally, another opportunity for future research can be found in studying the reasons behind a professional’s and/or average group coordination preference. The root causes of coordination mechanism preferences have been outside of the scope of this study but can be investigated in a follow-up study in order to create more awareness of factors which drive the coordination behavior of professionals. This could further encourage project professionals to employ more effective coordination mechanisms.
Chapter 7: Discussion and Conclusion

The final chapter presents the main conclusions of this dissertation. It answers the main research question, discusses the six design propositions to improve inter-organizational project coordination, and elaborates the theoretical and practical implications of the research conducted.
7.1. Overview of the chapter findings

The research conducted in this dissertation started with the goal of understanding complexity in the context of decision-making for system integration challenges, and as such how to coordinate these projects more effectively. Participants working in the railway system, specifically the infrastructure manager and the transport operator need to find methods for dealing with the complexities they experience while improving it. These participants rely predominantly on planning & control mechanisms inspired by the project management methodology of PRINCE II, which is commonly used in Dutch railway projects. Moreover, there is limited awareness of other coordination mechanisms that exist, and could be employed to improve project coordination. Finally, socio-political complexities often dominate inter-organizational railway projects. This is caused by multiple factors, such as the presence of system integration challenges which occur since responsibilities for system parts are distributed, whereas risks are shared, and the decision-making process regarding the project as a whole needs to be performed collectively, even though individual stakeholders have different interests.

In the final chapter of this dissertation, particular emphasis is placed on answering the main research question that guided this dissertation, and on how it was addressed throughout the different chapters:

“How can inter-organizational project coordination mechanisms facilitate shared decision-making on system integration challenges over the project lifecycle?”

In the following paragraphs, the answer to the research question is provided by means of discussing the developed designs, and their design principles. The main question is answered through approaching it from two different perspectives, which results in the thesis which addresses the two main research themes:

1. understanding the problem context of inter-organizational projects (problem exploration), and
2. improving inter-organizational project coordination (solution development).

This is achieved through firstly, understanding the problem context, in which complexities play a fundamental role, better (research theme 1), and subsequently, developing designs and implementing them in the inter-organizational railway project context to improve coordination when facing system integration challenges (research theme 2). Regarding the employed methodologies, CIMO-logic has been employed to generate problem understanding, and design science research has been used to design tools that achieve more targeted coordination.

Subsequently, the dissertation reflects on how the individual chapters contribute to answering the main research question. Afterwards, the design principles that are used within this dissertation are discussed, and summarized into a set of generalizable design propositions. Then, the research contributions and their implications are outlined, followed by an examination of limitations and future research possibilities.
Reflection on research theme 1 – Understanding the problem context of inter-organizational projects (problem exploration)

Chapters 2 through 4 of this dissertation are concerned with understanding the complexities experienced within inter-organizational railway projects, in order to comprehend the challenges pertaining to system integration and shared decision-making, for which, the complexity-response framework has been used.

As such, the first sub-question (What are the complexities and coordination mechanisms in inter-organizational railway projects?) has been answered by operationalizing CRF for the context of the Dutch railway system. In doing so, this dissertation has been able to study the complexities experienced in this context, and which coordination responses were used in these inter-organizational projects. This operationalization demonstrates the applicability of the framework in the railway system context when it is adapted to the language of railway professionals. Moreover, conducting the analysis made practitioners more aware of the complexities they experienced. This provided the first stepping stone for being able to assess the fit between the experienced complexities and the coordination responses employed in inter-organizational railway projects.

The second sub-question (To what extent do applied coordination mechanisms fit with inter-organizational railway project complexities, and how does this affect coordination effectiveness?) has been investigated through using CRF for assessing the degree of fit. It has been established that professionals working in inter-organizational railway projects are more satisfied with the coordination efforts when there is a higher degree of fit. This results in more project effectiveness since projects reach agreeable decisions sooner. Moreover, since levels of socio-political complexities appear to be especially high at the beginning of a collaboration, project members seem to be more satisfied with the coordination approach when developing the relationship is prioritized from the start. For example, the complexity experienced by project members in the context of decision-making for systems integration challenges consists of having different perspectives, which lead to a lower mutual understanding of the problem. A preliminary investigation revealed that valuable tools for addressing these particular socio-political complexities are sharing knowledge among system stakeholders, and conducting shared sensemaking activities.

Also, when addressing the third sub-question (What coordination mechanisms are currently applied in decision processes in inter-organizational railway projects, and how do these facilitate decision-making?) this dissertation has made use of the operationalized CRF. The application of CRF to railway system cases reveals that currently a strong focus on planning & control mechanisms exists. This type of behavior is especially observed at the start of collaborations (in the pre-project phase) when the socio-political complexities are experienced to a higher degree. Moreover, when levels of pressure and uncertainty are high, project managers tend to shift their focus more towards controlling mechanisms. Possible reasons for this were explored, such as the industry and organizational cultures which are prevalent within the Dutch railway system. As such, the contextual factors being highly socio-political does not seem to
encourage a good fit with the employed coordination mechanisms.

Lastly, as a result of this lack of incentive for using fitting coordination mechanisms, triggering behavioral changes would be beneficial. The first step in creating these changes is creating more awareness, and in doing so, increasing interest in varied coordination mechanism usage.

**Reflection on research theme 2 - Improving inter-organizational project coordination (solution development)**

Chapters 5 and 6 this dissertation focus on improving coordination for inter-organizational railway projects.

For the fourth sub-question (How can the shared decision-making process of inter-organizational problem contexts be better designed and coordinated?), this research first investigated a micro perspective on the decision-making process that inter-organizational projects deal with, thereby, exploring how this process can be improved. In doing so, it was determined that it is better to build consensus about the problem before decisions about remedial actions are made. Therefore, the solutions developed should aid in defining the problem to be solved early in the process. Understanding the complexities of the problem context is therefore essential. Hence, the solution proposed in chapter 5 is not a solution in the traditional sense, since it does not provide a plan of action for ‘how to solve the problem’, because without a proper understanding of, and alignment on the problem context, solutions are ineffective. The designed solutions should therefore aid in coordinating the complexities experienced in the problem identification stage of the decision-making process. The social aspect of decision-making processes appears to be particularly difficult for technical experts, who are not encouraged to consider these aspects in other circumstances. This is evident in this research through the way in which these experts often use planning & control-oriented tools. As such, it is important to align the characteristics of the design artefact with the working process of railway professionals, such as by proposing a step by step process for discovering individual differences which hinder the decision-making process. In this sense, this solution appeals to their preferred approach to coordinating by means of planning & control while still focusing on building the relationship.

Finally, the last sub-question (How can more awareness regarding personal coordination mechanism choices and fit with the project context be created among railway professionals?) was approached from a macro perspective. The need to answering this question is presented in chapter three and four, where the focus on planning & control coordination as the preferred approach among railway professionals has been observed, despite the fact that the complexities they experience suggest a fit with a different coordination approach. Thus, the first step in changing the coordination behavior of project practitioners is to make them more familiar with the options available to them. Awareness of coordination mechanisms can be increased in several ways. For example, workshops on coordination mechanisms can be conducted, information on different coordination approaches can be shared
on internal company systems, or training programs can be offered to educate railway professionals on project contingencies and coordination mechanisms. A particularly effective approach appears to be individual reflection on personal coordination styles through preference assessments, through which practitioners discover the available options, and subsequently discuss these with their colleagues. The implementation revealed this also encouraged them to employ more effective coordination mechanisms within the team, by identifying and discussing the usage of mechanisms that are not well developed.

### 7.2. Discussion of design principles

The main solutions that are discussed in this dissertation have been designed using well-established and empirically developed design principles that are based on the identified design criteria and design propositions. As discussed in the introductory chapter, design propositions and design principles are appropriate for use in organizational studies in order to enable learning from, and reflection on the designed artifacts. Moreover, reflection performed at the level of design propositions and principles, also allows for a thorough discussion of the generalizability of these design principles for other contexts. This paragraph discusses why the proposed design principles were effective in the railway system context. A summary of the design principles which were used, including their relationship to the proposed design criteria and design propositions is provided in Table 7.1. The table also indicates what kind of complexities are addressed by means of the specific design principles, and in which context the design principles are employed. Table 7.1 only provides a summary, which is discussed in more detail in the following paragraphs.

<table>
<thead>
<tr>
<th>Design Criterion</th>
<th>Design Proposition</th>
<th>Design Principle</th>
<th>Complexities</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP1 More problem clarity</td>
<td>Problem identification focus</td>
<td>Contingency decision-making framework</td>
<td>Socio-political</td>
<td>Micro: Decision-making</td>
</tr>
<tr>
<td>DP2 More mutual understanding</td>
<td>Collective learning</td>
<td>Intervision</td>
<td>Socio-political</td>
<td>Micro: Decision-making</td>
</tr>
<tr>
<td>DP3 Creating ownership</td>
<td>Continuous stakeholder engagement</td>
<td>Co-development</td>
<td>Socio-political</td>
<td>Micro: Decision-making</td>
</tr>
<tr>
<td>DP4 More awareness of coordination behavior</td>
<td>Presenting with coordination behavior</td>
<td>Preference assessment tool</td>
<td>all</td>
<td>Macro: System integration</td>
</tr>
</tbody>
</table>
7.2.1. DP1 – Problem clarity: Enable participants to focus on problem identification through the decision-making contingency framework

DP1 addresses the problem identification focus using the decision-making contingency framework. It was established to address the socio-political complexities of different perspectives and different interests and was developed as a result of the findings of chapter 4. These socio-political complexities are experienced particularly at the start, or even before the start of projects, as well as during the problem identification stage of the decision-making process. The focus on problem identification in the decision-making process by means of using the decision-making contingency framework is the first design principle, and is relevant throughout multiple chapters, as illustrated in Figure 7.1. In chapters 3 and 4 the problem is clarified by employing CIMO-logic and investigating coordination fit. Chapters 5 and 6 focus on developing solutions using DSR, and the developed artifacts also aim to create a higher degree of problem understanding.

<table>
<thead>
<tr>
<th>Methodological focus</th>
<th>Decision-making process</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROBLEM FOCUS</td>
<td>SOLUTION FOCUS</td>
</tr>
<tr>
<td>CIMO-logic; Coordination fit</td>
<td></td>
</tr>
<tr>
<td>DSR artifact</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7.1. Visualizing the dual role of the problem focus in both the methodological- and decision-making dimension.

Currently employed decision-making models in inter-organizational projects in the railway system are often some form of multi-criteria decision-making analysis, and focus on balancing the different decision criteria (Lahdelma, Salminen, & Hokkanen, 2000) or decisions are made without clarifying goals and/or the varying perspectives of stakeholders regarding the problem first (Hermans, Kwakkel, Thissen, Koppenjan, & Bots, 2010). As such, the main focus lies on the solution stage, with limited effort made to understand the problem first.
However, according to Daft and Lane (2008), when socio-political complexities exist, such as differing perspectives or conflicting interests among decision-makers, it is crucial to establish problem clarity beforehand, as when goals are unclear and/or contradictory, managers cannot agree on how to prioritize problems (Daft & Lane, 2008). This is especially useful in system-based environments, where different stakeholders are responsible for a part of the system and typically only have insight regarding the workings of their particular part. Nevertheless, risks are shared among all of the stakeholders in the decision-making process (Lehtiranta, 2014). Therefore, they must negotiate on problems and build a coalition for deciding which problems to address. Practically speaking, managers usually do not have the time, resources, or ability to recognize all the dimensions and process all the information relevant to decision-making (March & Simon, 1958). These constraints result in coalition-building behavior, which means that managers interact and share their perspectives in order to collect information and reduce ambiguity, and ultimately reach a problem agreement (Daft & Lane, 2008). However, reaching consensus on problems is difficult to achieve without considerable effort, as also the uncertain environment causes departments to have varying goals and attitudes. This differentiation leads to disagreements and conflicts, requiring managers to make considerable efforts to reach a consensus (Daft & Lane, 2008). The levels of disagreement between stakeholders tend to be higher in inter-organizational environments (Van Marrewijk et al., 2016) as is the case for decisions on system integration challenges in the Dutch railway system.

Another reason why it is necessary to focus on the problem identification phase is the backgrounds of individuals employed in the railway system. Engineers are specifically educated on how to solve problems (i.e., by using DSR) (van Aken et al., 2016), and are used to technical approaches. Therefore, they place strong emphasis on finding solutions rather than gaining an understanding of the various perspectives regarding a problem first. However, if solutions are chosen that do not adequately address the problem, these are unlikely to be effective. This further emphasizes the need to use the decision-making contingency framework of Daft and Lane (2008), in order for project managers to better understand the problem, and reach agreement on it with the engineers, before starting work on the solution.

In summary, the system-based context of the Dutch railway industry, as well as the educational background of railway practitioners that are working in inter-organizational projects, make the proposal to focus on the problem an important consideration in order to improve inter-organizational decision-making processes. This can be achieved through the use of the decision-making contingency framework, as it makes project stakeholders aware of where their pain points are in the decision-making process by asking them simple questions about the decision-making process at hand. This encourages them to focus on the problem before moving directly into the solution space.
7.2.2. DP 2 – Mutual understanding: Enabling collective learning of project practitioners through intervision

The design principle of intervision (DP2) was established in order to facilitate more collective learning. As discussed in chapter 4, in order to address the dominant nature of socio-political complexities during the decision-making process of inter-organizational projects, sharing knowledge among system stakeholders as well as conducting shared sensemaking activities are important mitigating measures (Staadt, 2012). These socio-political complexities in the Dutch railway system are experienced particularly prominently, because stakeholders are responsible for different parts of it, and their knowledge regarding the system is often limited to how their part interacts with the whole. As discussed in the previous section, during the problem identification stage it is crucial for system stakeholders to engage in discussion in order to gain clarity about information relevant to the decision-making process (Daft & Lane, 2008). One way of doing this is through engaging in collective learning in order to enable mutual understanding regarding the various stakeholder perceptions (Yu et al., 2018). Collective learning is a proven approach for improving sense- and decision-making. One way to learn collectively and build mutual understanding is conducting intervision (Staempfl & Fairtlough, 2019). Therefore, in the context of the Dutch railway system, where stakeholders have only a limited understanding of other system parts, and decisions taken by one party also affect the other parties, the design principle of intervision is a useful tool in building the required shared knowledge about the functioning of the system as a whole.

While intervision is typically used in education, rather than in complex inter-organizational decision-making processes, the implementation of this design principle explores and demonstrates the usability of intervision in system-based contexts. In previous inter-organizational railway projects, decisions regarding measures were made based on superficial agreements which were reached by writing down seemingly similar statements, without questioning assumptions and background information, which resulted in different interpretations of these agreements. This lead to dissatisfaction and decisions being re-evaluated repeatedly. Intervision addresses these issues by creating more shared understanding of stakeholder perceptions (Wagenaar, 2015), which aids in eliminating differences in interpretation. In doing so, intervision improves the relationship between stakeholders who have to deal with different system perspectives as part of the decision-making process. As such, it enables more relationship-development, which, according to Maylor and Turner (2017), is particularly useful in addressing the socio-political complexities experienced.

Furthermore, presenting intervision as a step by step approach, aided the technical railway experts in engaging more openly in applying the method: even the more skeptical practitioners recognized the value of this exercise. Since it is generally recognized to be more difficult for project managers to enable relational coordination when compared to planning & control-based mechanisms (Maylor & Turner, 2017), framing the design principle as a structured approach, proved valuable in the specific context of inter-organizational railway projects.
Nevertheless, conducting intervision in complex inter-organizational decision processes requires effort, time and resources. These time and resource constraints often deter project members from conducting such exercises thoroughly, because they do not expect immediate benefit. As such, an important first step is creating awareness, and guiding individuals through the process in order to demonstrate the significance of engaging with proper problem understanding tools. These types of activities predominantly have positive results, but this is usually not properly recognized. Creating awareness of the need to engage in more relational coordination is discussed more generally in the section on the fourth design principle.

7.2.3. DP3 – Creating ownership: Enabling continuous stakeholder engagement through co-developing the process with project practitioners

DP3; co-development of the design artifact, was implemented in order to facilitate more continuous stakeholder engagement (Missimer & Mesquita, 2022). This, in turn, creates a sense of ownership regarding the work processes and decisions among the team (Druskat & Pescosolido, 2002). As discussed in the previous section, in order to make the developed tools and processes endure, the stakeholders must recognize their value. This is particularly relevant for the tools/processes designed to enable relational coordination, because this usually does not come naturally to project managers (Maylor & Turner, 2017). As such, by co-developing processes, stakeholders are involved proactively, thereby building a relationship with both each other and the designed artifact, which facilitates more lasting and sustainable outcomes of projects (Armenia et al., 2019). This is caused by the fact that these collaborative processes create space for discussion and negotiation, which helps build mutual understanding in order to manage the complexity of the process (Yu et al., 2018). The fact that the ownership of the developed artifact is shared, may also be beneficial for the purposes of continuous usage of the artifact. This is important in environments where inter-organizational project members have to make decisions together repeatedly, such as when deciding on several measures related to system integration challenges.

Moreover, co-developing the artifact is particularly useful in environments where stakeholders have different backgrounds, represent different parties, and/or have conflicting interests (Y. Liu, van Marrewijk, Houwing, & Hertogh, 2019), see Figure 7.2, since in such situations, trust in the other stakeholders and in the proposed tools may not be very strong. Figure 7.2 shows that by co-developing the design artifact, the designers gain a better understanding of the requirements, and the engineers gain a better understanding of how the artifact works. Additionally, joint development contributes to higher degree of understanding between the different stakeholders involved. Therefore, a mutual understanding of the usability of the tools and the intentions of the other stakeholders builds trust – a basic requirement for a well-functioning relationship in inter-organizational projects. As discussed in Chapter 4, developing a high level of trust between project stakeholders is one of the prerequisites for the acceptance of decisions in teams, which in turn leads to project success showing the relevance of these co-developing exercises.
Furthermore, co-developing is advantageous in situations where the problem is not yet clear to all stakeholders, since it helps to clarify which propositions work and which do not, this leads to more shared problem understanding for the design process. The same idea can be applied to the decision-making process of inter-organizational projects. Applying the co-developing principle to the decision-making process of inter-organizational projects can potentially lead to more problem understanding regarding the complexities faced in system integration questions, and is a good starting point for finding appropriate solutions.

7.2.4. DP4 - Awareness of coordination behavior: presenting practitioners with their coordination behavior by conducting preference assessments

DP4 is a design principle used to improve inter-organizational railway project coordination, and is comprised of a preference assessment test designed to create more awareness of coordination mechanism usage. More awareness was required on two different levels: Firstly, regarding the problem context of the decision-making process (the micro level) and, secondly, regarding the complexities experienced when addressing system integration challenges (the macro level). This section focuses on the second kind, which is a more general principle and has the potential to address all complexities experienced in this field.

As has been discussed previously, within railway projects a tendency to focus on planning & control coordination exists, irrespective of the complexities experienced by the project managers. Possible causes for this include the emphasis on traditional project management methodologies in railway organizations (chapter 4). Moreover, project managers often find it especially difficult to use relational coordination (Maylor & Turner, 2017). Considering this, and the fact that the literature on project management has matured in recent years (Geraldi et al., 2011; Maylor & Turner, 2017; Williams, 2005), habitually applying established methods without questioning them is no longer feasible. Therefore, creating awareness of the use of coordination mechanisms in complex environments is important. Personal reflections on individual behavior can guide the process of becoming more aware of these, and can
be facilitated though employing preference assessment tools, such as the Thomas-Klimann instrument (Shell, 2001). The Thomas-Klimann instrument was originally intended to identify personal preferences in conflict modes (K. W. Thomas, 2008), but the underlying principles can be used to assess the preferences for coordination mechanisms. As such, it is a useful tool for presenting project professionals with their coordination behavior in inter-organizational railway projects, where management is becoming considerably more complex, and ways to address this complexity have to be identified. Furthermore, this reflection exercise can help in identifying potential training and education suggestions for professionals, especially when preferences are not developed in a certain area, but the tasks at hand demand such coordination mechanisms. Therefore, conducting preference assessments is especially useful at the start of projects where project members are not yet acquainted with the tasks, and each other. It can even assist in matching individuals to tasks, once awareness on preferences and job requirements is created.

Another important feature of the preference assessment is that it incorporates the fit between the complexities experienced and the responses employed. The instrument does this by outlining different situations to respond to. This context-dependency allows for choosing an equally fitting response for each of the three complexities. As such, an individual conducting the preference assessment can reflect on a specific complexity category in order to gain insight into how they react when encountering it. This can provide them with previously unavailable insight for improving their coordination behavior in specific situations. Over time, this can create awareness of how to respond more appropriately when faced with specific challenges. As such, it is important to re-evaluate preferences over time, since demands and preferences of project practitioners can change. Therefore, conducting coordination mechanism preference assessments is most useful at the start of a project, but is also valuable when repeated during later phases, such as when project members or project lifecycle phases change.

7.2.5. DP5 - Improving coordination behavior: Comparing project practitioners’ coordination behavior by means of a team-based assessment

A team-based assessment of coordination mechanism usage by means of comparing the different preference scores can aid in improving the coordination behavior of professionals working on system integration challenges. It does so by building on team-based learning, an approach that utilizes individuals’ knowledge through individual testing and group collaboration (Cestone et al., 2008). This further encourages shared understanding and the development of the team’s coordination competences (Brown & Malenfant, 2016).

Additionally, attention is paid to important considerations, such as mismatched coordination behavior. This design principle directly addresses the problem of a predominant focus on planning & control activities in situations where a high degree of socio-political complexity is experienced during decision-making processes of inter-organizational projects. This is a result of the investigation in
chapter 3, which revealed a low degree of fit between complexities experienced and the coordination responses employed in inter-organizational railway projects, leading to coordination ineffectiveness. To address this problem, the individual scores identified using the preference assessment tool (section 7.2.4) are used as input for the team-based assessment. In the team-based assessment, the differences in coordination preferences of the professionals are identified and coordination mechanisms that are not widely used in the context of inter-organizational railway projects are explored. An example of the scores provided to the group before the team-based assessment is provided in Figure 7.3. It is used as basis for personal reflection and discussion.

<table>
<thead>
<tr>
<th>Group average</th>
<th>My score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning &amp; control</td>
<td>Relationship-development</td>
</tr>
<tr>
<td>100%</td>
<td>24</td>
</tr>
<tr>
<td>75%</td>
<td>17</td>
</tr>
<tr>
<td>50%</td>
<td>10</td>
</tr>
<tr>
<td>25%</td>
<td>6</td>
</tr>
<tr>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 7.3. An example of the individual, and group average of coordination preferences used as input for the team-based reflection.

As indicated above, it is particularly interesting to conduct the preference assessment and the team-based assessment at the start of inter-organizational projects. In this context, the complexities experienced are often socio-political in nature, whereas the predominant project management approach is based on planning & control (chapters 3 and 4). Conducting these assessments can provide a starting point for creating awareness and encouraging changes in coordination behavior. It functions as a preamble that aids in effective coordination usage by engaging in coordination activities that mitigate experienced complexities.

Another way to use the results of the team-based assessment is the acquisition of new employees. If the team is aware that they lack a member with a certain coordination mechanism preference, they can pay particular attention to hiring
employees that have these competencies during the selection procedure. In doing so, a more balanced use of coordination mechanisms can be enabled in the team, and team members can more easily be matched to the coordination requirements of the task.

In conclusion, the fifth design principle can be used in the macro context of project coordination to address system integration challenges. Additionally, in cases where the results of the team-based assessment reveal a need to focus on socio-political complexities in order to improve the inter-organizational project coordination, it can be used in the micro perspective as outlined above as well.

7.2.6. DP6 – Effective coordination usage: Matching complexities and coordination responses through using the complexity-response framework

DP6, using the complexity-response framework, works well when combined with the other design principles, because it aids in matching complexities experienced to coordination mechanisms employed, in order to facilitate more effective usage of coordination mechanisms. Since each complexity has preferred specific coordination responses (Maylor & Turner, 2017), effective coordination mechanism usage can be facilitated by matching the complexities experienced with corresponding coordination responses. This is based on research on organizational structure, in which Donaldson (2001) describes that when a higher degree of fit between the contingencies of the organizational structure and the management approach exists, the latter becomes more effective.

This design principle is particularly useful in the context of system integration in inter-organizational railway projects (macro context) since many different complexities that interact with each other (see section 1.3.4) exist in this context. It is usually difficult to determine what the impact of any particular complexity on a project is, and which issues already receive appropriate attention through management activities. In situations like these, matching the complexity experienced with the coordination measures used by project managers can help identify more appropriate measures in order to promote more effective use of coordination mechanisms.

Moreover, in complex decision-making processes regarding system integration challenges (micro context), complexities are often socio-political in nature, such as, the differing perspectives and potential for conflict which play a role when making shared decisions (Van Marrewijk et al., 2016). Matching coordination responses to the experienced socio-political complexities can aid in identifying how to deal more effectively with the challenges of decision-making process.

7.2.7. Reflection on design principles DP1-DP6

Generally speaking, the first three design principles (DP1-DP3) are used in the micro context of decision-making processes of inter-organizational projects. Since decisions in the railway system context are made by various stakeholders, socio-
political complexities are often prevalent. The last three design principles (DP4-DP6) concern the macro context of inter-organizational projects and do not focus in on particular complexities.

It is worth mentioning that different types of learning regarding the problem definition phase of the decision-making process exist. Firstly, collective learning on the nature of the problem is enabled through intervision, and learning about other project members problem understanding occurs through co-development activities (DP1-DP3). Secondly, co-developing the design artifact leads to project members learning from each other about which design propositions work in the specific context (DP3). Thirdly, learning also takes place through reflecting on employed design propositions and design principles which allows project members to generalize the findings to other project and decision-making contexts, as discussed in sections 7.2.1-7.2.6.

Furthermore, some connections between design principles can be established. The fourth principle (personal assessment) and fifth principle (team-based assessment), for example, can aid in assessing preferences. In cases where the analysis shows that the use of relational coordination for addressing socio-political complexities is underdeveloped, the first three design principles may prove useful. Relational coordination can be established, for example, by focusing on the problem instead of the solution through utilizing the decision-making contingency framework (DP1), by learning collectively about the different viewpoints on the problem through intervision (DP2), and by creating ownership of the decision/design through co-developing the process (DP3). Additionally, both the personal, and team-based preference assessments are effective design principles when employed at the start of inter-organizational projects and, when employed to improve coordination efforts, it can contribute to a faster decision-making process for system integration challenges.

Moreover, DP6 has many connections to the other design principles, two of the most significant for enabling more effective coordination mechanism usage are in combination with DP4 and DP5. For example, one way of creating awareness on ineffective coordination mechanism usage is through conducting preference assessments (DP4). In a team-based assessment an ineffectiveness of coordination mechanism usage can be discussed, and subsequently improved (DP5). This can lead to improved coordination behavior in inter-organizational projects, which facilitates project effectiveness and ultimately, system integration (see Figure 7.4). Additionally, when approaching this from the micro perspective, employing the complexity-response framework aids in improving awareness of the particular complexity experienced in the context of shared decision-making among project professionals. Ultimately, it can help in finding more appropriate responses to the complexities experienced in order to facilitate more effective use of coordination mechanisms for decision-making. This can be done by focusing on the problem definition phase through using the decision-making contingency framework (DP1), collectively learning about the problem through intervision (DP2), and continuously engaging the stakeholders through co-developing the process (DP3). As previously
discussed, this leads to increased effectiveness in decision-making processes in inter-organizational projects, which in turn can have a positive effect on project coordination effectiveness and system integration (see Figure 7.4).

Figure 7.4. The connection between the six design propositions building on the six principles (DPs), highlighting the important role of DP6.

7.2.8. Generalizable design propositions

One of the benefits of design science research is that a successful design outcome not only solves a problem, but also creates knowledge about the nature of the problem and the types of solutions that were used to solve it. Overall, the design principles discussed in sections 7.2.1 to 7.2.6 can be summarized into six concise and generalized statements that can be transferred to other designs, and tested in contexts other than those outlined in this dissertation. The first three generalizable design propositions (GDPs) are applicable to the micro context of inter-organizational decision-making processes, whereas the last three are pertinent to inter-organizational project coordination overall.

Design proposition 1:

The problem focus of a decision-making process in the context of system integration can be established by utilizing the contingency decision-making
framework.

**Design proposition 2:**
Mutual understanding between the stakeholders can be encouraged through intervision which enables collective learning.

**Design proposition 3:**
Ownership of decisions relies on stakeholder engagement, which can be encouraged by the co-development of tools used for decision-making.

**Design proposition 4:**
Awareness of project complexities and options for coordination behavior can be increased by presenting practitioners with an assessment of their own coordination preferences.

**Design proposition 5:**
Improving the coordination behavior of project practitioners can be achieved by presenting teams with an assessment of their own coordination preferences as well as the differences between individuals within the team.

**Design proposition 6:**
More effective coordination usage can be achieved by matching experienced complexities to fitting coordination responses by utilizing the complexity-response framework.

### 7.3. Research contribution

In this section of the dissertation the research contribution will be discussed. Firstly, the contribution of our design propositions is elaborated on, after which the theoretical and managerial implications are outlined. This will demonstrate how the findings of this research are relevant to both theory and practice.

Concerning the contribution of our research, when studying the challenges of system integration and decision-making in the Dutch railway system, the obvious choice would appear to be to take a systems engineering perspective. Adopting such a perspective means that the majority of tools used are based on planning & control coordination, as a part of which the main focus is placed on breaking the system down into smaller units in order to manage complexity (reductionist view). However, system integration benefits from studying more broadly than doing so only from the systems engineering perspective, which does not consider all relevant aspects when addressing problems. This dissertation demonstrates how adopting a project complexity perspective when studying system integration challenges aids in finding more fitting responses to the experienced complexities in inter-organizational projects (chapters 2 and 3). It is a more inclusive perspective that does not only focus on structural complexities arising during system integration, but also on emergent and socio-political complexities, the latter being particularly important
in a context where multiple stakeholders make decisions jointly. As such, this perspective builds on a contingency view of the complexities experienced in system integration challenges using context-dependent responses, instead of applying a one-size-fits all approach. Moreover, instead of developing prescriptive knowledge on how tools are supposed to work, it identifies how complexities are experienced and finds principles that provide guidance for dealing with such situations (chapter 6). These principles include, for example, increasing practitioners’ awareness of coordination mechanisms by presenting them with their coordination preferences (GDP4), comparing coordination preferences in order to improve project managers coordination efforts (GDP5), and matching complexities to coordination responses for more effective coordination (GDP6).

Especially in joint decision-making processes during system integration challenges, socio-political complexities are experienced most commonly. In the Dutch railway system, these complexities have traditionally been addressed by means of a hierarchical power structure, which enforces controlling behavior and a prescriptive way of making decisions. This dissertation illustrates that such situations require a focus on relational coordination, which has been proven to create more mutual understanding and to promote trust among the project stakeholders, ultimately leading to finding agreements more effectively (chapter 4). As such, developing relational coordination in inter-organizational projects can be encouraged through decision-makers focusing on problems, leading to increased problem clarity (GDP1), through collective learning, which facilitates more mutual problem understanding (GDP2), and through continuous stakeholder involvement, which leads to more ownership of the decision (GDP3) (see chapter 5). Crucially, this demonstrates the importance of sharing knowledge when making decisions in an inter-organizational environment, a mechanism that encourages a decreasing level of focus on planning & control in these decision contexts.

7.3.1. Theoretical contribution and implications

The findings of this dissertation contribute to the field of project complexities and coordination in several ways, and provide a better understanding of the coordination of system integration challenges, as well as decision-making in inter-organizational projects. For this research a constructivist perspective has been adopted. As such, the focus is on understanding the meaning that individuals and groups attach to their experiences rather than on uncovering universal laws or patterns (Cohen et al., 2002). Consequently, generalizing findings to a broader population is not the primary goal of constructivist research. Nevertheless, analytical generalization can be achieved in constructivist research. Analytical generalization means identifying themes in the study that can be applied to other contexts (Halkier, 2011). These themes are represented as the generalizable design propositions described in section 7.2.8., which theoretical implications are discussed in more detail below. Employing a constructivist perspective in this dissertation had several benefits. The qualitative methods used in this study enabled us to explore the context and understand the process through which the coordination mechanisms were formed and enacted. In
addition, we were able to look more closely at issues of project complexity and find that the principle of coordination fit and its impact on coordination effectiveness were often not adequately addressed. Finally, in addition to facts, respondents were able to express concerns and dissatisfaction with project progress and collaboration. Since individuals are not all the times good at expressing issues clearly in words, this led to the identification of coordination difficulties that might otherwise have gone unnoticed.

The first contribution relates to inter-organizational transportation projects. This dissertation thoroughly explores the nature of projects by demonstrating how the dynamics of coordination mechanisms influence project progress in complex decision-making processes. In particular, attention needs to be paid to relational coordination at the start of projects, which, when supported by planning & control-based mechanisms as they progress, facilitates project advancement. The first three design propositions (GDP1-GDP3) are vital to helping build relationships among project participants in these situations. This contributes to a better understanding of the inner workings of inter-organizational projects when managing complexity, as Söderlund et al. (2017) call for. Moreover, this dissertation provides some answers to the question posed by Lenfle and Loch (2016): why do large-scale projects not succeed, in the form of responses to complexity. Failure to respond appropriately to experienced complexity can lead to project ineffectiveness. This can be remedied by applying the last three design propositions (GDP4-GDP6), which aim to raise awareness and improve coordination by better aligning responses to experienced complexity. However, there may be other reasons for unsuccessful projects which have not been explored in this dissertation.

The second contribution concerns system integration and its major challenges relating to the need for interdependent organizations when cooperating during the entire system lifecycle in order to add value to operations. Thus, when looking at GDP4-GDP6 from a system lifecycle perspective, two major conclusions can be drawn. The first implication is that, when compared to the project management perspective of the 1960s, the social element in project coordination is becoming increasingly important (see e.g., Bolton et al. (2021)). This change in perspective is also gaining momentum in the Dutch railway system with its socio-technical system complexity, and the increasing connectivity and interaction between the actors. This dissertation finds that the complexity of the railway system is more diverse than traditional project management with planning & control can deal with appropriately. When comparing this dissertation’s observations from the project lifecycle perspective to the well-known asset lifecycle perspective of Woodward (1997), it is likely that the trade-off described in Figure 7.5 will be relevant to improving coordination behavior. It shows that investing in matching coordination responses requires initial effort, but pays dividends later, as it directly contributes to the effectiveness of the project, thereby supporting GDP6. During the early stages of a project, unknowns predominate, which means that identifying matching responses requires both time and resources in order to gain a thorough understanding of the context. Once a good understanding of the context has been reached, it is easier to match responses to the
situation. From this it follows that losses that occur when coordination activities are not aligned with the project context, increase over the project lifecycle, as changing decisions and/or working methods becomes more difficult, and therefore requires additional investment. This demonstrates the importance of adjusting coordination mechanisms as necessary to keep overall coordination costs as low as possible. The highlighted area in Figure 7.5 shows a range where coordination efforts are both effective and affordable. Since it is impossible to ascertain with certainty that the most fitting coordination mechanism has been found, project managers should focus on investing in coordination efforts that fall within this highlighted area. This prevents managers from spending an inordinate amount of time optimizing their coordination strategy. The second implication is based on the premise that from a lifecycle perspective, projects are considered to be dynamic, since the phases of a project lifecycle evolve, the project members involved change positions or organizations, the project requirements advance, the context alters, or the stakeholders rotate. When any of this happens, project coordination requirements may also change, which highlights the importance of conducting analyses of coordination behavior on a regular basis. It is important that project managers take the time to regularly reflect on coordination behavior in order to find appropriate responses, and facilitate effective project coordination. The tools developed in this dissertation help to identify coordination needs, and by implementing the developed principles, on which the design propositions are based (GDP4-GDP6), into the project management methodology currently used in inter-organizational railway projects, this can be achieved.

The third contribution results from the six established design propositions pertaining to inter-organizational decision processes (GDP1-GDP6), since they can potentially deal with the inherent fuzziness of the problem context, as described by Daft and Lane (2008). The first three design propositions (GDP1-GDP3) contribute to gaining more clarity about the context in which decisions must be made, which
has been underemphasized in recent literature, according to Hetemi et al. (2020). This is particularly necessary in environments with many different interdependent stakeholders with different perspectives on the system, who deal with a fuzzy problem context. While these design propositions, developed using DSR, are not solutions for the decision-making process in the traditional sense, they can aid in reducing the fuzziness of the problem. The improved understanding of the context, thus gained, is important input for the problem definition phase of the decision-making process. Focusing on the problem definition phase is currently undervalued in the field of engineering (Leydens & Lucena, 2014). Therefore, in order to coordinate sustainably in engineering environments, as presented in Chapter 5, appropriate problem definition is necessary, and using the first three design propositions (GDP1-GDP3) offers a major contribution to inter-organizational project decision-making. Additionally, GDP6 aids in identifying mechanisms which improve project success, by adapting coordination responses to the experienced decision complexity, which was previously identified by Hetemi et al. (2020) as a topic in need of more research. Hetemi et al. (2020) examine the influence of the network of actors and path dependence in decision-making, which this dissertation acknowledges, and it therefore also recommends a higher investment for a downstream change in coordination of decision-making processes, as indicated in Figure 7.5. However, despite the existence of path dependence, focusing on the complexity that is experienced at any given point in time remains relevant, which emphasizes the importance of regularly matching coordination efforts to it, whenever the context changes.

7.3.2. Managerial implications

In addition to theoretical contributions and implications, this research also involved performing practically applicable work in identifying managerial implications when implementing and testing the developed tools.

These were provided in order to deal with the complexities experienced during shared decision-making processes of inter-organizational railway projects, which involve increasing levels of socio-political complexity. Since it appears to be difficult for railway professionals to deal with socio-political complexities, it is advisable to involve trained facilitators who help with the implementation and execution of tools based on relational coordination. Moreover, the developed intervison process is especially suitable in situations where there is limited mutual understanding and there are varying perspectives regarding the decision-making problem. Additionally, co-developing a process based on relational coordination can result in other tools when performed in a different environment but remains relevant to professionals in order to accept the tool and the resulting decisions (chapter 5).

As has been discussed in this dissertation, railway professionals often revert to responses based on planning & control when dealing with complexity during system integration challenges. The tools that have been developed as a part of this research project are essentially a toolkit for professionals that helps them to choose more fitting responses to the complexities they experience. To effectively use the provided tools,
it is important to initiate cultural changes within project management in the railway system. Changing the organizational culture in the railway system is a long process, which starts with creating a need (Kotter, 2007). For this, creating awareness of the need to focus on more fitting coordination responses is needed. This can be achieved in multiple ways. Firstly, an advocate for coordination fitting approaches, and more relational coordination in particular, is of advantage for creating more awareness. The advocate should have sufficient authority and decision-making power to launch the toolkit across the organization, for instance, by placing it on digital environment next to the PRINCE II toolkit or sharing it at company-wide events centered around project management. Secondly, experimenting with- and creating success stories around the toolkit also generates more awareness throughout the organization. When working on coordination fit, the COMPASS instrument, presented in chapter 6, is particularly useful. This bottom-up approach aids in experiencing first-hand the benefits of coordinating with fitting responses in complex projects. This way, these success stories can be shared with a broader community, slowly changing the culture of coordination in the railway system.

Finally, the findings of this research remain relevant also for other railway systems besides the Dutch. Countries such as France and Germany have a more integrated system, where the responsibilities of infrastructure manager and railway undertaking are not strictly split between companies (Briginshaw, 2015; Papatolios, 2021). Therefore, the challenges they face in system integration are less complex to coordinate. The coordination regarding system integration issues remains an intra-organizational affair. Nevertheless, also in an intra-organizational project coordination plays a fundamental role, where the established design propositions (GDP1-GDP6) stay significant. Interdepartmental coordination in systems integration projects benefits from more appropriate coordination measures and especially from relational coordination when different interests and perspectives are in the picture.

7.4. Limitations and future research

The results of this Ph.D. project, presented in this dissertation, also reveal several limitations. Specific limitations have already been discussed in chapters 2 through 6. In the following section, the most significant limitations to the Ph.D. project as a whole are elaborated on. Finally, suggestions for future research will be presented.

7.4.1. Generalizability of the research

Since the research presented in this Ph.D. dissertation focuses on a single system, namely the Dutch railway system, one of the limitations lies in the predictive power of the results. It is based on case studies which are qualitative in nature, and therefore statistical generalization is not possible (Rowley, 2002). The advantages of qualitative research lie in an improved empirical understanding of the rich problem context (Yin, 2003), which is one of the main goals of this dissertation. To compensate for this, the methodological challenges resulting from focusing on a single system have been addressed by means of triangulation, which is a means of
increasing the credibility and validity of the performed research by using multiple sources of evidence or methods (Voss, Tsikriktsis, & Frohlich, 2002). A detailed description of how the quality of the cases is ensured is provided in each individual chapter. Throughout this Ph.D. project, triangulation has been applied in multiple ways, such as data source triangulation, method triangulation, and investigator triangulation (Denzin, 2017).

Firstly, data sources were triangulated by using different cases throughout the Ph.D. project, involving different stakeholders, taking place in different local decision contexts, and at different lifecycle stages. For example, the cases range from the design phase, where the approach to assessing load reducing measures was discussed (CAPACITY case), to the implementation phase, where decisions were made on how to implement new technology into the operating system (NEW VEHICLE case). These cases are examples of different objects which are analyzed to offer sufficient diversity in order to draw reliable conclusions (Yin, 2003). Nevertheless, we were also bound by the cases of the organizations that were available to us.

Secondly, method triangulation was used, by employing multiple different methods to collect data. For example, throughout the various case studies semi-structured interviews, structured interviews, observations, and document analysis have been performed, both in the exploration and verification phases. Moreover, some of these data collection methods were used in longitudinal form, both before and after the interventions. In chapter 5, for example, data was collected during the problem exploration phase, during the evaluation of the design directly after implementation, and six months later. As such, method triangulation was utilized to decrease the bias inherent to situations where a single data source is relied on.

Thirdly, triangulation of investigators was used in the cases because several observers or interviewers were present during data collection, such as, during the interviews concerning the NEW VEHICLE case and the intervision session of the ERTMS case, and records were compared afterwards to decrease bias. This, and verifying interview transcriptions, are useful tools in order to ensure that the recorded information was understood correctly.

Fourthly, both deductive and inductive reasoning has been applied during data analysis. For research theme one, the core problem has been investigated both from a literature perspective and a practical perspective, both of which influenced the final coding scheme which was established for the data analysis. Moreover, for research theme two, the design science process has been guided by deductive reasoning which lead to establishing the design principles and inductive reasoning was employed during the evaluation of the implemented design principles.

As such, the design principles that have been employed and were derived from the literature are generalizable to other empirical contexts (Gregor & Hevner, 2013). The design principles were tested in the complex environment of system integration and decision-making, where many complexities, especially socio-political ones,
came to light, which suggests their applicability in similarly complex contexts with similar design goals. As a result, the design principles produced in this dissertation can be regarded as rules for creating similar artifacts (Markus et al., 2002).

7.4.2. Design science research in the field of organizational science

In order to improve the use of coordination mechanisms in inter-organizational railway projects the design science research methodology was used. As discussed in the introduction, DSR is particularly useful for developing solutions to practical problems (van Aken & Romme, 2009). It does so by creating prescriptive knowledge about an artifact that solves a problem and is therefore inherently positivistic (van Aken & Romme, 2009). Organizational studies, such as this one, have a primary goal of increasing understanding of social phenomena and the world at large. Moreover, as a result of the human agency impact in socio-technical systems, the system behavior is more difficult to predict and the design is more dependent on the context (van Aken et al., 2016). As such, implementing DSR in management and organizational studies should be done with caution. In this Ph.D. project, this issue has been addressed by incorporating design propositions and design principles into the regular design science research process of Peffers et al. (2007), which are summarized in the six design propositions.

Firstly, design propositions are ‘chunks of knowledge’ that should be regarded as suggestions, however, unlike in prescriptive studies, these are not based on strict if-then logic (Denyer et al., 2008). Therefore, a core aspect of the design propositions is the learning aspect present in practitioners making use of the proposition. This has been illustrated in chapter 5, where a process has been co-designed with professionals in order ‘to collectively determine what works and what does not’ (van Aken & Romme, 2009).

Secondly, design principles can be regarded as knowledge on how to develop an artifact, thus serving as a set of rules that can be used to design similar artifacts for similar contexts (Markus et al., 2002). This shifts the focus from the ends (the design) to the means (how the design works), thereby emphasizing the learning aspect as well (Romme & Endenburg, 2006). An example of this phenomenon can be found in the chapter 7 of this dissertation, which summarizes the leading design principles guiding this research. The resulting design propositions can be regarded as guidelines for creating artifacts for similar contexts.

7.4.3. Suggestions for future research

In this dissertation, several areas for future research are discussed in the individual chapters. In the following section, three areas for potential future research that have more overarching implications are outlined.

Firstly, this research has focused mainly on creating awareness of coordination suitability and developing tools to deal with socio-political complexities in particular. This is especially important in decision-making contexts with many different stakeholders who have different perspectives on the system, and decide
on measures jointly. However, new railway technologies such as ERTMS or ATO will be implemented into the Dutch railway system in the intermediate future. The knowledge concerning these technologies is limited, partly because they will be developed as part of the inter-organizational project. When coordinating emergent complexities and making decisions in dynamic and changing contexts, tools which build on the concept of flexibility appear crucial (Maylor & Turner, 2017). These tools could, for example, be rooted in agile project management methodology, where responsibilities are shared among the team (Highsmith, 2009). The concept of flexibility as the basis for project management coordination tools should be explored in future research concerning the Dutch railway system.

Secondly, the design science research performed in this dissertation has mainly focused on the project phase and the complexities experienced within it. Different project lifecycle phases were considered for study, for instance the design phase and the implementation phase. However, chapter 4 outlines that the complexities experienced in the pre-project phase are particularly difficult to manage. As such, implementing the developed coordination tools in the pre-project phase, where relationships have not yet been formalized, can facilitate effective decision-making. The importance of managing the pre-project phase effectively is also supported by Hetemi et al. (2020). Moreover, this is particularly relevant as chapter 4 suggests that the pre-project phase is especially sensitive to a lack of fit in coordination responses in the decision-making process. As such, an opportunity exists to test the developed tools in the pre-project phase, where shared knowledge is even lower, structures have not yet been established, and problems have not yet been agreed upon. Nevertheless, stakeholders have to collaborate which results in a high degree of socio-political complexity.
References


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Appendix

The appendix presents an overview of the data sources, the methodological overview (chapter 5), the design developed in chapter 6, and interview guides which have been used to collect data for the case studies conducted in this dissertation.
Table A1.1. Case 1 (SAFETY) data source overview (interviews).

<table>
<thead>
<tr>
<th>Data source</th>
<th>Interviewee</th>
<th>Org.</th>
<th>Date</th>
<th>Time</th>
<th>Input for</th>
</tr>
</thead>
<tbody>
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<td>Senior inspector railway</td>
<td>ILT</td>
<td>02-09-2019</td>
<td>1h</td>
<td>Chronology of events, CIMO-logic, fit assessment</td>
</tr>
<tr>
<td>Semi-structured interview</td>
<td>Expert licensing of infrastructure and equipment</td>
<td>ILT</td>
<td>02-09-2019</td>
<td>1h</td>
<td>Chronology of events, CIMO-logic, fit assessment</td>
</tr>
<tr>
<td>Semi-structured interview</td>
<td>Project manager safety issues</td>
<td>PR</td>
<td>03-09-2019</td>
<td>1:15h</td>
<td>Chronology of events, CIMO-logic, fit assessment</td>
</tr>
<tr>
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Table A1.2 Case 1 (SAFETY) data source overview (documents).

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Table A1.3 Case 2 (CAPACITY) data source overview (interviews).

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### Table A1.4 Case 2 (CAPACITY) data source overview (documents).

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Table A1.7 Case 4 (NEW VEHICLE) data source overview (interviews).
Table A1.8 Case 5 (IMPLEMENTATION) data source overview (documents).

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Table A1.9 Case 5 (IMPLEMENTATION) data source overview (interviews).

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</tr>
<tr>
<td>Open interview</td>
<td>Implementation manager</td>
<td>NS</td>
<td>24-05-2022</td>
<td>0:30h</td>
<td>Design evaluation</td>
</tr>
</tbody>
</table>
A2. Operationalization of the developed methodology

Table A2. Operationalization of the methodology, showing consistency between the process steps.

<table>
<thead>
<tr>
<th>CIMO</th>
<th>Context</th>
<th>Interventions</th>
<th>Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSR</td>
<td>Problem exploration</td>
<td>Implementation of solution x: Define process agreements</td>
<td>Planning &amp; control [defining]; solution focus</td>
</tr>
</tbody>
</table>

- Different interests of stakeholders representing different org.

- Different views of the stakeholders from diverse backgrounds
  - Clearly describe the solution and describe why it is a good solution
  - Planning & control [convincing]; solution focus

- Frustration of stakeholders with pace and decision-making process
  - Establish clear meeting structures
  - Planning & control [standard structure]

- Prioritize cases and work on most urgent ones for the decision
  - Planning & control [prioritizing]
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Design objective &amp; criteria</th>
<th>Design propositions</th>
<th>Design &amp; Implement</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No problem consensus</td>
<td>Establish more problem consensus</td>
<td>Focus on problem, not solutions</td>
<td>Intervision process</td>
<td>Evaluation of the three design propositions</td>
</tr>
<tr>
<td>Little mutual understanding during process</td>
<td>Create mutual understanding</td>
<td>Engage in collective learning through intervision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Still frustrated, not much progress</td>
<td>Create ownership of the decision</td>
<td>Enable continuous stakeholder engagement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No coordination fit</td>
<td>Establish better coordination fit by establishing relational coordination</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A3. Coordination preference assessment test

(Translated from Dutch)

In the questionnaire below, two statements have been grouped together.

Of these two statements, you should always choose the one that best applies to you. Sometimes neither of the two statements applies to you, however, you should still choose one of the two statements. Do not think about the answer for too long; answering quickly and following your first impression leads to the best result!

Situation 1. When you are joining a new team that is starting up, and does not have a proper structure yet, how would you be most likely to act?

1) A: I create a plan in order to establish collaboration agreements.
   B: I explore some initial collaboration principles with the rest of the team before a decision is made.

2) A: I explore who is part of the (project) team and what their perspectives and ideas are.
   B: I start by determining the project goal and scope, so it is clear what the aims are.

3) A: I have a cup of coffee with the team to get to know each other before the project/work starts.
   B: I adapt to the situation and requirements the team is facing.

4) A: I explore who is part of the (project) team and what their perspectives and ideas are.
   B: I make a plan that establishes cooperation agreements.

5) A: I adapt to the situation and requirements the team is facing.
   B: I explore who is part of the (project) team and what their perspectives and ideas are.

6) A: I have a cup of coffee with the team to get to know each other before the project/work starts.
   B: I make a plan that establishes cooperation agreements.

7) A: I start by determining the project goal and scope, so it is clear what the aims are.
   B: I have a cup of coffee with the team to get to know each other before the project/work starts.

8) A: I start by determining the project goal and scope, so it is clear what the aims are.
B: I adapt to the situation and requirements the team is facing.

9) A: I start by determining the project goal and scope, so it is clear what the aims are.
   B: I explore some initial collaboration principles with the rest of the team before deciding what works best.

10) A: I make a plan that establishes cooperation agreements.
    B: I adapt to the situation and requirements the team is facing.

11) A: I explore some initial collaboration principles with the rest of the team before deciding what works best.
    B: I have a cup of coffee with the team to get to know each other before the project/work starts.

12) A: I explore who is on the (project) team and what their perspectives and ideas are.
    B: I explore some initial collaboration principles with the rest of the team before deciding what works best.

Situation 2. In the event of disagreements within the team, how would you be most likely to respond?

13) A: I immediately write down the different points of view and make agreements on how to proceed.
    B: I do not worry about the differences but try to see it as an opportunity to learn more.

14) A: I engage in conversation in order to understand the other person’s point of view.
    B: I take stock of the different opinions and decide with the team which one is most consistent with the goals of the project and how to proceed.

15) A: I explain my point of view to the other team members and ask for the other person’s perspective.
    B: I immediately write down the different points of view and make agreements on how to proceed.

16) A: I immediately write down the different points of view and make agreements on how to proceed.
    B: I test a few assumptions and see what fits best before deciding how to proceed.

17) A: I do not worry about the differences but try to see it as an opportunity to learn more.
    B: I engage in conversation in order to understand the other person’s point of view.
18) A: I explain my point of view to the other team members and ask for the other person’s perspective.
B: I take stock of the different opinions and decide with the team which one is most consistent with the goals of the project and how to proceed.

19) A: I test a few assumptions and see what fits best before deciding how to proceed.
B: I explain my point of view to the other team members and ask for the other person’s perspective.

20) A: I take stock of the different opinions and decide with the team which one is most consistent with the goals of the project and how to proceed.
B: I do not worry about the differences but try to see it as an opportunity to learn more.

21) A: I engage in conversation to understand the other person’s point of view.
B: I immediately write down the different points of view and make agreements on how to proceed.

22) A: I explain my point of view to the other team members and ask for the other person’s perspective.
B: I do not worry about the differences but try to see it as an opportunity to learn more.

23) A: I take stock of the different opinions and decide together with the team which one is most consistent with the goals of the project and how to proceed.
B: I test a few assumptions and see what fits best before deciding how to proceed.

24) A: I engage in conversation to understand the other person’s point of view.
B: I test a few assumptions and see what fits best before deciding how to proceed.

Situation 3. How would you most likely react in the face of great uncertainty about the effects of the solution which was to be applied?

B: I identify potential risks and try to mitigate them.

26) A: I inform my colleagues on the team about the latest developments (e.g., in the form of a stand-up).
B: I plan for different scenarios.
27) A: I inform my colleagues on the team about the latest developments (e.g., in the form of a stand-up).
   B: As soon as new information surfaces, I assess it immediately and make decisions on the spot.

28) A: I identify potential risks and try to mitigate them.
   B: I collect as many ideas as possible from the team and discuss the pros and cons together.

29) A: I test solutions and learn what works through action.
   B: I collect as many ideas as possible from the team and discuss the pros and cons together.

30) A: I identify potential risks and try to mitigate them.
    B: I inform my colleagues on the team about the latest developments (e.g., in the form of a stand-up).

31) A: I plan for different scenarios.
    B: As soon as new information surfaces, I assess it immediately and make decisions on the spot.

32) A: I collect as many ideas as possible from the team and discuss the pros and cons together.
    B: As soon as new information surfaces, I assess it immediately and make decisions on the spot.

33) A: I plan for different scenarios.
    B: I test solutions and learn what works through action.

34) A: As soon as new information surfaces, I assess it immediately and make decisions on the spot.
    B: I identify potential risks and try to mitigate them.

35) A: I inform my colleagues on the team about the latest developments (e.g., in the form of a stand-up).
    B: I test solutions and learn what works through action.

36) A: I collect as many ideas as possible from the team and discuss the pros and cons together.
    B: I plan for different scenarios.
A4. Interview guides

A4.1 Interview guide SAFETY-case

General Introduction
1. Give a brief introduction about yourself, your position in the organization and your role in the project.
2. What do you think are currently the biggest challenges in shared decision making within NS/ProRail?

Case introduction
3. What was the main goal of the project?
4. Personal data
   a. Time period of involvement in the project
   b. Your main goals in the project (or your department’s goals)
   c. How did you come to believe that this decision is the right one?
5. What were the important milestones?
6. What were internal and external factors that influenced the decision?

Problem investigation
7. What were the challenges/complexities in the decision-making process to improve the braking criterion?
8. What factors influenced that the preparation of the decision took so long?
9. Looking back, do you think time could have been saved? Why and how?
   Explain.
10. How were the challenges within the project responded to?
11. How did the project team work/coordinate together to reach a decision?

Reflection
12. Looking back, what do you think were the aspects that went well during the joint preparation of the decision?
13. Looking back, what do you think could have been better during the joint preparation of the decision? Why?
14. Looking back, what was the most important learning moment for you in the project?
15. Are there any other important points you would like to add to the discussion we have had?

A4.2 Interview guide CAPACITY-case

General introduction
1. Give a short introduction to yourself (position, role & tasks in the project)
2. The timespan of involvement in the project.
3. How was the collaboration between NS and ProRail in the project?
Decision-making process
4. Outline the main influential factors to the decision-making process.
5. What are/were the biggest challenges and complexities in the decision-making process?
6. How was the problem agreement process and solution development process handled?
7. What were the biggest conflict points? How were they solved?
8. What were applied coordination mechanisms to come to a decision in the team?
9. How was a compromise achieved?

Reflection
10. Looking back, what could still be improved in the project?
11. Looking back, what were your biggest learning points in the project?

A4.3 Interview guide ERTMS-case (problem exploration)

General introduction
1. Introduction of interviewee (roles & responsibilities)

Safety board case introduction
2. What is the safety board?
3. What is the purpose of the safety board?
4. What is your role within the safety board? How do you coordinate your tasks with the organization you represent?
5. Do you experience problems with this coordination? If so, how does this affect the safety board?
6. What are the responsibilities of the safety board? Do you agree with them? Why / why not?
7. What are your expectations of the safety board?
8. What do you expect from other members of the safety board?
9. What would you like to accomplish with the safety board (from the perspective of the organization you represent)?
10. What are the strengths of the safety board?

Meetings
11. What do you think is needed to effectively coordinate safety board meetings?
12. Do you need coordination with safety board members outside of meetings? If so, how does that happen?
Decision-making process

13. What are the challenges in making decisions on safety board issues?
14. Choose an issue that has recently been discussed in the safety board and elaborate on the process of its implementation:
   a. How are the meetings within the safety board and the processes surrounding these meetings coordinated?
   b. Why do you coordinate it in such a way?
   c. How are the problem discussions and solution proposals coordinated within the safety board?
   d. Are the problems discussed clearly defined?
   e. Are the cause-effects of the solution proposals known and openly discussed?

Additions

15. Are there any other issues?

A4.4 Interview guide ERTMS-case (evaluation of problem analysis)

Reaction to presentation of problem analysis results

1. Do you recognize the identified complexities?
2. Do you recognize in particular the many socio-political complexities identified?
3. Do you feel this is a good overview of the complexities experienced in the safety board? If not, what is misrepresented?
4. Do you recognize the responses used to address the experienced complexities? Why (not)?
5. Do you recognize the misfit between the complexities experienced and the applied responses?
6. Based on the presented matrix (CRF), what kind of responses are you missing?
7. Based on the presented matrix (CRF), on which quadrant would you like to work on? Do you have interventions for this in mind?
8. Any other remarks?

A4.5 Interview guide ERTMS-case (evaluation of design implementation)

1. To what extent did the intervention session help you achieve the following:
   - Collective learning in the group.
   - Greater understanding of differences and similarities between viewpoints.
   - Greater understanding of the problem.
   - Greater understanding of what remains for us to do to come to decisions.
   - Understanding the benefits of asking non-suggestive questions.
   - Being more convinced that we can achieve good collaboration.
2. Was the intervision session helpful in helping you understand why there are different viewpoints on the role of the program direction regarding safety?
3. Was the intervision session useful in helping you understand how these viewpoints affect the safety board?

A4.6 Interview guide NEW VEHICLE-case (problem exploration)

General introduction
1. What is your role within organization?

Case discussion
2. What is your role within the Unimog project?
3. What are challenge and complexities in the context of the Unimog project?
4. How has the process been managed so far?
5. What can be better managed in the process?
6. How was the coordination with the project organization?
7. How is the communication with other stakeholders?

Reflection
8. Looking back, what went well in the context of the Unimog project?
9. Looking back, what would you have done differently?

A4.7 Interview guide NEW VEHICLE-case (evaluation of problem analysis)

1. Do you recognize the experienced complexities?
2. What don’t you recognize in the complexities? Why?
3. Do you recognize the activities that are working well?
4. Do you recognize the activities that still need improvement?
5. Do you recognize the classification in the matrix (CRF)?
6. What don’t you recognize in the matrix (CRF)? Why?
7. Any other remarks to the analysis?

A4.8 Interview guide IMPLEMENTATION-case (problem exploration)

Initial situation
1. What is your job function and role in the new and previous team?
2. Since when are you part of the (previous) team?
3. Do you have experiences with working in newly combined teams? If so, can you elaborate.
4. Can you give examples of tasks you normally take over?
5. To what extent were you familiar with the members of the new team beforehand? Have you worked with (most of) them before?

**Implemented interventions**

6. How did you perceive the process and activities that you conducted together in order to grow to one team?
7. In the last few months, which activities went well? Please elaborate.
8. In the last few months, which activities need improvement? Please elaborate.
9. How do you value the success of the relationship-based interventions that were implemented:
   a. Daily contact moment
   b. Team-up
   c. Team day
   d. Working on the job together
   e. Others? (e.g. impact analysis)

10. How do you think the activities have helped you to:
11. Increase your knowledge about the tasks/role of each-other
12. Have more mutual respect for each-other
13. Have more streamlined / aligned goals in the team

**Opinion**

14. Do you feel others know sufficiently about what you are doing and for what information to ask you?
15. Do you feel that in the new team your work is valued sufficiently? Why?
16. Do you feel the team is ready to perform well as a unit?

A4.9 Interview guide IMPLEMENTATION-case (evaluation of design implementation)

1. Were you previously aware of the three different coordination mechanisms that you can make use of in your projects?
2. Do you recognize your test scores (individual and in the team)? Why (not)?
3. What can you do with the findings of the preference assessment?
4. Do you take any action points from the findings of the preference assessment? If so, which ones?
Acknowledgements

The last four years have been an eventful journey in which I have met many wonderful people and experienced plenty of joyful and challenging moments together. For this, I want to say my word of gratitude.

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