

Evaluating Equitability of Risk Allocation

Creating a Risk Allocation
Equitability Assessment
Framework for Construction
Projects

Master's Thesis

Version 1.0

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November 20, 2024



Evaluating Equitability of Risk Allocation - Creating a Risk Allocation Equitability Assessment Framework for Construction Projects

by

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in partial fulfilment of the requirements for the degree of

Master of Science

in Construction Management and Engineering

at the Faculty of Civil Engineering and Geosciences

of Delft University of Technology

to be defended on December 5th, 2024, 13h00 at ECHO Hall D.

Student number: 4594878

Project duration: April 2024 – November 2024

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Summary

(Chapters related to the paragraphs are indicated to enable quick document navigation.)

The current Dutch infrastructure construction market faces various challenges in renovations and sustainability, while the global context shows its volatility. The currently rising construction demand strengthens the contractors' bargaining power while they previously have had to be (over-)accommodating towards the client to stay in business. Bad experiences from the past and the complexity of larger projects require a new approach towards collaboration between (public) clients and contractors. Both sides of the industry look at Bouwteams/ECIs, alliances, and other more cooperative construction project delivery methods for answers. These are expected to provide more acceptable approaches towards risk allocation. It is hoped that a more equitable allocation of risks gets the industry moving to solve current and future problems (chapter 1).

But what is equitability? What does it entail, and what is its objective? Answers to these questions are affected by the perspective that is applied: social, economic, or legal. And what is considered when assessing risks and how does equitability affect the principles on which they are allocated? What constitutes an equitable allocation method? (chapter 1)

To start answering such questions, this research has looked at the Dutch rail infrastructure construction industry. The topic is investigated with the help of literature, document and contract analysis, interviews, questionnaires, and five case study projects between ProRail (public client) and Van Hattum & Blankevoort (contractor). To this end, the following research questions have been used:

How can equitability in the risk allocation process of construction projects be defined, applied, evaluated, and improved?

- *What factors in construction projects influence equitability? (chapter 3)*
This describes what is considered according to the literature when equitability is evaluated.
- *How is equitability considered in the construction risk allocation process, and how does this relate to the allocation principles? (chapter 4)*
This compares how the theoretical factors are applied in practice by interviewing and distributing questionnaires among practitioners. Documentation and contract analysis were also applied, and all together they were used to study five case projects.
- *How can risk allocation be conceptualised and operationalised for equitability assessment? (chapter 4 & 5)*
This defines how an equitability assessment framework should be designed based on theoretical and practical findings. A prototype framework has been evaluated with an expert panel of practitioners.
- *How does the application of an equitability assessment framework improve the risk allocation process? (chapter 5)*
This determines how the framework should be applied and improved to optimise the value it provides.

The research has looked at both the rational reasonableness of contractual allocation and allocation principles and at the emotional fairness of its perception experienced by participants. (chapter 2)

The factors to consider for assessing equitability, according to the literature, are largely defined by justice-theory, which distinguishes between distributive, procedural, interpersonal, and informational factors:

- 'Distributive' is about one's balance between invested efforts and valence of outcomes compared to others.
- 'Procedural' assesses rules and processes used for collaboration and allocation.
- 'Interpersonal' takes a look at treatment and relationships in human interactions.
- 'Informational' focuses on communication.

However, this is a somewhat absolute perspective, while literature also shows a more dynamic perspective that evolves with experiences and is affected by trajectories. Trust and multi-actor-focused perspectives further extend the justice-theory factors. Besides justice-theory, philosophical theories about responsibility also contribute theoretical equitability assessment factors. The moral acceptability of allocation is said to depend on moral agency, causality, knowledge, freedom, and wrongdoing. Shared responsibility, the Problem of Many Hands, and legal responsibility can also be considered for allocation equitability. Next to justice and responsibility theories, the literature also provides equitability assessment factors for the insurer's perspective and factors based on practitioners' experiences. Examples include the consideration of social, economic, and legal contexts and an actor's attitude towards risk. Table 1 and Figure 1 provide an overview of equitability assessment factors identified by the literature. (chapter 3)

Table 1: Equitability evaluation rules

Target	Outcomes		Decision-makers		Risk allocation
Category	Distributive	Procedural	Interpersonal	Informational	
Aspects	Distribution based on Equity, Equality, or Need	Opportunity for voice	Respectful enactment of procedures with sincerity and politeness	Candidness and truthfulness of procedural explanations	Causation based preference
	Cost-benefit ratio compared to peers	Influence over outcome	Propriety	Thorough explanations of procedures	Moral Agency or Motive for acceptance of allocation (not ignorance or financial despair)
	Valence of outcome	Consistency across persons and time	Status confirmation & self-esteem	Timely communication	Knowledge of consequences
	Invested efforts/Contributions	Bias Suppression		Personalised communication	
	Completed work	Accurate and unfragmented use of information			
	Performance	Correctability through an opportunity to appeal outcomes			
		Representativeness			
		Ethicality			
		Justly Goal Progress (contributive)			
		Freedom to act in prevention			

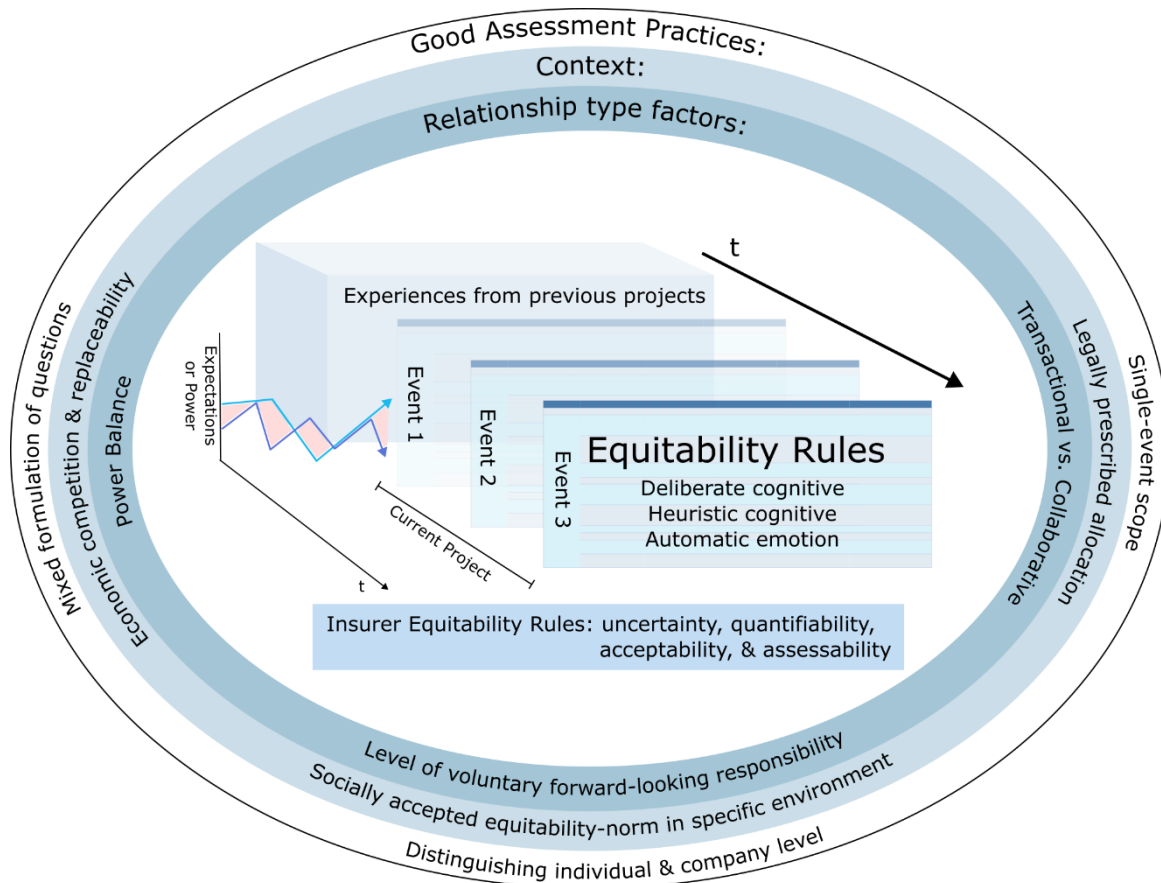


Figure 1: Factors relevant to equitability in construction

Evaluating and validating these in practice shows that the ten-step risk allocation process does not consider all factors (equally). This process starts when financiers set up a project and define their contribution. It starts to become relevant for this research when the client identifies and allocates project risks, and the process ends after project execution has finished. The relevance of the distributive factors is small, according to practitioners, because the (public) client usually (has to) dictate(s) the allocation, and information required for reliable comparison is insufficiently available. Distribution is often based on mutually agreed model agreements, which are subsequently used as the definition for equitability. Consequently, equitability perception primarily depends on communication, alignment, clarity, transparency, and interests, for which experiences, risk management proactivity, expectations, and a shared social basis for equitability are important. An organisational-personal relation level distinction, power balance, and the legal context are said to be not important. However, the economic context, attitude, and interaction behaviour play a role. An important note is that all analyses show a significant influence of subjectivity: every interviewee indicates and emphasises different aspects of allocation equitability. Therefore, the role and definition of factors such as expectations and a shared social basis are ambiguous. On top of that, the economic context can often only reliably be assessed from one's own or an industry-wide perspective, as information about other actors is often insufficiently available to the public. (chapter 4)

Taking a look at the contractual allocation and allocation principles shows that allocations are generally speaking quite similar, although alliance projects logically make more use of a shared risk domain. Allocations also mostly align with the UAC-IC2005 model agreement but the small adjustments to it slightly favour the client. It can also be concluded that three negative indicators of perceived project equitability can be distinguished:

- reduced allocation clarity compared to the UAC-IC2005
- allocation deviation from UAC-IC2005
- non-alignment between the contractual allocation and the form of collaboration.

However, these indicators are never explicitly mentioned for assessment of equitability by practitioners, and they also don't explain the whole picture. Nor are they able to serve as an absolute measure of equitability. Therefore, they are only one part of the relevant factors. Some of the relevant, more risk-specific factors are allocation principles, primarily:

- ability to control
- ability to bear
- preponderant economic benefit
- willingness to take risk
- ability to foresee risk.

Taking all factors from the research of practice to update the overview given in Table 1 results in Table 2. Still, most factors are quite subjective but all together they should cover the equitability perception factors for most people. Which details are focused on is somewhat dependent on whether one works for the client or the contractor and the project delivery method, but trade seems to be negligible and project size ambiguous. (chapter 4)

The variety of relevant factors for perceived project equitability, as shown in Table 2, makes a list of questions to score on a scale the best-fitting assessment tool. The risk allocation process analysis shows the most helpful applicability for the contract scan phase of the contractor and the 'Requests for Modification' (Dutch: VTW) substantiation. In the current practice, a better approximation of an undisputed 'objective' equitability definition than the UAC-IC2005 is unlikely to be found. However, this study shows that this does not cover all factors contributing to one's equitability perception. Due to the subjectivity of the matter, the prototype framework would, therefore, be helpful to clarify, visualise, and substantiate one's own perspective. It could

- show what relevant factors can be considered in equitability discussions,
- identify in what fields most inequity is experienced,
- provide a communicational guide for clients and contractors.

Although an evaluation of the resulting prototype assessment framework validates the choice for these two phases, expert practitioners primarily point out that its outcome is insufficiently compact and comprehensible. Furthermore, that it would be more useful to have an absolute measure of equitability as the assessment outcome, although a comparison between a client's and contractor's evaluation could also be used. However,

the practitioners' desire for an absolute equitability score is dubious. Multiple times, findings have indicated that it is aimless to try to capture equitability in a single score, as this does not do justice to the multi-faceted, subjective nature of equitability. Still, an approximation of it increases the framework's added value, making adoption more likely. Processing the practitioners' suggestions as best as possible has resulted in an updated risk allocation equitability assessment framework consisting of a list of questions. The answers to these could be processed onto a nine-part heatmap grid to identify points of attention (Table 3.1). This could be used to compare assessments between actors or to define measures based on severity or colour (Table 3.2). A benchmark value could be determined per category based on sensitivity (Table 3.3). However, this would require practitioners to define one based on applying the framework to a set of projects. Unfortunately, insufficient time was available to include this in the current study. (chapters 4 & 5)

Table 2: An updated overview of factors influencing equitability perception according to practice

Target	Outcomes	Decision-makers		Risk allocation	Other factors
	Procedural	Interpersonal	Informational		
Aspects	Opportunity for voice	Respectful enactment of procedures with sincerity and politeness	Candid, truthful and strategy-free collaboration and communication	Causation (only for simple projects)	Client's consideration of economic context (lowest price vs. risk identification completeness)
	Consistency across persons and time	Propriety and Bias Suppression	Thorough explanations of procedures	Organisational capacity and decisiveness for effective control	Contractor's consideration of economic context (limiting risk cost component in bid price)
	Limited masking of strategic behaviour	Minimal exploitation of exclusive contractual powers	Timely and specific answers/ communication	Knowledge, expertise and independence to make content-related decisions	Sufficient risk research and control budget
	Organisational/ personal alignment and inexperience with procedures	Not aggressively holding off risk responsibility; Balanced leniency; limited opportunistic behaviour	Unambiguous and definitive answers	Alignment between allocation approach and delivery method	Acceptable project time pressure
	Timely engagement of relevant parties		Reliability of risk research	Ability to control	Realistic compensation that considers changes
	Organisational alignment on expectations, interests, intentions, and motives.		Documentation over trust in daily agreements	Authority to decide	Continuous organisational alignment on intentions
	Working together in close proximity		Transparency of return on risk control costs	Intrinsic motivation to control	Mutual proactivity in risk control
	Candid sharing of relevant negative experiences			Access to information required for control	Acceptable level of secondary interests, preventing needless complication of collaboration
				For alliance: maximisation of alliance domain	Respecting and mutually securing interests

Table 3: Example for processing the risk allocation assessment framework

3.A				3.B				3.C			
	Distribution	Process	Interaction		Distr.	Process	Inter.		Distr.	Process	Inter.
Equitability	0.37	0.74	0.03	Equit.	0.37	0.74	0.03	Equit.	0.37	0.74	0.03
Compensation	0.85	0.29	1.00		0.33/0.67	0.33/0.67	0.33/0.67		0.40/0.75	0.20/0.60	0.33/0.67
Controllability	0.72	0.44	0.72	Comp.	0.85	0.29	1.00	Comp.	0.85	0.29	1.00
					0.33/0.67	0.33/0.67	0.33/0.67		0.15/0.50	0.25/0.60	0.33/0.67
				Contr.	0.72	0.44	0.72	Contr.	0.72	0.44	0.72
					0.33/0.67	0.33/0.67	0.33/0.67		0.33/0.67	0.33/0.67	0.40/0.75

To conclude and answer the main research question, drawing up a universal definition of construction risk allocation equitability is likely impossible due to the subjectivity of its perception. The UAC-IC2005 functions as a benchmark but, according to this research, does not define the full concept of equitability. Therefore, the much more varying total picture can only be approximated by applying a generally acceptable multi-faceted method. Considering the subjectivity of the matter, reasonably objective and more subjective substantiation of one's perception should be distinguished, but both are relevant. The framework designed in this research

provides a generally acceptable tool for such an assessment. However, benchmark values for specific categories are still to be determined. Although the framework does not provide an absolute, objective scoring of risk allocation equitability, it is a starting point that helps to guide conversations, secure attention, and give a deeper understanding of risk allocation equitability. Starting to explicitly discuss risk allocation equitability and standardising procedures to do so would already improve equitability. The planned revision of the UAC-IC2005 and adjustment of additional stipulations might also help. (chapter 8)

Generally, this study's findings align with those of others. However, the construction industry is very practical, making some of the more theoretical approaches from the literature less applicable. The broadness of this research and its more qualitative character makes it hard to recognise some of the more specific findings from other research, but patterns generally align. Most significant differences relate to the limited consideration of distribution for risk allocation equitability perception in construction. (chapter 6)

The most significant limitations of the current research can be divided into three categories: research method, participants, and framework. Regarding the research method, the small sample size of five case study projects, fifteen interviewees, and only a single contractor and client organisation limits the generalisability of outcomes. Additionally, some research parameters overlap, resulting in ambiguous relations for project characteristics such as size, complexity, and delivery method. Concerning the participants, more variety in interviewee gender, trade, and organisation might also change findings. The primary research recommendation is to study real-world application and validation of the framework and define and study benchmark values. Validation of the framework with a client organisation is also required. (chapter 7)

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List of Abbreviations

CAR	– CONTRACTORS ALL-RISK
D&C	– DESIGN & CONSTRUCT
DBFM	– DESIGN, BUILD, FINANCE & MAINTAIN
DIC	– DIFFERENCE-IN-CONDITIONS
ECI	– EARLY CONTRACTOR INVOLVEMENT
FIDIC	– FÉDÉRATION INTERNATIONALE DES INGÉNIEURS-CONSEILS (INTERNATIONAL FEDERATION OF CONSULTING ENGINEERS)
GR	– GATE REVIEW
IAB	– INDEPENDENT ADMINISTRATIVE BODY
KPI	– KEY PERFORMANCE INDICATOR
NEC	– NEW ENGINEERING CONTRACT
PI	– PROFESSIONAL INDEMNITY
PMBOK	– PROJECT MANAGEMENT BODY OF KNOWLEDGE
PMH	– PROBLEM OF MANY HANDS
PPP	– PUBLIC PRIVATE PARTNERSHIP
REP	– RANGEERDIENST EXPLOITATIE
RWS	– RIJKSWATERSTAAT (DUTCH CENTRAL PUBLIC AGENCY FOR INFRASTRUCTURE AND WATER MANAGEMENT)
TWAS	– TOEKOMSTBESTENDIG WERKEN AAN HET SPOOR (FUTURE PROOF RAIL WORKS)
UAC-IC2005	– UNIFORM ADMINISTRATIVE CONDITIONS FOR INTEGRATED CONTRACTS 2005 (DUTCH: UAV-GC2005)
VHB	– VAN HATTUM & BLANKEVOORT

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1 Introduction

On the 22nd of January 2024, the Dutch central public agency for infrastructure and water management, Rijkswaterstaat (RWS), aborted the tender process for the renovation project of one of the main highway bridges in the Netherlands: the Van Brienenoordbrug. The cause was the lack of interest from contractors in the project, attributed to the improper use of an integrated contract and its related risk allocation (Van Belzen, 2024). For construction industry actors, this was yet another sign of the already widely discussed failure to make integrated contracts work for this type of complex project in the Dutch construction industry.

1.1 Context

1.1.1 *The Past Decades of the Dutch Construction Industry Context*

The emergence of these integrated contracts in the Dutch context at the dawn of this millennium has been attributed to several factors, such as:

- the zeitgeist of privatisation and corporatisation (De Leeuwe, 2024)
- time savings on the traditional procurement approach (Chao-Duivis, 2019, p. 5)
- ability to use the expertise of all involved parties at a point where plans can simply adapt (Chao-Duivis, 2019, p. 5)
- improved price accuracy (Chao-Duivis, 2019, p. 5)
- reduced client efforts (Chao-Duivis, 2019, p. 5)
- reduction of cost and improvement of innovation, efficiency and effectiveness (Boes & Dorée, 2008)

Initial implementation in public projects was mainly driven by national-level public clients and embraced by the construction industry, but local-level public clients were more hesitant (Boes & Dorée, 2008). In reaction to the 2002 construction collusion exposure, in which a large group of Dutch contractors were reducing competition by covertly dividing assignments amongst themselves, the implementation of integrated contracts took rise (Boes & Dorée, 2008). This was further boosted by RWS's choice to prioritise integrated contracts for increasingly smaller projects (Koppenjan et al., 2020). However, when the Euro and credit crises hit in 2008, the Dutch construction industry was hit hard due to its ties to investor confidence (Hilverda, 2023). In the resulting wide market, contractors accepted small and even negative margins in combination with high, unclear risks just to stay in business (De Leeuwe, 2024; Koppenjan et al., 2020). During the prosperous recovery and growth of the industry in the 2013-2019 period (Hilverda, 2023) a group of public and private parties defined their vision on how to repair the relational damages and the shortcomings of the integrated contract that occurred during the previous period (Koppejan et al., 2020). This cultural change was to start with equal collaboration between client and contractor based on complementarity, mutual respect, and a focus on cooperatively tackling societal challenges. This required long-term result-focused collaboration, competition, trust, behaviour, information transparency, and equitable risk allocation starting before tendering (RWS et al., 2016). Clarity of assignments was to lead to more realistic tenders to be selected on a quality basis. Additionally, risk allocation should be based on the capacity to bear with financially realistic proportionality (Opdrachtgeversforum in de bouw & Bouwend Nederland, 2016). After 2019, the industry was hit again by the pandemic – causing a growth reduction from 6% to 1.7% – and the Russo-Ukraine war, together increasing construction costs by 16% due to material import and energy costs and a lack of personnel (Hilverda, 2023).

At the same time, the discussion on integrated contracts has continued. One side calls for their dismantling as they inherently force roles on both contractor and client that both parties don't like. They provide a responsibility allocation that is naturally too distant for the client and too isolated for contractors. These contracts were also said to suffer from an irresponsible pricing procedure taking place before risks are clearly identified, transferring those to the market. Experience shows application is too often to unsuited (complex) projects, not beneficial for collaboration and communication (Chao-Duivis, 2019). On the other side, it is acknowledged that the application of these contracts has not always been smooth, achieving less than

desired when it comes to contractor profitability, experimental innovation, flexibility, risk allocation, and collaboration. However, evaluation has concluded that they perform predictably when it comes to planning and investor profitability and that they are beneficial for availability. Above all, improvements and growth have been noticeable over the years. Knowledge that will be lost when these contracts get phased out (Koppenjan et al., 2020).

1.1.2 Current State of the Dutch Construction Industry

In the last few years, the Dutch construction industry has fully recovered, exceeding pre-pandemic levels, especially for non-residential objects. Standing out are the positive effects of sustainability policies on specialised construction revenue. However, signs of stagnation are appearing, driven by increasing interest rates, nitrogen emission limitations, and PFAS regulations. These reduced the number of approved construction permits in 2022-2023, likely reducing construction output and project development revenue in 2024-2025. Attributed to 'demand shortage', this is seen as the current most construction limiting factor by contractors (11.9%), only second to 'shortage of qualified personnel' (16.3%). With 73 vacancies per 1000 jobs, this shortage is 49% worse than the Dutch average. This is partially caused by the neglect of practical education facilities on construction sites after the 2008 crises, increasing demand for foreign labour (Hilverda, 2023). Additionally, circumstances and policies demand transitions in construction industry practices, such as realising circular ambitions, zero-emission construction, and digitalisation (Ministry of Infrastructure and Water Management, 2023; SEB, 2023; RWS, 2021). Furthermore, the amount of deferred infrastructure maintenance has been increasing during the last years to a total of €1.8 billion, of which €37 million is overdue (House of Representatives, 2023). Annual infrastructure maintenance spending is expected to grow from ca. €2.5 billion now to ca. €3.5 billion from 2040 onwards (Rasker et al., 2023).

In the middle of this, the integrated contract discussion continues. As the introductory example highlights, Dutch contractors are currently reluctant to take on large and complex integrated projects due to high risk and low return, reducing competition, quality, innovation, and knowledge and increasing duration and costs (Van Staveren, 2023; RWS, 2019). Consequently, interest seems to shift from typical D&C and DBFM contracts, in which the client is more distant on matters of control and involvement, towards alternatives such as Bouwteam/ECI (De Koning, 2022). Others propose a more flexible, collaborative, coherent, and updated set of model agreements like NEC4 (Chao et al., 2021) or framework agreements and alliances for increasingly complex projects (Hermans, 2021).

In the Dutch infrastructure industry, this shift can be seen with large actors choosing new ways. RWS (2019), the largest (public) client in the sector, concludes that the sector is growing in size and complexity, with a key role to fulfil in future necessary societal transitions. The way integrated contracts are applied – and their risk allocation in particular – threatens the financial health, innovativeness and competition required for these complex projects. To solve this, RWS has shifted focus to two-phase and portfolio approaches (RWS, 2021). Another large (semi-)public client, ProRail, has favoured a short-term project-based alliance approach for complex projects for several years now, for it benefits collaboration and risk management (ProRail, 2013). However, it is important to note that this mainly applies to projects larger than €400 million or projects of high complexity (Koppenjan et al., 2020).

An overview of all previously mentioned developments is provided in Figure 2:



Figure 2: Overview of contextual and contractual developments in the Dutch construction industry

1.1.3 International Perspective

In international comparison, the Dutch construction market stands out for its relatively economically cyclical and capricious character due to its dependency on the interest of private individuals (Hilverda, 2023). For the infrastructural component, this is less so. The more general trends and factors influencing that part mostly have a more global character, such as cost stabilisation after the pandemic and Russo-Ukraine war for

materials and energy, labour shortages, investor uncertainty and emission reduction (Turner & Townsend, 2023). Facing challenges similar to those faced in the Netherlands, the UK government has been balancing collaboration, risks, and innovation to face future transitions and renovations since 2013 (HM Treasury & Infrastructure UK, 2013). In the latest Construction Playbook, portfolios are favoured, and sustainable win-win contract agreements aim to improve risk management and general financial health. Using a single set of conditions, the client, contractor and supply chain get aligned on how to create early involved, long-term, strategic, collaborative partnerships to anticipate much-required changes (HM Government, 2022). Another example of such an approach can be found in Australia (Infrastructure Australia, 2022).

Overall, it can be concluded that a change in socioeconomic context, relationships, and complexity levels calls for a re-evaluation of collaboration and a more equitable risk allocation. A point of attention not only relevant in the Netherlands but the world over. A topic that has led to some rigorous decisions in the Dutch infrastructure industry. But what role does equitability actually play in these projects?

1.2 State of the Art

Several concepts require an introduction to enable the analysis of equitability in construction projects and provide points of improvement for dealing with it. The next section focuses on the collaborative allocation of risk responsibility and defines the objective of equitability, the content of risk, the principles of allocation, and the methods of allocation used in the context of this research.

1.2.1 Objective of Equitability

Equitability, or having the quality of being equitable, fair, just, impartial, and having equity, can be looked at from various perspectives. From a conceptual point of view it is said that although terms like 'fair' and 'equitable' are ultimately subjective, even when based on objective principles (Baker et al., 2020; Levinson, 2002; Lee, 1978), the concept can still be described. Based on Levinson (2002) and Lee (1978), the following structure can be identified (see Figure 3):

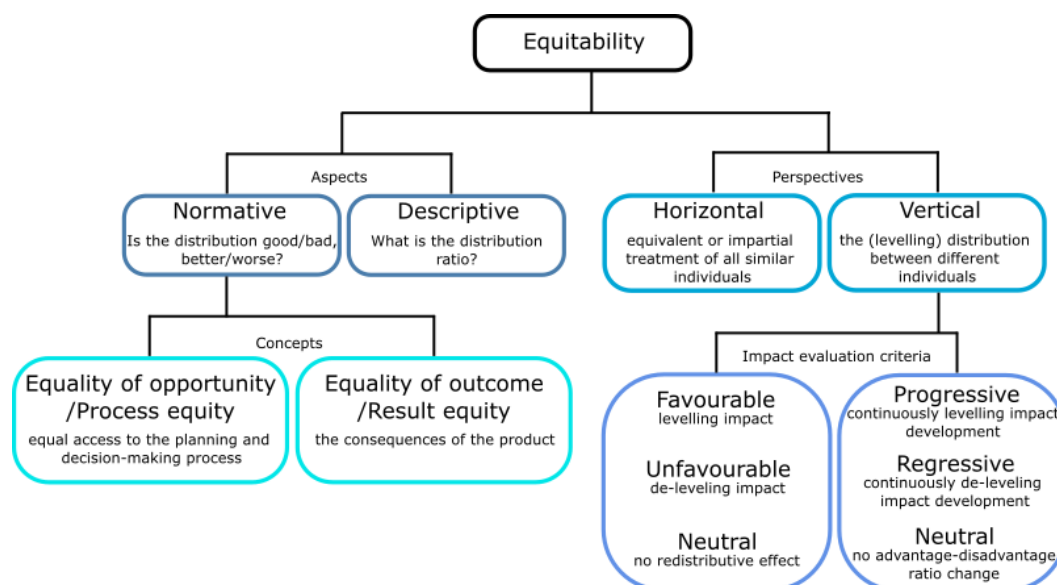


Figure 3: Structure of the equitability concept based on Lee (1978) and Levinson (2002)

A basic theory about the concept of equity was derived by Adams (1963) based on transaction and perception. Equity describes the result of an exchange where one party provides input (e.g. skill, knowledge, traits, possessions), which is rewarded by the output provided by another party (e.g. payment, status, privileges). Both inputs and outputs can be perceived differently on recognition and relevance. When only the possessor of an input recognises it and its relevance and, therefore, expects an output for it in return, inequity arises. When the output has no marginal utility to the recipient or is perceived to be irrelevant to the exchange, inequity arises. The perceived equity of the balance between inputs and outputs is based on a personal comparison of perceived similar cases in one's surroundings and is affected by norms and values.

From the economic perspective, the importance of the equality of opportunity concept is also endorsed by Fleurbaey (2023). He defines it as the equal ability for everyone to choose their option from the same

complete set of options. When it comes to realising equity, Fleurbaey (2023) presents two approaches: “no-envy equity” and “egalitarian-equivalence”. “No-envy equity” occurs when no party prefers to have the combination of rights and obligations another party has. Economically speaking, a competitive equilibrium (Pareto-optimised, non-egalitarian) with equal shares would provide an envy-free allocation. An “egalitarian-equivalence” allocation occurs when all parties are indifferent between their currently allocated combination and an egalitarian one, where every party is allocated the same. To assess fairness, Fleurbaey (2023) uses several aspects, such as the solidarity-basis (all parties will be similarly affected by external influences) and welfare-bound-basis (equal distribution of benefits). As the no-envy approach easily conflicts with the solidarity aspect, the egalitarian-equivalence approach is often better suited for real-world application (Fleurbaey, 2023).

Other approaches to equity can be defined based on Thompoulos & Grant-Muller’s (2013) categorisation of mutually exclusive principles to define equitability:

- Utilitarian: optimising what naturally comes to each party without sharing
- Equal shares: distributing an equal share of benefits to all parties
- Rawlsian: favouring the least advantageous party until all parties reach the same level
- Egalitarian: distributing all benefits to the least advantaged parties
- Minimum floor: distributing a minimum level of benefits to all parties
- Maximum range: setting a maximum range of benefits to be distributed to each party and distribute benefits to all parties, respectively

The third and last perspective is the legal one. In the Dutch legal context, “reasonableness and fairness” (redelijkheid en billijkheid) is a common concept related to equitability, especially in contract law (Wolters, 2013, p.17; Cartwright, 2016). Linguistically, the two are hard to differentiate, but sometimes ratio is attributed to reasonableness and emotion to fairness. Legally, the two are often used only as a combined single concept (Van Lochem, 2019). Equivalents are present in international and foreign legal systems, but they could be less prominent (Wolters, 2013, p. 310; Cartwright, 2016). For example, in a case-based-system like the English one, the opinion juris is often such that it conflicts with the freedom of contract, legal certainty (Cartwright, 2016; Zwitter, 2020) and the principle of trias politica (Van Lochem, 2019).

The legal concept of “reasonableness and fairness” aims to provide flexibility in the application of the law when this is desired and required, and it also protects the weak (Wolters, 2013, p. 142). Generally, three functions are distinguished:

- Complementation: providing additional conditions when the agreement lacks coverage)
- Restriction: invalidating parts of an agreement to prevent unacceptable consequences
- Explanation: defining the legal effects of an agreement, as these are naturally based on the mutual interpretation of each other’s intentions (p. 21).

Therefore, “reasonableness and fairness” depend on the specific context (p. 5). This context is defined by six overlapping factor categories affecting “reasonableness and fairness”, for which the relevance-question is the most important consideration (p.40):

- Norms: all moral rules, opinion juris, unwritten law and principles of law relevant to the case with explicit consideration of the circumstances. Their primary effect can be seen in interpreting and weighing the other factors.
- Behaviours & events: the factual, physical, and observable circumstances which have an objective and changing nature, with consideration of the change initiating party. These are relevant when ‘responsibility’ and ‘change’ play a role.
- Party characteristics in the legal relationship: non-relative characteristics that might be expected of a party. These are easy to prove and also influence the relevance of norms and interests. It is used to compensate for party inequality when this is relevant. This is tightly related to the balance.
- The positions in the legal relationship: both the factual and legal relationship between the parties involved. This considers levels of collaboration and trust and the presence of habits. It shapes the strictness of the “reasonableness and fairness” concept to be applied.

- Interests: Mutual, general, third-party, and personal interests should be safeguarded. This is a test for whether the other factors are relevant. Both the type and size of interest should be considered, as well as the presence of an alternative interest.
- Balance: this considers the relative aspects of the other factors by comparing the different parties. This also includes subsidiarity.

The subjectivity and vagueness of equitability that are shown by these viewpoints can also be seen in the misaligned perspectives on the fairness of risk allocation in construction projects. The percentage of clients who think risk allocation is imposed and inappropriate is significantly lower than that of contractors (Blake Dawson, 2011; Perez et al., 2017). This disagreement on risk distribution patterns is also valid for the wider supply chain, and it is most prominent in the lower reaches of the chain (Loosmore & McCarthy, 2008).

1.2.2 Content of Risk

An often-used definition of risk is the one from the PMBOK Guide:

“Risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on a project’s objective.”

An important note to make is that variability – the guaranteed fact of parameter instability – is not considered to be a risk (Weaver, 2008). Several frameworks to categorise risk can be found in the literature. Based on the principle that anomalies in knowledge create uncertainty and, therefore, risk, Bammer et al. (2008) take the so-called ‘Rumsfeld-matrix’, which was actually Kerwin’s (1993) concept, as the point of departure (see Table 4). However, Bammer et al. (2008) acknowledge that this does not provide a structure on which all perspectives from practice can be mapped.

Table 4: ‘Rumsfeld-matrix’, from Kerwin (1993)

		Meta-level	
Primary Level	Known	Known	Unknown
	Unknown	Known knowns	Unknown knowns (tacit knowledge)
		Known unknowns (conscious ignorance)	Unknown unknowns (meta-ignorance)

Krane et al. (2009) propose a categorisation based on the project objectives management hierarchy to include strategic risks, which are often left out of scope in practice. They distinguish operational, short-term strategic, and long-term strategic risks. Based on an extensive literature survey, Jakas & Haupt (2015) concluded a risk classification of client-related, consultant-related, contractor-related, and exogenous-related risks. A more practice-based classification framework is the one from the Construction Extension to the PMBOK Guide (Project Management Institute, 2016) (see Figure 4).



Figure 4: Construction project risk classification according to the PMBOK Guide

According to Jansen (2021a), information risks are the most influential risks hindering integrated contracts in the current Dutch construction industry. These are risks that stem from assumptions about the actual state in which the project-specific environmental factors are expected to be. These will always be present at the time contracts are signed. According to Baker et al. (2020), risks typically included in contracts are:

- Quantity: the 'remuneration'-'used resource volume' relation
- Employer-provided information errors: level of guaranteed correctness of requirements, site conditions, permits, etc.
- Unforeseen ground conditions
- Force majeure (although often covered by laws, international differences on how they are covered often result in a project-specific allocation incorporated in the contract)
- Change in law
- Delay
- Performance guarantees of the result
- Indemnification
- Insurance

1.2.3 Principles of Allocation

The act of allocation requires conditions and beliefs based on which the division is created. A source frequently used when it comes to such risk allocation principles is Latham (1994), who states that it depends on the project which party should bear a certain risk but that that party should be best able to manage, estimate, and carry that risk. This is a simplification of Abrahamson's (1984) principles that the risk should be borne by the party that:

- is able to control the risk.
- can transfer the risk (e.g. by insurance) when it is most economically beneficial to transfer the risk.
- has the preponderant economic benefit of controlling the risk.
- can most efficiently deal with the risk with the least consequences for long-term industry health.
- will face the loss in the first instance if the risk eventuates and it is not practicable, or there is no reason under the above principles, to cause expense and uncertainty by attempting to transfer to another.

Similarly, Bunni (2009) proposed the risk to be allocated to the party that:

- can best control the risk and/or its associated consequences
- can best foresee the risk
- can best bear that risk
- ultimately most benefits or suffers when the risk eventuates

A list of principles by Lam et al. (2007) contains:

- | | |
|---|---|
| - The ability to foresee | - The ability to sustain consequences |
| - The ability to assess risk consequences | - Benefitting from bearing risk |
| - The ability to control risk chance | - Acceptability of risk-bearing-premium for the payer |
| - The ability to manage eventuation | |

To which Xu et al. (2010) add:

- | | |
|--|---------------------------------|
| - Consequence eventuation minimisation | - Ability to assume direct loss |
| - Bearing risk at the lowest price | - Willingness to take risk |

Xu et al. (2010) also provide a ranking of the relative importance of these principles. An alternative approach could be based on the transaction cost economics and resource-based view perspectives (Jin & Doloi, 2007; Jin & Zhang, 2011), for which research of practice found that principles for the transfer of risk onto contractors are rather based on:

- | | |
|---|--|
| - Low intended asset specificity | - (More indirectly on) capability |
| - Low contractor behavioural uncertainty | - (More indirectly on) cooperation frequency |
| - Low contextual uncertainty (legislation, technique maturity, construction duration) | |

These allocation principles aim to increase the effective, timely and efficient design and construction of projects. They consider the theoretical efficiency of the risk allocation, the political and market dynamics and

the needs of the particular project and its financiers (Baker et al., 2020). Baker et al. (2020) have described how these are theoretically allocated in FIDIC and some other model agreements for several frequently contractually allocated risks. In the Dutch practice of traditional and integrated contracts, each actor is liable for the consequences of his own decisions (leaving aside the duty to warn) (Jansen, 2021a). Such an attitude might not be beneficial to collaborative risk management. Loosemore & McCarthy (2008) present a literature and survey-based overview of risks and the parties to which they are generally allocated.

1.2.4 Methods of Allocation

Besides the previously presented principles to decide on allocation, the literature presents several methods that could be used for this. One of the most simple forms is using a flowchart like the one Corea Galdeano (2022) has created for the Dutch Bouwteam form of collaboration. Peckiene et al. (2013) describe a game theory-based cooperative decision-making technique, simulating a conflict situation between contracting parties, letting them confront each other to find an optimised, fair and equitable risk allocation ratio. This prevents the client from allocating risks on its own, as is often the case, resulting in inadequate allocation. A similar risk allocation bargaining game has been more thoroughly developed by Li et al. (2016). The literature also presents modelled options to define a balanced risk allocation ratio for PPP projects. Xu et al. (2010) created a fuzzy synthetic model to translate client and contractor attitudes towards certain risk allocation principles into the percentage of risk to be equitably allocated to each party. Similarly, Jin & Zhang (2011) trained an artificial neural network model based on the transaction cost economics and resource-based view perspective for risk allocation decision-making, taking even more factors into account.

Ultimately, however, contractual collaborative allocation of responsibility alone is not enough for successful collaborative risk management. It requires information sharing, decision synchronisation, incentive alignment, supply chain process integration, collaborative performance systems, and standardisation of procedures (Friday et al., 2018). Although trust and confidence affect efficiency and joint risk management capability, project success depends much more on communication (Doloi, 2009).

1.3 Knowledge Gap & Scope

Market developments in the Dutch infrastructure industry ask for a more collaborative approach to risk management with special attention to equitability. Although equitability is a subjective concept, various professional fields have made several attempts to define and describe it in their respective perspectives. Despite the market development, the construction industry has not yet received specific attention on this matter. The broader risk management and allocation research has often received more attention from the construction industry. Several approaches that can be applied are therefore available. However, their relation to equitability in the construction industry has not yet been defined.

To fit the available limited time reserved for this research, only a small selection of the construction field has been surveyed. Considering the access to knowledge and expertise and the challenges to be faced, the focus has been directed at the Dutch infrastructure industry. As equitability in risk allocation is about the collaboration of different parties, both the contractor's and the client's perspectives have been investigated. Considering time limitations, the last part of validating the research has been limited to the contractor.

1.4 Research Questions & Objectives

To investigate and further the use of equitability in construction risk allocation, this research answers the following question:

How can equitability in the risk allocation process of construction projects be defined, applied, evaluated, and improved?

This research question addresses both the equitability of the actual distribution process of risks and the participants' perception of its equitability. To this end, the distinction by Van Lochem (2019), as defined in paragraph 1.2.1, is used as a base structure: rational reasonableness for the actual distribution versus emotional fairness for its perception. The objective is to create a framework to assess equitability in construction projects to be collaboratively used by both clients and contractors in the Dutch infrastructure industry. For this end, the following sub-questions are used:

- *What factors in construction projects influence equitability?*
To be able to answer the main research question, the components to take into consideration should first be defined. As paragraphs 1.1 and 1.2.1 have shown, context, culture, experience, and emotion could affect the perception of the risk allocation balance. Contractors might accept different allocation ratios when there is intense competition, a need for business or positive collaborative experiences from earlier projects. An identification of what factors influence a risk balance and the perception of it and the selection of which are present in construction projects should, therefore, comprise the first research step. Regarding the “reasonableness versus fairness” distinction, the answer to this research sub-question primarily focuses on the emotion-related fairness part.
- *How is equitability considered in the construction risk allocation process, and how does this relate to the allocation principles?*
Taking the outcomes of the first sub-question into account, clarity should be provided on how risk allocation and equitability relate to each other. This should not only consider theoretical principles but also the approaches to risk allocation in practice. Furthermore, participating actors and their perspectives should be identified to investigate the unity and focus between them on the identified relevant equitability influencing factors. This investigates both rational reasonableness and emotional fairness, although the latter is more significant. The answer to this sub-question also includes a more ratio-focused reasonableness part. This describes where a particular risk is contractually allocated and how this influences the perception of project equitability. Other parties, such as insurance companies, are also considered, as well as the allocation of residual risk.
- *How can risk allocation be conceptualised and operationalised for equitability assessment?*
Building on the different factors and perspectives identified by the previous sub-questions, what components are necessary for a framework to assess equitability in risk allocation in a construction project? What is the required input, and what is the desired output? How can the result be shaped to provide a clear and communicable message?
- *How does the application of an equitability assessment framework improve the risk allocation process?*
By integrating fairness into reasonableness, the resulting framework drawn up with the previous sub-question is applied. Its use, usability, and value are tested and evaluated with expert practitioners. One of the earlier case studies is used to investigate the improvement the framework contributes to construction projects.

1.5 Reading Guide

This thesis document has been structured along nine numbered chapters, six lettered appendices, and some general structural components. After the preface, summary, table of contents, and lists of abbreviations, figures, and tables, this first chapter has introduced this research’s topic, relevance, and questions. The next chapter explains how the research has been conducted and which methods have been applied. The third chapter revolves around the first sub-question, providing an overview of equitability assessment factors identified in the literature. The fourth chapter investigates the risk allocation practice and validates and complements the findings from the literature. This answers the second sub-question. The following fifth chapter completes the answer to the last two sub-questions by translating the factors identified in the previous chapters into an equitability assessment framework for construction projects. Chapters 6, 7, 8, and 9 provide the discussion, limitations and recommendations, conclusion, and used references of this research, respectively. The appendices follow these chapters in order of occurrence in the numbered chapters. Appendix A elaborates on how the data from practice has been gathered. Appendix B and C provide contextual overviews for analysed organisations. Appendix D revolves around the contractual analysis used for chapter 4. The last two appendices show the evolution of the equitability assessment framework resulting from this research.

2 Research Design

This chapter describes the research design, starting with approach and strategy, followed by an elaboration and schematisation of the research methodology, explaining methods.

2.1 Research Approach & Strategy

As the research is mainly focused on providing insight into the workings of a concept – that of equitability in allocation – and people’s experiences with it, a qualitative research approach has been applied (Aspers & Corte). For the same reasons, a case study research strategy seemed to best suit the totality of this research (Eisenhardt, 1989). This is visualised in Figure 5, which will be further explained in the next section.

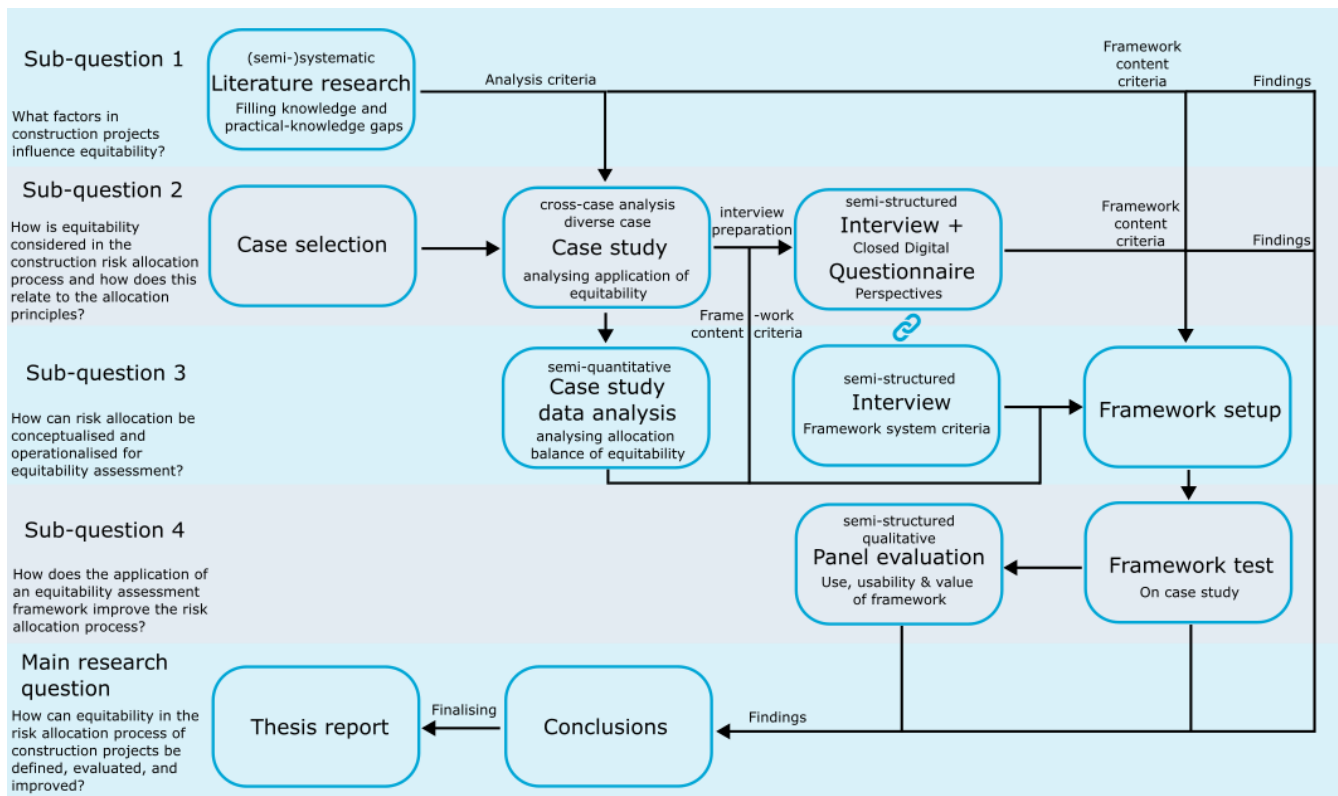


Figure 5: Schematic representation of the research

2.2 Research Methodology

As Figure 5 shows, five types of research methods have been used: literature research, case studies, interviews, questionnaires, and panel evaluation. This section will discuss all five.

2.2.1 Literature Research

Literature research is a more or less systematic way of collecting and synthesizing previous research. It creates a foundation for advancing knowledge and developing theory and allows for an interdisciplinary approach when specific knowledge is missing (Snyder, 2019). As sub-question 1 aims to define a concept with limited specification in the construction and allocation contexts, synthesising and overviewing by applying (semi-)systematic literature research is appropriate (Snyder, 2019). The outcome also provides the knowledge required for later interviews (Kallio et al., 2016).

Using the Google Scholar search engine and the Scopus database, ca. 35 papers were selected and found to be helpful for this research. These papers were found by using search queries like “equity in construction risk allocation”, “interorganisational AND justice AND construction”, and “risk allocation” AND (justice OR fairness OR equitable)”, and by the use of interferences. The topics covered by these papers include

equitability-related theories, inter-organisational collaboration, responsibility theories, and the construction risk allocation practice. Often used selection criteria included a publication date no older than 15 years, prioritising the newest, often cited considering its age, preferably a highly esteemed journal and available using the licences provided by the TU Delft. This method focuses primarily on the emotional fairness side of the reasonableness-fairness distinction.

2.2.2 Case Studies

Case studies give the researcher an empirically valid understanding of dynamics in particular situations (Eisenhardt, 1989). However, as with interviews, the results are in-depth but also very specific (Flyvbjerg, 2006). Selecting a case should be done by balancing pragmatism and purpose, for which Seawright & Gerring (2008, p. 296) present several methods. As sub-question 2 aims to provide a perspective that covers the full range of construction risk allocation approaches in exploratory research, a Diverse Case Method has been applied. To represent these different variations of risk allocation, different forms of collaboration have been used as approximations. However, these are not completely categorical or continuous. Therefore, case selection has at least included the extremes. The extremes can be found in maximum and minimum client participation approaches for construction project collaboration, such as Alliance (max.) and D&C (min.). As Alliance collaboration has not yet been commonly applied for a long time, case studies have been limited to relatively recent projects (ca. 5-10 years since initiation). Further case selection conditions included a variation in budget, variation in the number of participating parties, variation in managers, and interview availability. In total, 5 cases were selected. As 1.2.1 shows, the perception of equitability is somewhat subjective. Therefore, this research is limited to the collaboration between two main parties: Van Hattum & Blankevoort (contractor) and ProRail (client). This client was chosen for its sufficient number of projects with Van Hattum & Blankevoort. Optimally, projects used as case studies would be completed or in the same state to limit assumptions and improve comparative quality. However, as construction projects often have a long duration and the application of more innovative forms of collaboration has only started relatively recently, the availability of projects complying with all criteria is very limited. It was also more likely to find interviewees, as for projects in execution, the client and contractor actors are still communicating, and knowledge and memories are fresh. Therefore, projects that have at least completed the design phase and some early work packages are used. In Table 5, the selected case study projects are presented. As case studies often contain business-sensitive information, confidential data management should be applied.

Table 5: Selected case study projects

Project	State	Contract type	Budget
ZwolleSpoort – IJssel-Herfte	Finished	Alliance	€ 200 m
OV-SAAL Southern-branch West	Finished	Alliance	€ 140 m
Ede Public Transport Hub – Construction of station and rail	In execution	D&C	€ 100 m
Nunspeet – Construction of station area underpasses	In execution	D&C	€ 20 m
Nijmegen REP: construction of working pits	Finished	D&C	€ 1 m

2.2.3 Interviews

By conducting interviews, the individual perspectives and experiences that the interviewee deems important can be gathered. It provides insight into practice as an alternative to theory. The interviewer can choose between different levels of openness and room for elaboration for the interviewed expert. Personal contact improves communication, but findings are often context-specific and subjective (Hammer & Wildavsky, 1993; Knott et al., 2022). A semi-structured interview is appropriate as sub-questions 2 and 3 aim to find the practitioner's in-depth views and methods. The suitable people for the interviews are contract, risk, process or project managers or board of directors members. This covers both strategic management and operational management. Optimally, both the contractor and client sides are represented to provide all relevant perspectives. It is important to note that interviews require informed consent and confidential data management. Inspiration was drawn from Kallio et al. (2016) to set up the interview protocol.

As part of the case study, several interviews are used to get the substantiated and personal insights required to answer the research questions. The interviews required for sub-questions 2 and 3 have been combined into one. These interviews covered three substantive topics:

- validating the literature-based conclusions of sub-question 1 by practical experiences
- general professional experiences and practices on risk allocation and equitability considerations in projects
- personal perception and evaluation of risk allocation equitability in one of the specific projects described in 2.2.2

The full interview protocol can be found in Appendix A. In total, 15 interviews have been conducted with the participants described in Table 6, aiming for 3 interviews per case study project. The average relevant working experience of the interviewees was 18 years. The first interview was used as a pilot and conducted in a combined interview with an interviewee from the client side and one from the contractor side. This way, the questioning and protocol could be tested for relevance and suitability for both sides simultaneously. The primary result of this test was to slightly reduce the number of questions to fit better the 60-minute interview duration deemed acceptable.

Table 6: Overview of interview participants

	Process Manager	Contract & Tender Manager	Risk Manager	Project & Construction Manager	Total
Client		2	1	3	6
Contractor	2	2	1	4	9
Total	3	4	2	7	15

2.2.4 Questionnaire

A questionnaire's content and structure is similar to an interview's. However, due to the one-on-one data gathering in interviews, questionnaires provide some advantages and disadvantages in comparison. According to Patten (2017), the main advantages are efficient data gathering from a large sample group and easy processing (p.1). The disadvantages can be found in the quality of the responses. The non-committal character of questionnaires lowers the response rate and increases bias (p.2), and responses only provide superficial insight (p.3). Krosnick & Presser (2010), who provide a wide range of recommendations on the content and structure of questions and questionnaires, agree. They argue that the quality of answers is limited by unknown factors like the participant's motivation, context, and ability at the time of answering. Difficulty should, therefore, be minimised and motivation maximised. All in all, questionnaires are better suited for numbered, ranged, or closed questions than open ones, although this also increases bias.

As the equitability-factors found in the literature are already validated by the interview, the only purpose of the questionnaire is to determine how the participant has experienced these factors in his respective case study project, as introduced in 2.2.2. This was initially planned to be part of the interview but has been detached due to time limitations. The questionnaire poses one statement per equitability-factor. In alignment with the recommendations by Krosnick & Presser (2010), the difficulty has been minimised by letting the participant only choose whether he agrees or disagrees with this statement. A description of the questionnaire and the statements can be found in Appendix A.

2.2.5 Panel Evaluation

To validate the fitness of an instrument – in this case, the equitability assessment framework – the use of expert panel evaluation is an appropriate method (Sireci, 1998). The prototype framework was intended to be applied during a project's contract scan phase and during later phases to substantiate Request for Modification discussions. The validation panel, therefore, had to include experts involved in either pre-qualification and contract scan processes or project management. Optimally, at least one should have experience with both to evaluate the transferability of the framework. To improve validity through triangulation, experts must be different from the interviewees, but to safeguard continuity, at least one interviewee should participate. To balance the influence of subjectivity with the level of engagement, the panel size was set at 4 people. The composition of the panel consisted of 1 project acquisition manager and 3 project managers, of which one has working experience as a tender manager, and one had already participated as an interviewee in this research. Using this panel evaluation approach, the use, usability, value, and opportunities for improvement of the framework have been assessed during a 1-hour hybrid meeting. As preparation, the basis and criteria for the assessment framework as described in 5.1 and the prototype framework (see appendix E) were made available to the panel members to study.

3 Literature Research

In preparation for establishing an equitability assessment framework and to partially answer the main research question, a literature review has been conducted. This study focused on the question: “*What factors in construction projects influence equitability?*” This chapter describes the results of this research. First, the two most relevant theories are described. The part on justice-theory (3.1) dissects its concept and factors considered relevant by literature, such as fairness, dynamics, trust, and perspective. Several theories about responsibility (3.2) are combined to show its structure and the aspects of collective responsibility and legal responsibility. Next, the atypical role of the insurer within the construction project context is elaborated on (3.3), and the considerations of risk allocation practitioners in earlier research are summarised (3.4). The end of this chapter briefly highlights some injustice signs to be used as warnings (3.5) and answers the research sub-question in the conclusion (3.6). The most important literature domains with their most significant literature and usage are summarised in Table 7:

Table 7: Overview of the most significant literature used

Domain	Paper	Main contributions	Intended application
Justice-theory	Colquitt & Rodell, 2015	<ul style="list-style-type: none"> - An overview of justice rules - Instructions for justice assessment on scope, depth and tone. 	Provides a starting point for evaluation and assessment rules and scoping
	Colquitt & Zipay, 2015	<ul style="list-style-type: none"> - Relation between justice-theory and other theories - Different ways in which justice perceptions are shaped, both deliberate and heuristic 	Provides a way to link additional rules to the justice rules and different origins of perception to consider
	Bouazzaoui et al., 2020	<ul style="list-style-type: none"> - The dynamic aspect of justice perceptions: the recently experienced development of justice affects one's perception of it. 	Shows that equitability evaluation answers should be specific to a certain decision-event
Responsibility	Van de Poel & Fahlquist, 2013	<ul style="list-style-type: none"> - The structure and conceptions of responsibility - Blameworthiness as link between responsibility and risk - Fairness conditions for blameworthiness - The Problem of Many Hands and possible measures 	Provides additional rules for the evaluation of equitability from the responsibility and fairness perspective
	Van de Poel et al., 2012	<ul style="list-style-type: none"> - The structure of and conceptions of responsibility - The Problem of Many Hands 	Provides additional rules for the evaluation of equitability from the responsibility and fairness perspective
Insurance	Bunni, 2003	<ul style="list-style-type: none"> - The role of insurance in construction projects: transferring liability - The requirements for and types of insurance in construction 	Provides insurer-specific evaluation rules for equitability and a better understanding of reality.
Risk allocation practitioners	Ward et al., 1991	<ul style="list-style-type: none"> - The complications in following risk allocation principles: they might conflict - The pitfalls in risk acceptance: one's willingness to get risks allocated might be corrupted 	Provides additional rules for the evaluation of equitability from the risk allocation perspective

3.1 Justice-Theory

3.1.1 The Theory

At the heart of the answer to the question of what factors influence equitability lies justice-theory. This is an evolution of Adams' (1963) equity-theory introduced in 1.2.1. Justice-theory categorises the relevant perceptions one has about justice, distinguishing structural (outcome-focused) justice and social or interactional (decision-maker-focused) justice, each containing two dimensions: distributive and procedural

justice for structural and interpersonal and informational for social justice (Liu et al., 2012; Colquitt, 2001). In literature, interactional justice is also often used as a single dimension.

- **Distributive justice** aligns with Adams' equity-theory. It assesses the equity or perceived balance of one's cost-benefit-ratio compared to that of others (Liu et al., 2012). This can be done on an equality basis, where every party has an equal chance of receiving the outcomes; an equity basis, where the possibility of receiving the outcomes is based on the effort made by a party in comparison to peers; or a need basis (Hornibrook et al., 2009). Distributive justice evaluates the relation between the valence of the outcome on one side and invested efforts, completed work, contribution, and performance on the other side (Colquitt, 2001; Cohen-Charash & Spector, 2001). It defines the cognitive, affective, and behavioural reaction towards a specific task or outcome from an egocentric perceiver bias perspective and aims for productivity and efficiency (Cohen-Charash & Spector, 2001).
- **Procedural justice** assesses the rules and process of collaboration, dispute resolution, and risk allocation (Liu et al., 2012). It evaluates the control and ability one has over the presentation of opinions, arguments or feelings and the sufficiency of time to do so. Or, in other words, the influence one has on arriving at a certain outcome. This includes the consideration of process consistency over people and time, freedom from bias and self-interest, information accuracy, process correctability for unfairness, representativeness of norms, values and outlooks, and compatibility with moral and ethical values of the perceiver (Hornibrook et al., 2009; Cohen-Charash & Spector, 2001; Colquitt, 2001). It defines the cognitive, affective, and behavioural reactions towards the organisation and aims for group harmony (Cohen-Charash & Spector, 2001). Procedural justice safeguards the 'equality of opportunity' described in the introduction (1.2.1) (Fleurbay, 2023).
- **Interpersonal justice** assesses fairness in interpersonal treatment and relationships during human interactions, including communicative aspects such as politeness, dignity, and respect (Liu et al., 2012; Cohen-Charash, 2001) and the refraining from improper remarks or comments (Colquitt, 2001). It defines the reaction towards the person of the decision-maker (Cohen-Charash, 2001). Additionally, interpersonal justice increases trust and, thereby, the sharing of information, improving informational justice (Lim & Loosemore, 2017). It also increases one's tolerance towards lower distributive, procedural, and informational justice (Lim & Loosemore, 2017; Skarlicki & Folger, 1997).
- **Informational justice** assesses the open communication of information and explanations given about the distribution of outcomes or enactment of procedures as provided to individuals (Hornibrook et al., 2009; Liu et al., 2012). This includes candid communication, the thoroughness and reasonableness of the explanation, timely communication, and need-focused personalised communication (Colquitt, 2001).

A short overview used by Colquitt & Rodell (2015) can be found in Table 8.

Table 8: Justice rules (Colquitt & Rodell, 2015, p. 189)

Type	Name	Description
Procedural	Process Control	Procedures provide opportunities for voice
	Decision Control	Procedures provide influence over outcomes
	Consistency	Procedures are consistent across persons and time
	Bias Suppression	Procedures are neutral and unbiased
	Accuracy	Procedures are based on accurate information
	Correctability	Procedures offer opportunities for appeals of outcomes
	Representativeness	Procedures take into account concerns of subgroups
	Ethicality	Procedures uphold standards of morality
Distributive	Equity	Outcomes are allocated according to contributions
	Equality	Outcomes are allocated equally
	Need	Outcomes are allocated according to need
Interpersonal	Respect	Enactment of procedures is sincere and polite
	Propriety	Enactment of procedures refrain from improper remarks
Informational	Truthfulness	Explanations about procedures are honest
	Justification	Explanations about procedures are thorough

Depending on the context and goal, the relative importance of a certain dimension might change. With a strict contract or underdefined dispute clauses, procedural justice and some interactional justice are more important (Lu et al., 2017). This is also true for cooperation in construction project negotiations (Lu et al.,

2017) and other relationship-focused endeavours (Liu et al., 2012; Hornibrook et al., 2009). However, in the case of weak legal enforcement, procedural justice is insignificant (Liu et al., 2017). And when the relationship is purely transactional, distributive justice is most important (Hornibrook et al., 2009). In general, all dimensions of justice are relevant (Liu et al., 2012), especially because they also influence the perception of each other, where interactional dimensions are often most influential (Lim & Loosemore, 2017). As interactional justice is more informal and based on swift interactions, its perception is more transient than distributive or procedural justice (Rubenstein et al., 2019). Therefore, it requires different and continuous attention. Similarly, when one is working outside the familiar context, adjustment of justice perceptions to the new one might be required to comply with its norms (Liu et al., 2017).

Colquitt & Zipay's (2015) literature survey showed that the question of justice originates from uncertainty. This could be uncertainty about:

- trustworthiness (see 3.1.4)
- status: how one is treated (by superiors) emits a signal about one's status and position within a group, also affecting self-esteem.
- morality: applying a backward perspective, one could theorise about what should have been. This provides a point of comparison to clarify the morality of a past decision.
- goal progress: whether an event contributes to achieving a goal and whether this is just is often answered by an unconscious automatic response. The justice question is relevant in this context to safeguard progress and prevent hindrance.
- anything: for completeness, Colquitt & Zipay (2015) add that the question about justice or fairness can be used to shape one's response to any matter of uncertainty.

3.1.2 Justice, Fairness & Assessment

Although justice and fairness are often used interchangeably in literature, some authors separate them (e.g. Colquitt & Zipay, 2015). Justice, then, is defined as the perceived adherence to rules that reflect appropriateness in a specific decision context, whereas fairness is a more global perception of appropriateness. This global perception can be shaped in several ways. The beholder can apply deliberate cognitive processing based on self-interest or optimal outcome comparison. Another way is heuristic cognitive processing, which is based on an unconscious comparison between an event and personal morals while aiming for justice. The order and type of information unconsciously used significantly affect the conclusion. This closely relates to the third way based on affect and automatic emotional response as people can 'feel' unfairness rather than just think about it. This perception-shaping way is affected by the mental state of the beholder at the time of perception. A mix of these three ways also occurs (Colquitt & Zipay, 2015).

This distinction is important to consider when assessing a situation. There could be a significant difference in perception of fairness in general or when it is specified for a particular interaction in a specific context (Colquitt & Rodell, 2015, p. 188). Theories from literature might be more appropriately used when considering single decision events rather than objects or actors, which are the subject of assessment when multiple events are combined (p.190). The same goes for too general an assessment of fairness (p. 193). The questions asked will define which of these foci is used. Another variable consists of the level of inquiry. Depending on the questions asked, the response is focused on e.g. the organisational or supervisory justice level, which might be perceived significantly differently (p. 188). Assessing a limited number of specific events in specific contexts, keeping these events separated, and clearly distinguishing between company and individual levels would likely provide the best results.

Another assessment approach to consider is whether to use the four dimensions distinctively for both justice and fairness or to apply justice and fairness as two singularities. Because the dimensions are highly interrelated, separating them should only be done when necessary to prevent unnecessary distortion. For justice, the dimensions are most appropriately used as independent variables (Colquitt & Rodell, 2015, p. 195). A list of justice rules drawn up by Colquitt & Rodell (see Table 8) based on an extensive literature review can be used as inspiration for basic justice factors, but for completion, additional context-dependent rules could be applied (p. 189). As injustice seems to be experienced more strongly than justice, eliciting stronger reactions, using both these original assessment factors and negatively formulated versions of them, improves results (p. 198).

3.1.3 Dynamics: Experiences & Trajectories

Justice-theory on its own, focuses on assessing a specific moment or project, taking a more absolute point of view. However, experiences from the past can shape one's perception, and continuing experiences can alter one's perspective (Hausknecht et al., 2011). Therefore, a more dynamic point of view should also be considered (Bouazzaoui et al., 2020).

As parties become familiar with each other over time, their justice perceptions are continuously rebalanced through consecutive alterations based on their interactions. Therefore, a justice perception develops over time, eventually reaching a more stable state that is only altered by more extreme events (Bouazzaoui et al., 2020). This change in perception over time can be plotted on a trajectory, which provides insight into reactions to (in)justice: sensitivity and resilience do not just depend on one's absolute, instantaneous perception of it but also on whether extrapolation of recent experiences provides an improving or declining prospect (Bouazzaoui et al., 2020). When experiences are used to assess justice, the most recent experience and the trajectory are most influential, but extreme experiences and the average also play a role (Rubenstein et al., 2019). This relates to the concept of anticipatory justice (Colquitt & Rodell, 2015, p. 196), which states that past experiences shape expected future justice, affecting self-esteem, acceptance of change and commitment. However, this could also create distortion, as the experience of injustice could be used as a scapegoat to falsely increase self-esteem by ignoring personal flaws. On the other hand, high self-esteem can also increase the level of expected respect, making actors more sensitive to injustice (Cohen-Charash & Spector, 2001).

3.1.4 Trust

When it comes to the decision to start a collaboration, experienced justice perceptions from previous collaborations significantly affect the willingness to cooperate (Liu et al., 2017). This is also related to trust, which, in the absence of information on a future partner's trustworthiness, is often based on perceived procedural fairness (Zhang & Jia, 2010). After all, adherence to rules like equity, consistency, respect, and justification is more observable than qualities like competence, integrity, and benevolence, making procedural justice of an unfamiliar party easier to assess than other types of justice (Colquitt & Zipay, 2015). This form of calculative trust is forward-looking and based on the conviction that the other party's cost-benefit ratio will guide them towards contractual compliance and away from opportunistic behaviour. Longer and more intense collaboration will transform this into relational trust based on beliefs and experiences about the other's goodwill, honesty, and good faith efforts (Poppo et al., 2016). However, the factors that build trust differ between client and contractor. While both require integrity, only the client significantly values competence (Pinto et al., 2009).

An important point about the relationship between justice and trust is that there is no consensus on causality. While authors like Colquitt & Zipay (2015) emphasise trust before justice, others emphasise justice before trust (Hubbell & Chory-Assad, 2005). Bidirectional causality seems therefore fitting.

3.1.5 Two Sides & Even More Individuals

Another important aspect to emphasise when evaluating equitability is that two or more sides are present with their own and possibly different perceptions of justice. Nyaga et al. (2010) studied the relationship between a procuring and supplying party. They conclude that although effort, investment, and commitment are valued by both, each has distinctly different expectations of the relationship. This could affect justice perceptions differently. As a relationship can only be built on something acknowledged by both sides, only a simultaneous and shared perception of high justice enables a relationship to be profitable and stable. This requires the continuous alignment of justice perceptions (Liu et al., 2012). Therefore, a mutual justice perception inquiry should be a continuous endeavour in collaboration. This is only fruitful when performed freely, actively, and earnestly (Rubenstein et al., 2019).

The presence of multiple actors also enables power asymmetry between them. Imbalanced dependency for compensation of investments, imbalanced dispersion of uncertainty consequences (Zhu & Cheung, 2022), institutions (i.e. (in)formal rules of interaction), and resources create power of one actor over another. This also considers the degree of replaceability of an actor due to competition (Chen & Hubbard, 2012). Opportunity-driven (Chen & Hubbard, 2012) misuse of this power (e.g. strategic use of information asymmetry, indiscriminate risk allocation to one party, inappropriate risk-reward, etc.) damages the

relationship and affects equitability (Zhu & Cheung, 2022; Ward et al., 1991). During the project, powers may shift sides, often initially favouring the client but swinging towards the contractor as the sunk costs of retendering increase (Zhu & Cheung, 2022). In a context with strong and independent legal enforcement, public clients are often locked in between the contract with the contractor and its accountability to provide services towards the public, magnifying the shift (Chen & Hubbard, 2012).

And where on the project level, companies or organisations are perceived as a single entity, in reality, many individuals are involved. A relationship between companies is, therefore, more than just that. It is a network relation of different individual human actors in each of the companies. All these individuals influence the relationship at the company level (Hornibrook et al., 2009). They also serve as company representatives on which their counterpart may base their perception of the company as a whole (Bouazzaoui et al., 2020). Additionally, individuals influence each other's personal perceptions (Hornibrook et al., 2009). Therefore, the perception of justice may differ between individual, company, and supply chain levels (Hornibrook et al., 2009; Bouazzaoui et al., 2020). However, multi-level analysis of inter-organisational justice is underresearched (Bouazzaoui et al., 2020).

3.2 Responsibility

Other factors and perspectives that say something about equitability can be found in the primarily philosophically oriented theories about responsibility. As with risks, responsibilities are allocated, both intentionally and unintentionally. And when risks are allocated, in fact, certain responsibilities related to those risks are allocated.

3.2.1 The Concept of Responsibility & the Relation to Risk

When defining responsibility on its own, different sorts and conceptions of it can be distinguished. Responsibility can stem from moral, legal, or organizational grounds (Van de Poel & Fahlquist, 2013). In contracts and reality, these don't necessarily follow each other, as one can have legal responsibility without being morally or organizationally responsible and vice versa (Bunni, 2003, p. 135). Expanding (primarily) the moral branch of responsibility, a descriptive and normative perspective and a backwards-looking and forward-looking approach can be distinguished. The approach refers to the point in time when the responsibility question is assessed in relation to the event relevant to this responsibility. At the end of the branches, eight conceptions or senses of responsibility can be distinguished (see Figure 6). However, both legal and organisational responsibility are also embedded in these conceptions. Legal responsibility often focuses on accountability and liability and organisational responsibility on role and authority. Both categorisations are related (Van de Poel & Fahlquist, 2013).

When looking at the relationship between responsibility and risk specifically, blameworthiness and obligation provide the seminal links through recklessness and negligence and the obligation to avoid risk respectfully (Van de Poel & Fahlquist, 2013; Van de Poel et al., 2012). Regarding blameworthiness, the condition to blame reasonably and fairly becomes important. Although the literature shows there is a discussion about the exact content, formulation, and individual necessity and joint sufficiency of the different criteria, generally, the following are accepted (Van de Poel et al., 2012; Van de Poel & Fahlquist, 2013):

- Capacity or Moral Agency: the (mental) ability to act responsibly
- Causality: being the cause of a consequence
- Knowledge: One should have or might have reasonably expected to have known the consequences
- Freedom: One should have acted voluntarily and been in control
- Wrongdoing: One should have done something wrong

However, other sets of criteria could also be used, such as Mastop's (2013) agent-based criteria set. The assessed responsibility or event should be sufficiently defined when applying fairness criteria. In the case of a too general, large or complex definition, a singularly responsible person is hard to find as his individual contribution to the eventuation is disproportionate to the consequences (Thompson, 2014).

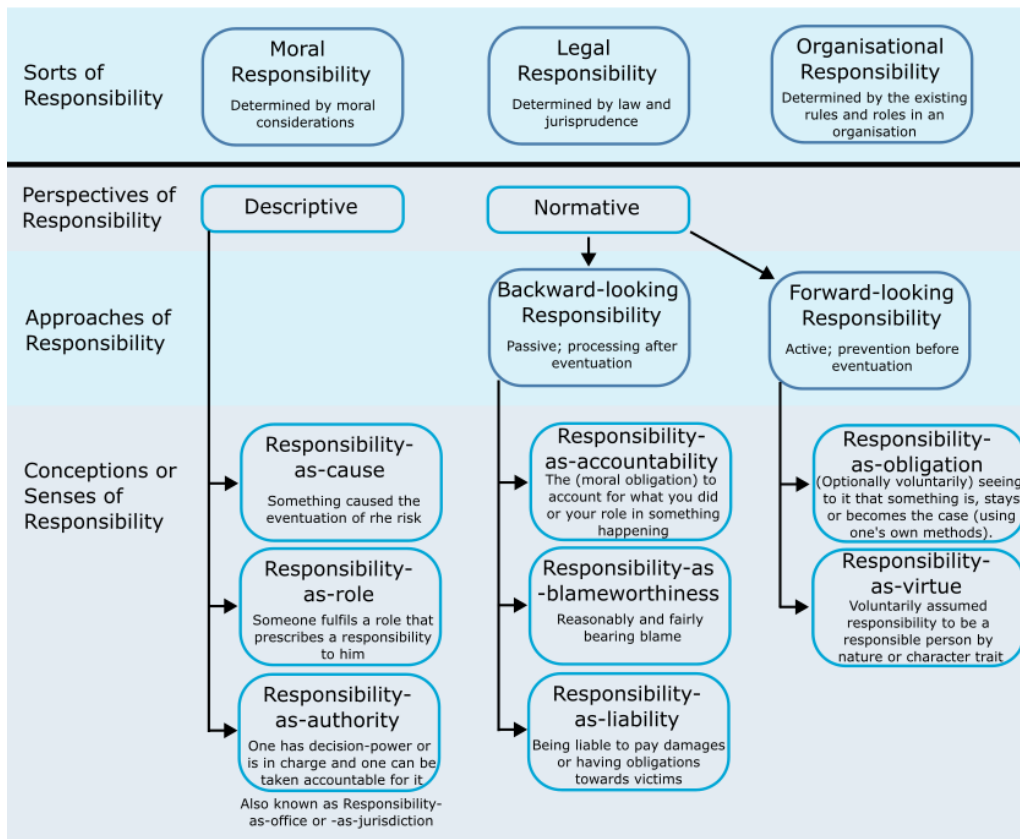


Figure 6: Taxonomy of (moral) responsibility, based on Van de Poel & Fahlquist (2013) and Van de Poel et al. (2012)

Besides the previously mentioned blameworthiness and obligation, the link between responsibility and risk is also influenced by controllability (freedom & knowledge), voluntariness (freedom & causality), decision-making (causality, wrongdoing, freedom & knowledge), and acceptability (of liability). Acceptability again depends on whether someone can be fairly held responsible for its eventuation (blameworthiness) (Van de Poel & Fahlquist, 2013).

With risk allocation, the forward-looking approach is used. Usually, four types of risk responsibility can be distinguished (Van de Poel & Fahlquist, 2013):

- Responsibility for risk reduction: e.g. engineers are primarily responsible for the safety of a construction
- Responsibility for risk assessment: defining the risks. Due to uncertainty, this is not always sufficiently possible.
- Responsibility for risk management: deciding on how to handle the risks by setting levels of acceptability and effort. This is a subjective endeavour.
- Responsibility for risk communication: how risk is communicated depends on perspective (individual or collective), intention, and bias

3.2.2 Collective Responsibility & the Problem of Many Hands

Often, risks have an individual and collective component. The individual component is an often backward-looking approach that distributes responsibility between all individuals involved in a causal chain. To this end, the fairness conditions are considered. The collective or systemic, often forward-looking approach focuses on system rules, standards, designs or the “collective actors with the resources and abilities to affect the situation in a positive direction” (Van de Poel & Fahlquist, 2013). Collective responsibility can also be defined as a collectively shared responsibility that, if an individual had performed the collective task, responsibility would have been his (Van de Poel & Royakkers, 2011). Holding a collective responsible could be helpful to prevent unfairly and inconsiderately blaming its individual members. Still, it is questionable whether collectives, in addition to legal agents, can be considered moral agents: the members stay targets and solvers of the consequences. However, sometimes it is necessary to hold a collective (legally or financially) responsible but then the role of the members should not be ignored, as this would increase unfairness and damage incentives for responsible behaviour (Thompson, 2014).

However, a situation can occur in which a collective is responsible but in which, nevertheless, none of the individuals that together constitute the collective is responsible (Van de Poel et al., 2012). The undesired state of affairs is not directly caused, wanted or intended by any of the individuals. Yet, it is felt that someone should be held responsible despite the absence of legal wrongdoing and (near) impossibility of applying the fairness conditions (Van de Poel & Fahlquist, 2013). Consequently, the gap in responsibility distribution results in a morally problematic collective setting (Van de Poel et al., 2012). This is known as the Problem of Many Hands (PMH). This can arise from a lack of knowledge (Van de Poel et al., 2012), fragmentation of information, accumulation of individual harmless consequences to a collective disaster, or conditional freedom to act (Van de Poel & Royakkers, 2011). Besides the problem of blameworthiness, the consequences of a PMH include impossibility for retribution, a lack of motivation for forward-looking responsibility for both individuals and the collective (Van de Poel et al., 2012), and prevention to learn (Van de Poel & Royakkers, 2011). Additionally, with increasing collaboration and a desire to be aware of risks and manage them in the modern world, PMH has become an increasingly important obstacle (Van de Poel & Fahlquist, 2013).

Literature also provides suggestions to address the PMH:

- Fostering and cultivating forward-looking responsibility through responsibility-as-virtue improves the willingness to take responsibility actively. This induces a feeling of personal involvement, commitment, dependableness, and willingness to sacrifice. It is about carefully balancing different moral demands (Van de Poel & Fahlquist, 2013). This environment of responsibility-as-virtue can be used to anticipate responsibility distribution gaps.
- A second option consists of the mutual acceptance of the different views on responsibility and distribution that might have caused the distribution gap. This requires respect for the differences but also consensus on the most basic structures and foundations of society: values about freedoms, respect, collaboration, etc. (Van de Poel & Fahlquist, 2013).
- The last suggestion focuses on institutions. Institutions facilitate and shape behaviour and, therefore, influence the extent to which people act responsibly. To counter PMH, optimally, the institution would be functionally designed by defining roles with rules and general action-constraining norms to safeguard responsibility (Van de Poel & Fahlquist, 2013; Thompson, 2014). Nonetheless, it remains an important question to determine which party is responsible when the contributions of multiple parties underly a risk and its eventuation.

3.2.3 Legal Responsibility

As previously mentioned, legal responsibility is based on law and jurisdiction and is primarily concerned with accountability and liability. Liability means that someone is or may be legally obliged to do or suffer something (Bunni, 2003, p. 140). It is often allocated based on effectiveness instead of fairness and can be used by the government as a tool to prevent undesirable consequences. Where regulations are limited as they can't consider unforeseen or unknown situations, liability focuses on the actor to address such cases (Van de Poel & Royakkers, 2011).

In risk allocation, not all risks are therefore free to allocate, although this might depend on the perspective used. For example, in the Dutch context, when taking a public law perspective, ultimate responsibility for health and safety legally always resides with the client. Some of this might be transferred to the contractor in private law, like the responsibility for a healthy and safe working environment and personnel instruction during execution. However, from the public law perspective, the ultimate responsibility is unchanged (Inspection Social Affairs and Employment, 2017). Furthermore, according to Article 7:754(1) of the Dutch Civil Code, the contractor is liable for the consequences of his duty to warn. When the general terms and conditions from the model agreement and contract are ignored, the Dutch Civil Code (Article 7:750 et seq.) prescribes the following responsibility allocation (see Table 9) (Jansen, 2021b):

Table 9: Prescribed legal responsibility allocation according to the Dutch Civil Code

Client	Contractor
Duty to pay	Responsibility to deliver: constructing according to agreed plans and other agreements
	Duty to warn: warning the client of deficiencies in design or prescriptions
	Responsibility for Resources: used materials and personnel (incl. subcontractor) unless prescribed by the client.
	Duty to warn of cost-increasing circumstances
	<i>In the case of own design:</i> Responsibility for qualitative design: design according to (legal) rules and regulations and client conditions

3.3 Insurance

Regarding liability in projects, a different type of actor enters the picture. One that cannot be allocated risks to avoid or mitigate them: the insurer. It is the actor to which liabilities are transferred. As its role and function within the project are so different from the others, an explicit closer look at its function and motivation is needed to comprehend its perception of equitability.

Bunni's (2003) 'Risk and Insurance in Construction' is a primary source on the relationship between risk, liability and insurance. He states that the main principle of insurance is the equitable contribution of many to benefit an individual suffering a loss. This equitability is safeguarded by criteria limiting what can be insured. The applicability of these criteria depends on the height of the premium and the risk-averse attitude of the insurer. These criteria are (p. 189):

- Uncertainty: there must be an aspect of unforeseeability or probability. Eventuation should be accidental or fortuitous.
- Quantifiability: insurance requires the ability to calculate probability and premiums.
- Acceptability: As insurance is a service, the matter to be insured must be accepted by the insurance market and fit in a portfolio. For example, for construction insurance, political risks or risks on an international scale are often unacceptable for insurers.
- Assessability: the insurer must be able to assess the occurrence, cause and extent of damages.

Generally speaking, in a construction context, this means risks leading to personal injury, death or physical damages can be insured. For economic or time loss, this is often not the case (p. 130). To enable the participation of the insurer and the alignment with the four criteria above, insurance contracts require a high level of trust, obligatory transparency, unprofitability of the insurance to the policyholder, interest for the insurer, and subrogation (p. 180).

As every additional party to a construction project increases the level of risk (p. 46), an insurer must provide additional value. This value can be found in ensuring compensation in case of failure when a contract stipulates an indemnifier to pay an indemnity he is unable to afford with his own resources (p.179). This is done by transferring the liability. Construction contracts are characterised by their difficulty in being prematurely dissolved, their sizeable pricing, the uniqueness of the product, and the significant role played by hazards and risks. As a result, they are eminently suited to insurance (p. 181). Often, insurance clauses are part of model agreements, stating which actor to take out which type of insurance or coverage (p. 130) (see Table 10). It is also often the case that multiple insurers take part in the project with each actor having its own insurance policy (p. 191). Insuring is, in itself, also a risk, as insurers might rightly or wrongly refuse to pay out or they can become insolvent (p. 182).

Table 10: Overview of construction-relevant types of insurance (Bunni, 2003)

Type of Insurance	Status	Coverage	Policyholder	Ref. page
Contractors All-Risk Insurance Policy (CAR) or Erection All-Risk Insurance Policy	Often required by contract	A type of property insurance that covers works, materials, equipment, and machinery.	Contractor	191
Clients Property Insurance	Often required by contract	A type of property insurance that covers any part of the works taken over, used or occupied before completion.	Client	192
Employers' Liability Insurance (EL)	Often required by contract	A type of liability insurance that covers injury or damage towards employees.	Client, contractor, and professional	191
Public Liability Insurance (PL)	Often required by contract	A type of liability insurance that covers injury or damage towards third parties. The client often only insures liability in excess of what has contractually been allocated to the contractor.	Client, contractor, and professional	191, 192
Professional Indemnity Insurance (PI)	Could be required and often recommended	A type of liability insurance for hired external professionals like designers or consultants to cover their indemnity liability for caused injury or damage to others than employees in case of negligence. This does not overlap with PL coverage.	Professional (and contractor in case of design work)	351
Non-negligence Insurance	Could be optional	Covering the client for damage to third-party property not caused by contractor negligence.	Client and Contractor	192
Decennial Insurance	Optional	Covering latent construction defects out of the contractor's control for ten years, not including wear and tear, maintenance or minor defects.	Client	195
Difference-in-Conditions Insurance (DIC)	Most often optional	Contextually dependent additional property or liability coverage for specific insurance gaps between all standard policies deemed to require insurance. Some might be contractually required in international projects, such as Marine or Air Transport Policy. Other examples include increased liability limits or expropriation of assets.	Client, contractor, and professional	191, 380
Project Insurance, Principal-Controlled Insurance, or Wrap-up Insurance	Optional	It is understood in different ways. Generally, it is not a separate insurance policy but rather a combined insurance package, jointly issued by participants, providing CAR, PL, DIC, optionally PI, and temporary works, equipment and ancillary buildings used.	Jointly	381
National insurance schemes	Might be compulsory	An example of this is Motor Insurance. These are not necessarily related to the project but might affect one's insurance perspective.	Client, contractor, or professional	388

3.4 Considerations of Risk Allocation Practitioners

When it comes to equitability in risk allocation in predominantly PPP projects, a large number of studies asked practitioners what risks they consider and where they think those risks should be allocated. However, their motivations often stay unaddressed. When motivations are addressed, control and cause are often leading (Chen et al., 2023; Ke et al., 2010; Zhang et al., 2016). Ke et al. (2010) also suggest that the more elusive, complex and uncontrollable risks shouldn't be allocated to a single actor. The same goes for risks where allocation principles conflict and consequences are usually much larger than the probability of occurrence. Clear agreement on where to allocate specific types of risk does, however, not exist, both between actor roles (client, contractor, consumer, insurer) and members of these groups (Wibowo & Mohamed, 2010). This might be caused by the inherent uncertainty of risks (Sastouque et al., 2016) or conflicting allocation principles (e.g. best able to control vs lowest cost or best able to anticipate) (Ke et al., 2010; Ward et al., 1991).

Additionally, equitable risk allocation is highly related to the unique social, economic, and legal context (Ke et al., 2010). A wrong focus on equitability or fairness could be dangerous. An egocentric perspective on fairness may be unbeneficial to outcomes and progress. Addressing the fairness concerns of the other party is a more beneficial approach (Chen et al., 2023).

The consideration of whether an allocation is equitable should, however, not be the end, as Ward et al. (1991) have defended. The motive for risk allocation should also be assessed as a contractor might accept risk due

to risk-ignorance and financial despair. Additionally, a client might force risk onto a contractor without providing sufficient time, information, or compensation just to get rid of it, resulting in a client's careless behaviour and inconsiderate flexibility (Ward et al., 1991). Even when sufficient compensation is provided, if it concerns a risk caused by the compensating party, this allocation is not beneficial to the justice perception (Zhang et al., 2016). Therefore, a consideration of allocation should include risk attitude, risk perception, ability to bear consequences and manage uncertainty, need for work, and the perception of risk transfer outcomes (Ward et al., 1991).

3.5 Signs & Consequences

Lastly, some consequences of inequity are illuminated, as these can serve as signs when equity is threatened and as examples of what not to do.

An often-mentioned consequence of inequity is opportunistic behaviour (Chen & Hubbard, 2012). Once the contracts are signed and allocations are defined, a negative assessment of its fairness can move the aggrieved party to try to narrow the gap through ex-post opportunism and non-cooperation (Zhu & Cheung, 2022). The main project milestone at which this is likely to happen is upon the commencement of physical work once reality proves to differ from the plans and subsequent allocations made than was expected earlier on (Zhu & Cheung, 2022). These consequences can emerge through a reduction of input by the disadvantaged party, obstructing progress, quitting, or (un)fairly eliminating competition from the playing field. A less aggressive alternative is an acceptance of reality by the disadvantaged party by altering its perception of what is equitable (Adams, 1965).

3.6 Conclusions

Based on the previous paragraphs, five categories of relevant factors for equity in construction projects can be distinguished. These are context, relationship type, rules, evolution of experience, and assessment. However, an important note to make is that this distinction primarily focuses on identifying relevant aspects to keep in mind when considering equity. In practice they will likely be more interrelated than their descriptions below might suggest. This interrelatedness has primarily been described in 3.1.2 and 3.1.4 but can also be seen in the linking role between factors as played by aspects such as self-esteem. The earlier defined five factor-categories will be shortly described:

A construction project is never on its own but is performed in a context. When risks and responsibilities are allocated, the legal context might prescribe an allocation to a certain actor. The economic context might provide alternative options for revenue and collaboration. So, when one party is replaceable due to its competition, the imbalance in power might skew the perception of equity. Lastly, the alignment of perceptions plays a role. Especially in international projects but relevant for every project, one's personal perception of justice might not align with the perception common in the environment in which the project is performed. This might require one to alter their perception to be able to fit in. In this way, consensus on the structure and foundation of the relationship within the collaboration can be reached so that a single set of social rules aligns all. Equitable risk allocation is, therefore, highly related to the unique social, economic and legal context.

The type of relationship also affects the equity. When the goal is only transactional, only distributive justice is of significant importance. When (financial) dependency, dispersion of uncertainty consequences, rules of interaction, and resource distribution create a power imbalance, this should be acknowledged by all sides and used considerately. The type of relationship might also determine the level of (voluntary) forward-looking responsibility, which should be balanced to maintain equity and to be helpful in countering the Problem of Many Hands.

The rules used to evaluate equity are applied in three ways: deliberate cognitive, heuristic cognitive, and automatic emotion. These rules focus on different aspects and targets, as summarised in Table 11 (for a more elaborate explanation of some of the aspects, see Table 8):

Table 11: *Equitability evaluation rules*

Target		Outcomes		Decision-makers		Risk allocation
Category	Distributive	Procedural	Interpersonal	Informational		
Aspects	Distribution based on Equity, Equality, or Need	Opportunity for voice	Respectful enactment of procedures with sincerity and politeness	Candidness and truthfulness of procedural explanations		Causation based preference
	Cost-benefit ratio compared to peers	Influence over outcome	Propriety	Thorough explanations of procedures		Moral Agency or Motive for acceptance of allocation (not ignorance or financial despair)
	Valence of outcome	Consistency across persons and time	Status confirmation & self-esteem	Timely communication		Knowledge of consequences
	Invested efforts/Contributions	Bias Suppression		Personalised communication		
	Completed work	Accurate and unfragmented use of information				
	Performance	Correctability through the opportunity to appeal outcomes				
		Representativeness				
		Ethicality				
		Justly Goal Progress (contributive)				
		Freedom to act in prevention				

The different categories of these rules do not stand alone but are interdependent influences. Good interpersonal justice increases tolerance towards lower justice in other categories. Bidirectional causality can also be seen between justice and trust.

When it comes to the insurer, and his role in taking over liability, when an actor cannot afford indemnity with his own resources, uncertainty, quantifiability, acceptability, and assessability are required. This enables the insurer to perform fairly. The relationship with the insurer must be built on trust and transparency.

The appropriate use of these rules is, however, limited to a single event. Yet the perception of equitability is influenced by experiences from past collaborations (which might have been with different parties), which can also evolve during the project. These experiences shape one's expectations of equitability, self-esteem, acceptance of change, commitment, and expected respect. From the start, justice-related expectations might differ between parties. These expectations and perspectives should be discussed and aligned, and continuously and earnestly monitored, discussed and aligned in their development during the project. This provides insight into the maturity of the relationship, which, at the start and during changes, primarily relies on procedural justice to shape one's level of trust. Over time it can grow into a more stable relational trust based on interpersonal justice. As opportunistic behaviour, non-cooperation, and reduction of input are noticeable warnings for inequity, they can be used to trigger a collective reassessment of equitability. When the rules are applied to assess a series of events, equitability perception trends can be distinguished which can indicate sensitivity and resilience to injustice. Additionally, the imbalance of power should also be continuously acknowledged, monitored, and managed.

The last factor of assessment does not necessarily affect the real level of equitability but it influences how equitability is evaluated and subsequently managed by measures taken. Assessment should be done using an appropriate scope, which is often limited to a single decision-event or a specific responsibility. A distinction should be made between the perception of equitability on a personal level between the persons of representatives and the perception an individual has of another party. When basing an evaluation of equitability on the questioning of participants, the use of mixed positively and negatively formulated questions in regard to the rules provides the best insights.

Figure 7 summarises all conclusions. It shows three shells and a centrepiece. The centre describes the assessment event's equitability rules and evolution of experience. The temporal element and recurring

moments of application of the rules stand out. The centrepiece is surrounded by the three factors that describe the conditions of the assessment event: relationship type, context, and good assessment practices, each with their respective aspects in their shell.

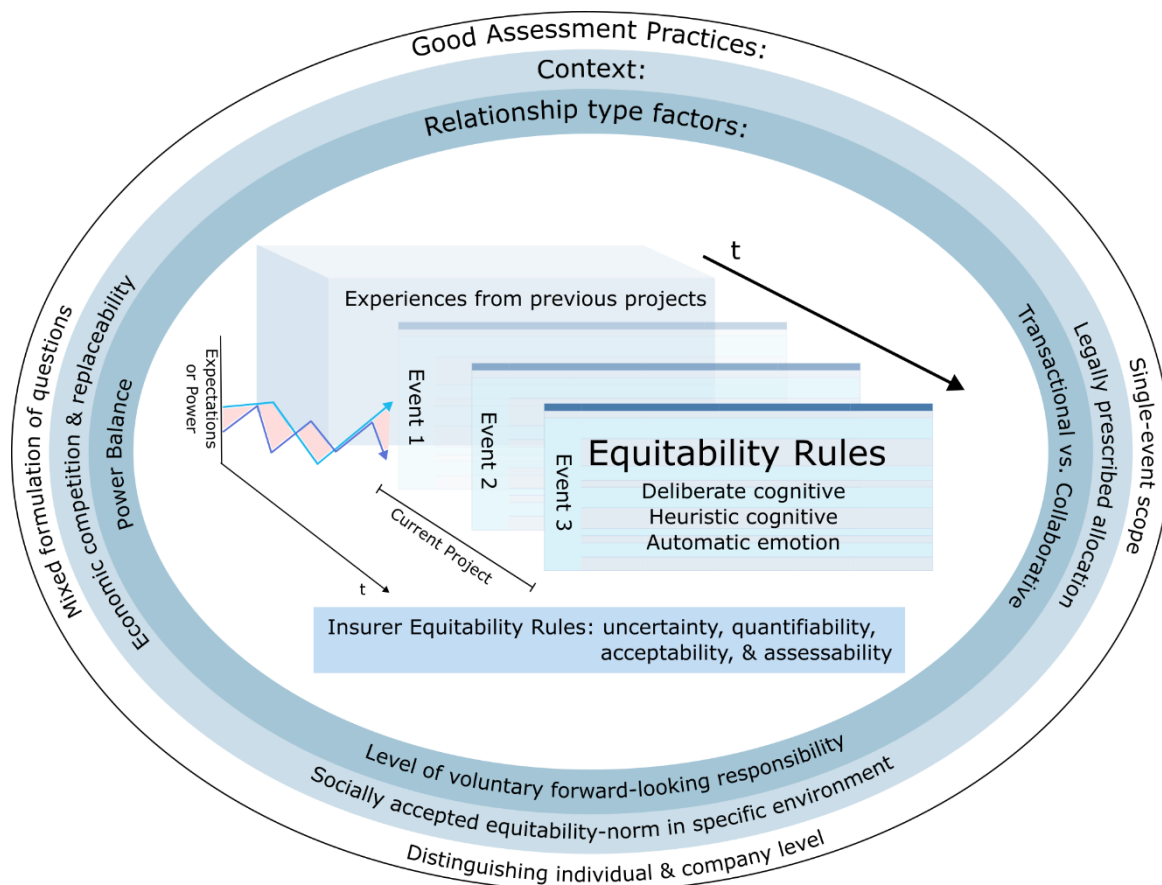


Figure 7: Factors relevant to equity in construction

4 Case Study Results

After studying the theoretical perspective on equitability in chapter 3, this chapter focuses on the construction practice. It validates to what extent theory and practice align and adds relevant factors that affect equitability perception in risk allocation practice. Ultimately, the answer is provided to how equitability is considered in the construction risk allocation process and how this relates to allocation principles. First, a mainly interview-based overview is provided on how the risk allocation process in construction projects is built up (4.1). Next, the theoretical factors are validated through the same interviews and additional factors from practice are identified (4.2). This is followed by an overview of how the interviewees evaluated the equitability of the risk allocation process (4.3). Then, a more detailed assessment is conducted by introducing five case study projects (4.4) and evaluating their allocation equitability based on a contract analysis and interviews (4.5). This includes both the rational reasonableness of contractual allocation and the emotional fairness of its perception. Finally, the influence of interview parameters is assessed (4.6), and a conclusion is provided considering allocation principles. To illustrate the findings, anonymous quotes from interviews with expert practitioners have been inserted throughout the text.

4.1 Risk Allocation Process

To determine what role equitability plays in risk allocation, it is necessary to know the allocation process components. Only then can points in this process be identified where an equitability assessment framework would be beneficial. Based on the interviews and documentation referred to therein, an overview of the risk allocation process in Dutch infrastructure projects has been created. As the realisation of such projects requires a chain of parties, multiple ‘clients’ and ‘contractors’ could be distinguished. For clarity, the following terminology is used: the main contractor is called ‘contractor’, its client is called ‘client’, the client’s client is called ‘principal’, and the contractor’s contractor is called ‘subcontractor’. Figure 8 clarifies their relations.

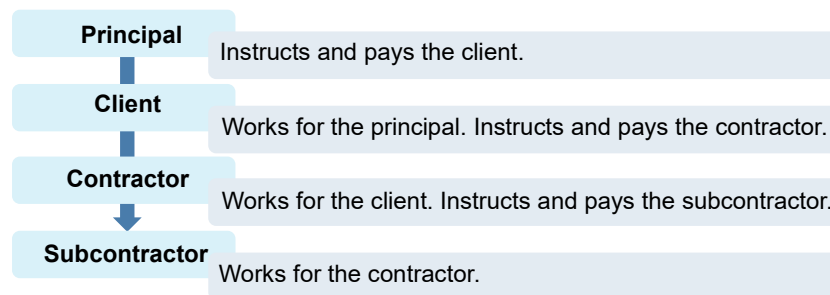


Figure 8: Terminological relations

As the process description is only a model depiction of reality, distinguished phases might be less separated, sequential, and independent in reality. The distinction of phases is based on key decision moments, participating actors, and ways of collaboration. Although the process is probably generalisable, the steps are based on the approaches of ProRail as the client and VHB as the contractor and may not be universal in detail. The process described below is summarised in Figure 9.

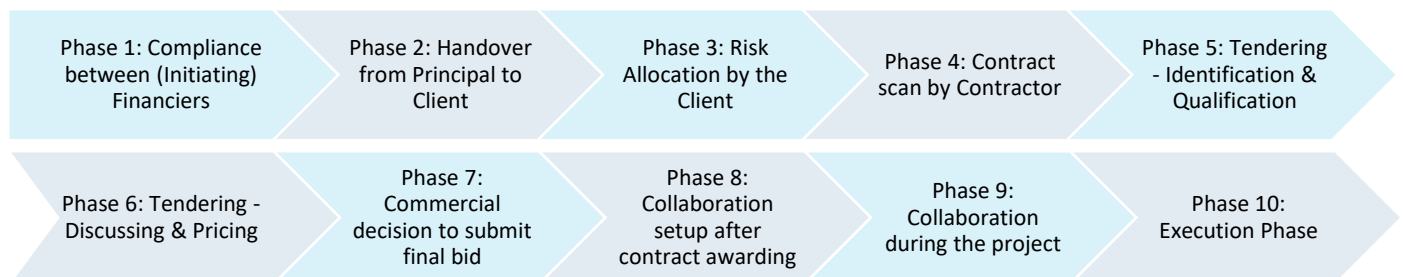


Figure 9: Summary of the risk allocation process

Phase 1

Compliance between (Initiating) Financiers

*(Potentially) involved:
principals (e.g.:
national, provincial,
or municipal
governments;
waterboards; EU)*

Although this phase does not concern direct coordination between the contractor and its client, it is an important element in Dutch public infrastructure procurement processes. Executive branches of the Dutch Ministry of Infrastructure and Water Management, like ProRail, don't have much budget of their own. Instead, their work is primarily commissioned and, therefore, paid by the ministry or third parties (often branches of government). As risks relate to financial responsibility and, therefore, funding, Dutch public infrastructure projects are almost completely for the principals' expenses and risks. During this phase, the principal(s) initiate(s) the project plans and collect(s) funding. All financiers agree on their individual contributions, which relates to the risk they take on: if a financier contributes a set amount of money, it bears less risk than if its contribution is set as a share of the total project costs, especially in case of increasing costs during project execution.

Phase 2

Handover from principal to client

*(Potentially) involved:
risk analyst, project
manager and
technical manager of
the client;
construction manager
of the client and
external engineering
firm join later;
principal(s) if
necessary*

In coordination with the principal, the client starts to develop further the plans/design to be able to identify and quantify risks, which enables the rough pricing of the project. During the exploration and plan study, the client holds risk identification sessions, transforming fuzzy project visions into clearer technical requirements and risks. For each risk, probability, impact on surroundings, time factors, and costs are defined. Often, selecting relevant risks from standardised risk lists/matrices is the first step for the majority of standard risks. These are based on experiences in other projects by the client. (From the contractor's perspective, this is not necessarily wrong, but in multiple cases, this selection does not seem to be critical enough.) For the more project-specific risks, participants in the sessions could mention any risk they see, and these should be taken seriously. However, before documents are signed off, they usually pass through many hands, climbing the organisational hierarchy. Due to communication, strategy, and diplomacy, the mentioned risks are not always kept. Keeping many considerable risks with small probabilities could cause cost distortions, unnecessarily scaring the principal and leading to the abortion

of the project. In simple cases, the principal is fully responsible for the project costs, so once the principal agrees with the rough pricing, the process can proceed. However, when the project overlaps or shares interfaces with the client's existing assets, the principal and the client have to agree on replacement costs: who has to pay for overdue maintenance/replacement and what is to be done with not yet fully depreciated assets? This does contain some sort of risk allocation. Once agreement on the project budget has been reached, the principal transfers most project management responsibility to the client. However, there are instances where these responsibilities are shared (e.g. Tunnel Alliance projects, see appendix B.3.2).

Phase 3

Risk allocation by the client

*(Potentially) involved:
risk analyst, project
manager, tender
manager and team
members responsible
for specific fields
(technology,
surroundings,
processes, etc.)*

To a certain degree, this phase is easily merged with the previous one, but for clarity, they are separated. In European public procurements, it is often mandatory that the client proposes a risk allocation. This could be explicitly attached as a document to the other tender documents or the allocation could be implicitly incorporated into the tender documents. Ca. 99% of ProRail's procurements are based on the UAC-IC2005. This is a Dutch model construction contract where the client contracts both design and execution responsibilities to a single party. It is widely supported in the industry, elaborate, and familiar to many, making the risk allocation it contains a suitable basis. This also reduces the time required to discuss the risk allocation between client and contractor, improving efficiency. For this reason, deviation from the UAC-IC2005 allocation hardly occurs. All previously identified risks are allocated by determining to which 'domain' they belong: client's, contractor's, or a shared (alliancing) domain. In exceptional cases, other domains are also possible (e.g.: in the Tunnel Alliance, timely arrangement of permits and societal/political support are

partially allocated to the principal. Sometimes, ProRail's asset management organisation could also almost be considered to act separately from its project management organisation, creating two instead of one domain). In this allocation, the client considers both the contractor's perspective and its own: if a contractor isn't able to manage the risk, the tender is almost guaranteed to fail due to a lack of contractor interest. On the other hand, if a project is too big, complex, or challenging for the client alone and requires design and execution knowledge from the contractor, a different contract type and risk allocation should be chosen.

Equitability, however, is virtually never a consideration, but it is the intended result. Through market consultation, the client can improve alignment with market parties and let them guide his decisions. Discussing allocations and procurement/tender methods helps him shape attractive foundations and conditions for collaboration. Once allocated, calculations are made to translate risks into costs, using certain rules of thumb about the level of coverage and cost estimation methods. This results in an amount for foreseen risks and unforeseen risks, aiming to get as many of the unforeseen risks as possible to the foreseen side. Usually, cost estimations use the P85 value, but some principals want the P50, which often results in budgetary problems during construction. Once the principal has approved the risks and their costs, they are explicitly or implicitly included in the tender documents and put on the market. Often, elaborations are included to prevent interpretation differences regarding project-specific risks.

“Dividing risks already covered in the UAC-IC contract, that's not going to happen. When a client starts doing that, every contract is target practice. Ultimately, contracting should also be an efficient process because everything costs a lot of money. So if, with every contract, you have to discuss whether it is an equitable allocation over and over again, those tenders will all take three times as long. Therefore, clients will be quite reluctant to do that.”

Comment on “illogical” allocations

Some allocations seem illogical to contractors but are caused by the client's procedures. For example, to provide the principal with some stability in costs and planning, ProRail has to define a rough design and premises to estimate costs and durations. This would only be meaningful if the contractor continued this design and these premises. As it is only a rough design, the contractor still has to make many improvements and changes. Because UAC-IC2005 places design responsibility in the contractor's domain, the responsibility for the rough design and premises has to be transferred to the contractor, even though he didn't come up with it. This does not seem fair, but is legally necessary.

Phase 4

Contract scan by contractor

(Potentially) involved: Contractor's contract manager and core team (e.g. project manager, head of design, project coordinator)

Once an interesting contract is put on the market, the contractor will study it to familiarise itself with the project plans and determine whether the contract terms are acceptable, fair and clear. The contract manager will analyse the legal side of it with a legal contract scan, and with larger, more complex projects, a technical contract scan is also conducted. These contract scans are long lists of questions that help direct the contract analysis. VHB has separate lists for small, large, and Bouwteam (a Dutch variant of an Early Contractor Involvement) contracts. As 80-90% of VHB's projects are publicly procured, standard contracts are often used, containing a risk allocation dictated by the client. Due to their objective, these contract scans identify risks and uncertainties. This can be unclear definitions, unrealistic planning, insufficient budget, unacceptable allocations, etc. Although a very precisely quantitated and strict contract would appear to solve such problems, it also provides

more content to be discussed on every risk allocation detail, needlessly prolonging tender processes. It also reduces flexibility and room for adaptation to changes in real-world contexts, resulting in an unattractive contract. Sometimes, a contractor could also look at whether the contract provides an opening to ask the client to incorporate additional work. If accepted, this would also require the planning to be adjusted. On the one hand, this could be applied negatively when the contractor aims to get as much money from the client as possible. On the other hand, this could alter the contractor's opinion on the constructability of the plans: additional time to construct with only limited additional work could tip the balance in favour of constructability. Once the uncertainties are identified, they must be appealed to the client. As the Dutch civil engineering industry is not that big, boards of directors of clients and contractors frequently meet on other construction projects or gatherings. This could be a way to strategically and informally address some larger uncertainties or contract errors during the contract scan phase. However, the formal approach is part of a later phase.

Phase 5

Tendering: identification & qualification

*(Potentially) involved:
every field required to
design and execute
the project (e.g.
design, realisation,
project, contract,
technical, and
environmental
manager, process
coordinator, planner,
and optionally
representatives from
subcontractors)*

The contractor's tender process starts with Gate Review 1 (GR1), determining with the help of a Gate-specific list of questions whether the tender team is ready to start. GR1 considers the conclusions of the contract scan and analyses of collaboration agreements, the tender plan, and other threat/opportunity identifications (Huitema et al., 2018). It also assesses whether the insurance department has been consulted and whether the risk allocation is feasible. At the same time, the tender team agrees on how to handle the risk allocations and bookings in collaboration with other parties, the limits of the contractor's risk domain, and the identification of relevant stakeholders (VHB, 2023). During the remainder of the tender process, risk identification sessions are organised to expand the list of identified threats and opportunities of the previous phase. This is often organised by discipline and tools like posters, post-its, or Risk Challenger could be used. It's advisable to wait until 6 weeks after the start of the tender to organise these sessions to enable team members to gain sufficient knowledge and insight into the project, increasing the relevance of the identified risks. The number of identified key risks to steer the project on should also be limited to 20-25 because that is the effective risk management capacity of a normal-sized tender/project team. Other risks are often just accepted. Inspiration for risks can usually be drawn from similar projects (the

same VHB Product-Market Combination, see appendix C.3), however, searching for these experiences is often neglected (VolkerInfra, 2013). As design and (contract) requirements are front of mind in this stage, identified risks also mostly fall in these categories. Once identified, risks are quantified in probability, consequence, and RISMAN-score, trying to reach an agreement on each individual's estimation. For simpler VHB projects, this is done with Excel, but for more complex ones, specialised VISE software is used. Subsequently, allocation of risks takes place, which in practice seems to be little more than checking one of the possible boxes in a process where many boxes need to be checked. The allocation is based on which party is best able to control the risk. Regardless of allocation, a risk owner is designated in the contractor's team for communication purposes. As design, plans, and preliminary procurement talks progress, newly identified risks can be added to the risk list available to all team members. The contract manager reviews these, determining whether they are already addressed by contractual conditions (e.g. UAC-IC2005). If not, they follow the same process as earlier risks: identify, quantify, allocate, appoint owner, and apply control measures.

"I don't really recognise the procedure category because – and I deliberately put it that way – the whole allocation is just one of the many boxes you tick within our risk register."

Phase 6

Tendering: discussing & pricing

*(Potentially) involved:
project manager,
tender manager, cost
calculator, and
management team*

Contractors interested in the project can submit their uncertainties identified during the contract scan or other not yet contractually allocated risks identified during the tender process to the client. This way, they can ensure their contract interpretation aligns with the client's intentions. These submissions form the 'Summary of Additional Information and Changes' (NvI) to be published by the client to keep a level tender playing field. For smaller projects, submission is often only in writing, but for large projects, direct communication with the client is enabled by organising 3-5 talks in a 'dialogue phase'. Although submissions could theoretically lead to the alteration or removal of conditions or additional funds, results are often limited to clarification. If the client's response to the enquiry is sufficient, the contractor can continue its tender process. If not, the contractor has to decide whether the contract

is still acceptable enough to proceed, accepting certain uncertainties: acceptability is applied as a scale and not absolute. Those uncertainties fall in the contractor's domain and require risk control measures from the contractor. Once risks are quantified, they need to be priced. Known (preventive) risk control measures can be directly priced and included in the final bid. For residual risks (corrective measures), a quantitative analysis can be conducted to estimate the risk booking (expected values for smaller and P70 Monte Carlo Analysis for larger projects), followed by a scenario analysis and cost expert analysis (VHB, 2023). Additionally, a percentage is added to the total price to build up an inter-project reserve to cover Black Swan-like risks that appear once every 10-20 projects. This process considers both financial and planning risks (VHB, 2023). However, strategically, not all risks are explicitly defined in the final bid. The next step is to start managing risks (improving the description of measures, defining time requirements, evaluating measure effectivity), but

on the contractor's side, risk management only receives considerable attention after the contract has been awarded. This is especially important during the design phase, as it is hard to prevent or change during execution.

Perspectives on the discussion of project requirements and contractual conditions

Client: The process must run efficiently, costing as little money and time as possible. The more submissions are approved or the more detailed an allocation is discussed, the less efficient the process. Procedural delays require more money and threaten the continuation of the project in terms of planning and costs. Many submissions contain standardised questions, for which ProRail has a list of standardised answers.

Contractor: Although the submissions clarify contractual vagueness, the contractor's aim shouldn't be total clarity: some vagueness allows for interpretation, which enables the contractor's solution to stand out from its competitors. It's more strategic to use the submissions to safeguard the level playing field between contractors in case you come across a cost-increasing interpretation. However, room should be left for your bid to excel in alignment with your specialisations. This prevents you from pricing yourself needlessly out of the competition. However, the past years have also proven that a contractor should set and respect clear boundaries and not think an unfavourable allocation can be amended once the contract has been awarded. Experience has also shown that smaller public clients like provinces or municipalities are more open to negotiation and nicer to negotiate with than larger ones like Rijkswaterstaat.

Phase 7

Commercial decision to submit final bid

(Potentially) involved: Project manager

As described in phase 5, the VHB uses Gate Review 1 to determine whether to start tendering based on analyses like contract scans. During the tender of larger projects, GR2 would be a separate decision point to determine whether to continue tendering. This would, amongst others, be based on the applicability of organisational expertise and distinction in design solutions or execution methods. At the end of the tender process, GR3 takes place to decide whether or not to submit the final bid based on the acceptability of the risk profile, sufficient quality of the bid, and a reasonable probability of win (Huitema et al., 2018). Having a clear threat-and-opportunity-overview, a reliable risk-sharing mechanism, and an internal allocation of risks and tasks is a prerequisite for this. With each of these Gate Reviews, risk allocation assessment plays some role.

As part of GR3, the project manager has to decide whether to adjust the risk pricing. If the tender is very competitive and a large number of risks are included in the bid price, it could be decided to lower the final price somewhat to gain a more competitive position. On the other side, negative experiences with the client might lead to a slight increase in the price.

Phase 8

Collaboration setup after contract awarding

(Potentially) involved: project teams from both sides

After VHB has won a contract, GR4 takes place to determine whether the team is ready to start the post-contract award stage and whether all required management systems are set up (Huitema et al., 2018). During this phase, contract validation sessions between the client and the contractor are organised, providing some very limited room for negotiation on interpretation and alignment to discuss assumptions made by the contractor. However, larger changes would invalidate the contracting. After this, most risk management responsibilities are transferred from the client to the contractor, and the contractor is required to report on this to the client from this point on. Because most attention at this point of the project is paid to collaboration, structures, document management, environmental management, permits, design etc., risk management is often neglected. Although procedures aim to integrate risk management into other processes (VHB, 2023), in practice, it is often said to be an afterthought. This reduces the opportunity to learn and develop.

Excursus: Alliancing & allocation

As explained in Phase 3, a large, complex, or challenging project requires a different approach to the collaboration between client and contractor. One of the options is alliancing. The choice for an alliance is based on the client's conviction that the contractor is needed to be able to manage key risks. As with the 'standard' allocation process, the client proposes an allocation. However, subsequent discussions with the contractor are much more extensive and level, making the proposal more likely to change. The alliance allocation also distinguishes the three domains, but here, the aim is to place as many risks as reasonably possible in the shared alliance domain. The shareability of the risk is, of course, a prerequisite. This aim is because a large alliance domain is more likely to force effective collaboration and improve the efficient use of human resources. As with the 'standard' process, the first step in the allocation is to identify which party is best able to influence the risk, considering both probability and consequences. The second step is to optimise the 'minimisers'. These are the risks that can effectively be shared, as the party to which the risk has not been allocated is able to influence at least 20-30% of either probability or consequences, making the sharing of the risk economically viable. When this results in a large shared domain, it should be concluded that an alliance is fitting and that the shared domain should be maximised. Then, the third step is to identify the 'maximisers'. These are risks that are highly related to a shared risk but are themselves not shared. However, to make the collaborative management of the shared risk effective, the related risk might also be required to be shared. The fourth step is allocating the tasks and activities related to the shared risks. Joint influencing of risk can be found in every project and alliance collaborations often result in a more pleasurable experience and better solutions. However, they also drain the client's resources, limiting their applicability. An alternative is the 'mini-alliance', which ProRail has applied to several projects. In a mini-alliance, during the tender, both client and contractor can mark a small number of risks to be allocated to a small shared risk domain instead of their own. Risk control measures are paid from a set reserve, and the final result of that reserve is shared after the project.

Example minimisers & maximisers

*About the risk of getting a sheet-pile wall to a sufficient depth, one could say that it is an execution risk best controlled by the contractor and that the risk should, therefore, be allocated to him. However, the probability of this risk is also influenced by the time and space available for the equipment to be deployed for the activity. In many cases (and certainly in rail projects), these are factors that the client can influence. For example, 75% of the management of this risk can be attributed to the contractor, but then the other 25% to the client. This degree of control gives the client sufficient intrinsic motivation to contribute to its risk management if the risk were to be shared. Such shareable risks are **minimisers**. However, this risk is also closely related to the thickness and length of the sheet-pile elements. When the design responsibility is allocated to only 1 of the two parties, sharing the initial risk would probably be only successful to a limited extent. This is because the design responsibility allocation allows the non-designing party to rightfully or wrongfully blame the design in case the risk effectuates. This causes the cooperation to bog down into tug-of-war, losing the focus on joint problem-solving. To avoid this situation, design risk, even though it is not controlled in any way by one of the parties, must also be shared by both parties. These are **maximiser** risks.*

"In my opinion, every project is, in essence, suitable for an alliance because every project has risks, and of those risks, there is always a good part that can be managed together. Either because you actually come up with better ideas together or because one can influence the chance and the other the consequence, and so on. So, in theory, you could do any project in an alliance. Except that our organisation is not set up for that."

"The idea behind this is that for most risks, although one particular party can probably control it best, in many cases, both the client and the contractor have at least some influence on the extent of the risk."

Phase 9

Collaboration during the project

(Potentially) involved: project core team members from both sides, sometimes including risk managers

Once the designing starts, the client and contractor usually organise a session every 1, 3 or 6 months to discuss the risk management of the top 10 risks of every domain (client, contractor, and shared). This might coincide with the written risk management update in the progress report the contractor has to send to the client frequently. The report covers these same top-10s, including their description, cause, allocation, owner, and RISMAN-score. The focus of the sessions is mutual support in risk management, sometimes focusing on specific topics like identification of new risks, risk management up to the next milestone, or re-evaluation of the allocation of all shared risks. As contractors often focus on the top 10s, discussing Black Swan risks could result in attention to otherwise neglected risks. Once the execution stage approaches, a larger execution-risk-focused session is often organised.

Although risks have been allocated theoretically, once they eventuate, discussions on allocation and responsibility often start all over again in practice. The client will defend his cost-stake and legitimacy-stake, and the contractor his profitability-stake. As a result, a game is played in which the client tends to hold off responsibility, and the contractor tends to allocate risks as reasonably as possible to the client. If contractual terms cover the new risk, allocation is clear. However, at such a moment, it could also turn out that allocation and influence don't align and that the client is often willing to adjust contractual terms as long as additional costs are limited. However, usually, legitimacy is disputed. Either way requires a so-called Request for Modification (Dutch: VTW) procedure, which is described in the UAC-IC2005. This procedure could be initiated by the client's or contractor's project/contract manager. Requests are then assessed within ProRail's organisation on content and legitimacy. This usually includes a discussion with the principal whether it is a foreseen risk to be paid from the budget or an unforeseen scope expansion requiring additional approval and money from the principal. However, low-cost requests initiated by the client's side are only assessed on content, simplifying the procedure and reducing duration. If personal relations are good, this difference could be advantageously used by the project managers. When requests are approved, the contractor usually receives additional time or money. When denied, the contractor usually has the possibility of arbitration. On the contractor's side it is often thought that conclusions of Requests for Modifications, especially in case of non-alignment between allocation and influence, do not affect initially proposed allocations in new projects. Overall, a good (personal) collaboration and working together in person can significantly decrease procedural durations.

"Collaborative risk management is some give and take, but in the end, you always end up in the middle. You can try to engage each other and consider each other in everything to end up in the middle. Or you can complicate everything, have a bad time together and have a lot of arbitrage to end up in the middle as well."

The contractor's internal risk management

This process is often intertwined with other phases and parties but is important enough to receive some attention of its own. Even though the client and contractor collaborate on the project, they strategically withhold certain risk management information from each other, preventing opportunistic behaviour by the other party. Therefore, the contractor shields a part of his risk management process from the client. Risk management is regularly discussed during project core team meetings, evaluating the number and effectiveness of applied control measures, no longer applicable risks, and the necessity of risk re-allocation due to contextual change or risk mutation. Risk evaluation and actualisation are also part of the four-weekly internal risk report. Also, part of the contractor's process is the risk distribution with sub-contractors and suppliers. This is a much more flexible process than the one between client and contractor, enabling an easier risk transfer in return for monetary compensation. During the entire project, VHB conducts up to ten Gate Reviews in total, assessing at specific moments, among others, whether identified opportunities have been exploited, risk control measures have been correctly documented, allocated, and managed, and whether risk evaluation has been sufficient (Huitema et al., 2018). Pitfalls in this process are: not having an overview of risk management responsibilities, neglect of threats and opportunities in daily work, and neglect of the relations between contractor, client, and principal (VolkerInfra, 2013).

Phase 10

Execution phase

*(Potentially) involved:
project core teams
from both sides*

Once the design has been finalised and execution starts, many of the processes described in Phase 9 continue in Phase 10, but there are also some changes. Often, the people who have been working on the design leave the project, and new people enter the team for execution. Handovers often receive minimal attention, so the amount of effort put into risk control and allocation is reduced. The consequences of this reduction are partially countered by the fact that risk management shifts from primarily preventive measures to corrective measures, as there is little left to steer. However, as most of the execution risks are in the contractor's domain, the reduced effort is certainly not beneficial. A theoretical allocation does, however, in case of eventuation, still not necessarily guarantee the allocation in practice: in case of risk eventuation, the game to find an interpretation in the contract to support a re-allocation is continued. The contractor's duty to report on risk management top 10s to the client is also continued, providing a method to strategically steer what and how risks are reported, influencing the client. However, as the client does not report on its internal risk management, the contractor doesn't know how the client tries to influence him.

Based on this process description, there are two primary moments where mutual discussion of risk allocation takes place: during the submissions for the 'Summary of Additional Information and Changes' (see Phase 6) or during the Requests for Modification (see Phase 9). For these moments or their preparations (e.g. Contract scan (see Phase 4)), an allocation equitability assessment framework is most likely to be beneficial.

Excursus: Insurance

Insurance is usually scarce on the public client's side because the client often has fewer insurable responsibilities, the bill ultimately lies with the principal, and insurance could unnecessarily increase project costs upfront. That is why the client insures as little as possible, even when insurable responsibilities are shared with the contractor. The client prefers to seek additional money from the principal when needed once risks eventuate. These principals are usually large enough to bear these costs anyway. However, the client does anticipate scarcity by procuring (specialised) materials on its own in time if necessary. Furthermore, the client prescribes quantified coverages on CAR, corporate liability, and sometimes hidden defects (VGv) to the contractor.

VHB is covered by the insurance policies of parent company VolkerWessels, and insurance (conditions) must, therefore, also be discussed and reviewed by a central insurance department. For this, the project manager usually enters into discussions with that department during the tender phase. The basic principle is that a contractor insures what he cannot bear himself, which are multi-million sums. This is usually limited to the repair insurance type, such as CAR, PI, vehicle insurance, public liability, and theft insurance, as risks themselves cannot be insured. However, many standard insurance coverages like CAR are very specific and thus limited. Therefore, sometimes, a choice is made to take out special insurance, for instance, against collision or transport damage. Because there is a VolkerWessels-wide insurance package, a new project to be insured must fit within the policy's limits. If the project exceeds those limits or if this arises during the project due to changes, the policy has to be extended, leading to a higher bid price and/or project costs. Since the insurance pays out only above a certain amount, the contractor is responsible for the residual risk by its own contribution. Furthermore, like the client, the contractor requires subcontractors to insure themselves as well. Usually, not getting uninsurable risks allocated is a condition of VHB to compete in a tender. However, given the scale of the Dutch rail construction sector, this is tolerated in ProRail projects.

Compared to the overview in Table 10, insurance is much more of a contractor's business, and only the optional DIC is not used. About the conditions of uncertainty, quantifiability, acceptability, and assessability, half of the participants indicated they didn't have the knowledge, and a slight majority of the remaining half indicated that these conditions are not considered when insuring.

4.2 Recognition of Literature's Equitability Factors in Practice

To determine whether theoretical factors for equitability (as concluded in 3.6) are recognised, experienced, and valued similarly in practice, interviews and questionnaires were conducted and analysed. Subsequently, findings were compared with the contextual analyses.

4.2.1 Recognition & Influence

Generally, in the interviews (see Appendix A.2), the influence of the theoretical equitability factors is acknowledged. Although a single interviewee indicates that the factors are not recognised, most indicate that they recognise the factors but that they are not applied explicitly. The most often mentioned cause of non-recognition is the risk allocation dictated by the client in European public procurements. Consequently, risk discussions between client and contractor often don't focus on the allocation distribution but are limited to interpretations and intentions. This is most closely related to the distributive category of equitability rules. For some interviewees, this dictated allocation means that contextual factors are irrelevant to equitability in construction projects. For others, the distributive equitability rules were irrelevant for this reason, but some also explicitly stated that distributive equitability rules do play a role in equitability. However, the objective of distributive equitability rules to compare one's own situation to that of peers is said to be unlikely to be achieved in practice. Often, required information about others' situations is unavailable or incomparable. Additionally, allocations need not be very rigid. If collaboration is good and procedure and agreement are clearly and explicitly documented, deviation from the contractual allocation does occur in practice.

For procedural equitability rules, the same can be concluded as for the distributive ones, with some negating its recognisability and others stating its importance for facilitating alignment and making parties feel heard. Frequently, interpersonal and/or informational equitability rules are also mentioned to be important for this alignment. Often emphasised in this is the necessity for a transparent and respectful conversation about each other's interests, intentions, and motivations. Since project contexts and collaborating team members often vary between projects, building relationships with other parties than suppliers is difficult. Therefore, such conversations define the rules of the game. These rules are to be clearly included in the contract and are highly influential in how collaborative risk management is shaped. Regarding the informational equitability rules, it is stated that both the client and contractor usually know that information can be strategically shared to direct the other's attention, which could be beneficial.

"I believe ten years ago, we, as Van Hattem, VolkerWessels, were a bit more focused on collaboration, and now we are a bit more focused on contract management. A bit more juridified, so to speak. But that can partially be attributed to our project experiences: you can't buy anything with that relationship. You are simply judged on what you put on paper, so let's hold the customer to that. And you don't buy a new project for it either because we do everything in public tenders anyway."

The risk allocation-specific equitability rules are not mentioned as much as the others, presumably because they form less of a recognisable cohesive group. However, both the client and contractor state that causation (also: VHB, 2023), understanding consequences, and the ability to estimate consequences are relevant. Yet, it is also stated that a causation focus starts a blame-game, especially damaging to effective (shared) risk management in case of eventuation. Both sides also acknowledge the relevance of experiences from past projects. These influence the client's procurement procedures, the contractor's bid pricing, and the iterative development of standardised processes on both sides. But most of all, it affects trust and, thereby, the persuasiveness to apply the contractual allocation more flexibly in practice. Experience also helps in dealing with unforeseen circumstances. The distinction between the relation on the organisational level and that on the personal level is sometimes acknowledged but does not seem to affect the perceived equitability at all.

When it comes to voluntary forward-looking responsibility or proactive risk management, it is stated that equal effort from both sides is not a basis for equitable allocation. However, it is a prerequisite for collaborative risk management to prevent a rat race to the bottom in which both parties alternately reduce their effort in reaction to the other's effort reduction. Consequently, collaborative risk management dies out slowly. In alliances, proactive risk management is especially enforced, but for D&C, it is as important to support each other's risk management efforts. Usually, this comes naturally as neither party wants any risk to eventuate and threaten the project's progression. However, a theoretical contractual allocation does not guarantee sufficient risk

management effectivity, requiring the other party to step in, making this a factor of trust rather than equitability. Therefore, it is more related to transparently acknowledging one's problems, mistakes, or incompetence and engaging the other party in resolving this. Yet, some have also contradictorily stated that proactivity is defined and safeguarded by model agreement risk allocations like UAC-IC2005.

"So normally you put down a contract and 'this is yours and that is mine'. Then, when a risk eventuates, you step into the trap if you start by looking at: 'Whose risk is it?' 'Oh, that's yours, I'm not doing anything.' Whereas for that same risk, even though it may be yours contractually, I could easily make two calls. That takes me 10 minutes of work, but then I might be able to set something in motion here or there, slightly reducing your risk. But just as easily, I don't do it because the contract states it's yours. In an alliance, the contract also exists, but it basically says: we put as many project risks as possible in the shared domain (apart from those typical contractor and typical client risks). For anything in the shared domain, you can't say: it's not mine. Because it actually is mine. Just as much as it is yours. So no one is going to sit back."

Discussing and managing each other's expectations is recognised to be important to understanding interests and defining a uniform interpretation of the collaboration, especially as contexts are constantly evolving. However, the ideas on how to achieve this differ. On the one hand, a group of interviewees states that expectations are supposed to be logical and based on model agreements like the UAC-IC2005. The other side focuses on dialogue, either officially during the tender phase or informally on a personal basis between project managers (especially during execution). Discussing expectations is relevant for equitability as it helps create a shared social basis to define equitability to prevent deception and mistrust. However, as the ideas about discussing expectations differ, so do the ideas on what other factors underlie the shared social basis. Some say the cultural context, others again point to the standardised allocations in model agreements, and some say that it just naturally develops out of the necessity to collaborate to achieve a shared result. Contradictory to the claim that understanding and respecting each other's expectations and claims helps to create a shared social basis to define equitability, it has also been stated that the differing interests oppose such a basis once money is critically involved. The topic of money is also where the power distribution in the collaboration is most prominent. However, the relation between power and equitability perception is disputed as this is said to be the game that is being played: the client has the money and, therefore, the power to impose, and the contractor tries to get the money while keeping off as much risk as possible.

Based on the interviews, it can thus be concluded that the recognition of what factors influence equitability perception in construction risk allocation to what extent is very subjective. What is clear is that distribution is often imposed based on mutually agreed model agreements and, therefore, irrelevant to the perceived equitability. Other equitability rule categories are recognised better as the focus is often directed at interaction in communication, alignment, clarity, transparency, and interests. Experiences, proactivity, expectations, and a shared social basis are also acknowledged to be of importance, although the precise contributions of the last two are unclear. The organisational-personal relation level distinction and power balance are not recognised as significant factors. The focus seems to be on interaction.

Analysing the questionnaires (see Appendix A. 3) has provided a better perspective on the influence of all factors. In the questionnaires, 27 of the factors from the literature (primarily equitability rules) have been assessed. Participants have indicated whether each of these 27 factors contributed positively or negatively to the equitability of their case study project (event). Again, the most noticeable is the subjectivity of the matter, as even the assessment of the same project event by members of the same organisation differs widely. However, by comparing the overall project equitability evaluation by the participant as defined in the interview and comments in the questionnaire with the evaluation of the individual 27 factors, the relation between the factor and equitability perception can be determined. From a more general perspective, it can be concluded that the relation between the number of positively evaluated factors and project (event) equitability perception can be roughly split into three segments. As Figure 10 shows, even when the project is perceived not to be equitable, up to a quarter of the factors are still positively evaluated. When 0-67% of the factors are positively evaluated, projects are most likely perceived to be (predominantly) not equitable. Above 67%, projects are most likely perceived as (predominantly) equitable, although even the most positive evaluation still included 10% negatively evaluated factors. However, the overlap in Figure 10 shows that these boundaries are not very defined and that a higher number of positively evaluated factors does not necessarily result in a more equitably perceived project. There are also three important notes to make about

the analysis method. First, it is based on only 13 responses, resulting in a rough approximation and low reliability. Second, not every respondent answered every question (correctly) due to a lack of knowledge or applicability. When a wrong understanding of the question was indicated by the comment attached to it in the response, the answer was ignored (a total of 7 times). For this reason, a percentage is used on the x-axis instead of a number. Third, the questionnaires mainly focused on specific events during the project, which showed that the equitability perception of a single event does not necessarily align with the equitability perception of the entire project, positively or negatively. For 2 projects the participant from the client's side and the one from the contractor's side evaluated the same event. Analysis showed that the client evaluated these cases slightly more positively than the contractor. Still, with a sample of 2 projects and a difference of 1 or 2 factors on a total of 27, this might be unreliable and negligible.

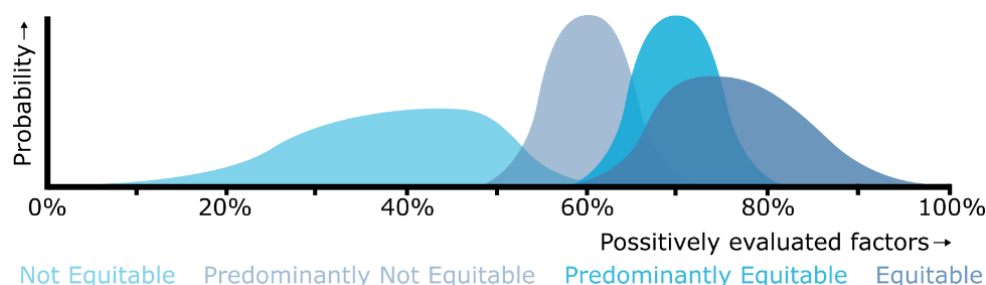


Figure 10: The relation between the number of positively evaluated factors and project equitability perception

The same questionnaires have also been analysed to determine the significance of each of the 27 factors when it comes to equitability: how often does its individual evaluation align with the final project (event) equitability evaluation? In other words: how often does a positive evaluation of the factor result in an equitable project perception and a negative evaluation in a not equitable project perception? For most factors, this alignment is around 50% of the cases, providing no clear answer to the question of whether that factor could predict project equitability perception. Only a few factors aligned in more than 66% of the cases (making them somewhat significant) or less than 33% (conflicting in 66% of the cases, seemingly not having a significant relation to perceived equitability) (see Table 12):

Table 12: Factors with a relatively insignificant/significant relation with project equitability perception

Factor	Insignificant Alignment	Comment
Comparability of the risk-to-compensation-ratio with other contributors to the project	31%	As mentioned during the interviews, required information is often not available regarding others' projects.
Comparability of risk management compensation with other projects	31%	
Causation as primary allocation principle	31%	Participants often indicate that the ability to control is much more important, but that this might relate to causation.
Factor	Significant Alignment	Comment
One party gets off easier than the other in risk management	77%	What this entails has not been clearly defined.
Attentive listening to one's opinions/argumentations	69%	
Ethical considerations	71%	
Being treated with respect, sincerity & courtesy	69%	

4.2.2 Additional Factors From Practice

Besides the factors relevant to allocation equitability identified from the literature, the interviews provide additional factors based on practice. A factor mentioned by many is the ability to control the probability and/or consequence of the risk. One should have the authority to decide and the motivation to control. This also requires the access to certain information. Related to this, it should also be noted that often the distinction is made between the allocation of risks and the allocation of control measures, as the client often needs the contractor's capacity and resources to control the physical risks, even when those risks are allocated to the client. This distinction is also applied when risks are shared. A second factor several mention is the ability to bear, which is related to the organisational capacity or decisiveness to establish effective control. An accusation often expressed by the contractor's side is the lack of expertise on the client's side, resulting in

ill-timed participation and consultation of experts, and subsequent redoing of work. This reduces process efficiency and the feeling of being heard. A third factor mentioned by some is primarily valid for alliances, stating that allocation should try to place as many risks as possible in the shared/alliance domain. This would force collaboration and minimise domain interfaces which elicit discussions about responsibility. However, in addition to these factors, it is often stated that the allocation distribution does not consider equitability and vice versa: the dictated allocation is expected to be mutually supported and equitable because it stems from the UAC-IC2005. This contract is thought to define equitability. Making changes would only cause ambiguity and discussion.

"If your cooperation is really good, you join forces in risk allocation, and you primarily look at: which party can best control the risk? That would be ideal, but in practice, you often see – the client does not have its own people walking around the construction site – that a client ends up relying on a contractor for risk control in nine out of ten cases."

"In the end, my definition of risk management is always: getting the right people talking at the right time so that you can take measures at the right time. However, 'the right people', that considers a certain expertise. So, if you don't have that expertise or can't provide those people, it often becomes a bit complicated to do risk management together and to define that allocation."

Equitability in construction projects is therefore more considered with interactional factors. These can be divided into two related categories:

- **Opportunism & Attitude:** As a base principle, it can be assumed that both client and contractor desire good collaboration, sincerity, and equitability, as both put their limited resources on the line to realise the project. By working physically close together, collaborative pace, engagement, transparency, and helpfulness increase, which is beneficial to perceived equitability. Collaborating is easy as long as the unforeseen-risk budget and accepted project scope are not overstepped. Once money is involved, equitability is more clearly perceived. So, when these lines are crossed, unity is often the first victim as procedures are accused of failure, and attitude and politics start leading decisions. For equitability, it is therefore important to prevent opportunistic behaviour where actors seize any opportunity to shift costs to the other party, backtracking on the contractual risk allocation. Equitability requires actors to know when it is reasonable to discuss a new risk, when risks are needlessly held off, and when one should rise to the occasion. This should also consider the influence one party has over the preconditions that enable the other to do so. Human behaviour and attitude are, therefore, decisive in how collaborative risk management is approached: give-and-take or battling. Is there willingness, leniency, and goodwill to seek equitability? It has also been stated that you can count on mutual reasonability only when there is trust. This touches on the personal factor, as the form of collaboration should fit the participants' personalities. A good personal relationship improves mutual understanding and explanation, prevents taking advantage of each other, and helps manage expectations.

"As long as the project is going well, the collaboration is going well, and you don't pay much attention to the other party's risk management efforts, you are mainly concerned with managing your own risks and considering: shouldn't this risk be the client's responsibility? Only when the risk eventuates do you start looking at: did the client actually do what he should have done, and is he being fair now that it eventuates? Is he not still trying to pass something on to me that does not belong to me?"

"So if you occasionally show each other some leniency in risk allocation discussions, it goes much smoother than when the parties (as in Ede, for instance) are rather rigid. Then it's just constantly moving pickets or digging in. And in the end, it's not like that's more profitable for one party compared to normal conditions. So it costs a lot of energy, but in the end, it often doesn't even pay off, so it's really a waste of everyone's effort."

- **Interests & Compensation:** Both client and contractor have their interests in the project and collaboration. The public client primarily wants market conformity: product quality in line with its price to ensure tax money is spent effectively, legitimately, and responsibly. Its employees must be able to account for their decisions to their managers. The contractor's primary interest is profitability to ensure business continuation. This requires sufficient covering for risk research and mitigation measures and adapting costs to contextual (price) changes. In projects, there are also secondary interests from

within the organisations. For equitability, it is important that parties can defend their interests and that these are mutually respected and secured. However, it is important to set limits for secondary interests so as not to overcomplicate or distort collaboration and interaction. This requires transparency of interests and mutual trust, so risks are not (strategically) made more significant than they actually are, and measures are not made unnecessarily expensive. To do so, parties should converse as equals and listen to understand each other's interests and needs, preventing dig-ins. Procurement methods such as Bouwteam have been mentioned as examples to safeguard this. In line with the earlier cited accusation that the client lacks expertise, combined with the client's distance from construction reality, multiple contractor interviewees stated that the client sometimes negates risks or misunderstands argumentation, reducing perceived equitability on both sides. Regarding equitability of compensation, the economic context and a tender selection procedure favouring a low price could inhibit contractors from including all risk costs in their bid price. Here, the client's market conformity and risk transparency are conflicting. For the contractor, profitability largely depends on the extent of his responsibility. Unlimited allocation of responsibility for risk, also known as uncapped exposure, is too large of a threat to this profitability. Just like uninsurable risks and too-tight budgets, it is said to be an unacceptable risk. An alternative would be to cap the contractor's exposure, making the client fully financially responsible for the risk once the preventive and corrective risk measures have crossed a threshold value. This method is often applied to alliances (see appendix B.3.1).

"Having a certain expertise or trust in one another is a prerequisite. That is a part of equitability: as a client in collaborative risk management, you must not feel like you are being conned. That is an ever-present threat. And even if you take measures, as a contractor, you don't want to take over the risk either. You are willing to take measures, but you often cannot guarantee these will actually prevent the risk from occurring. So that is a bit tricky: what exactly are you paying for as a client?"

"Afterwards, the project is completely reviewed by the ACM (Autoriteit Consument & Markt), and they look at whether the money was spent effectively. This creates much tension in a client's organisation as everything has to be documented, proven and recorded to the letter. This complicates the process very much for the contractor. So, for me, that is the crux of it: is it completely equitable? No. Do I understand what is happening? Yes, I understand very well why the client does it because they also have someone after them. Is that efficient and effective? Ultimately, in my view, it costs more money than it saves. But now you can pinpoint where the money went."

"In my experience, that is the full story of equitability: to start with a realistic task. It might be sportsmanlike, but it doesn't mean money is spent excessively. It just has to be realistic. So the contractor has to try his best, but if he succeeds, profit will be good."

4.2.3 General Remarks on Equitability

While this research uses the term 'equitability' or 'fairness', some interviewees would rather use 'decency' or 'acceptability'. Decency, because equitability sounds absolute without gradients and allocation does have gradients. Acceptability, because many things in projects might feel unfair while they are not, making acceptability a more neutral or professional alternative. A similar stance can be seen in the clients' focus shift towards contract management over the last years, leading to the juridification of collaborations instead of socialisation. A shift subsequently followed by contractors. As a result, it is often more advantageous to give in when you are objectively right and agree to a 50/50 split to avoid (legal) discussions and get on with the work. However, interviewees from both the client's and contractor's sides point out that juridification is not the way to go but that (risk) content should be leading.

"The word equitability bothers me a bit. I think that has to do with the fact that there is something absolute in the word 'equitability'. Either it's there, or it's not. But 'degrees of equitability', I find that a bit difficult. Whereas if you look at risk allocation and whether you do that somewhat decently, there are many degrees in that."

4.2.4 Relevance of Contexts

From the three contexts defined in the literature (see 3.6), the legal one seems to align with the dictated allocation distribution, making it less relevant to equitability. The social one is important for managing expectations and understanding interests, but perspectives on what it is based on vary (see 4.2.1). It also

appears to be a somewhat person-dependent, project-specific endeavour. The economic one, on which appendices B and C are focused, seems relevant for identifying interests. Especially when it comes to the extent of the contractor's ability to include their risk costs in the bid price. However, as indicated earlier, interviewees have stated that the unavailability of required information complicates this. Based on appendix B, it can indeed be concluded that it is hard for a contractor to get a detailed, complete and reliable overview of the client's economic context. Most available information stems from backwards-looking reports, making it hard to create an up-to-date overview. Available forward-looking information is often too vague to be able to anticipate its application to a specific upcoming project. The economic context of contractors, as shown by appendix C, is often either related to the state of the market/industry or business-sensitive information. A client is, therefore, likely limited to general market information to get an economic context overview. The same goes for the contractor anticipating a competitor's context. The relevance of the social and especially economic context for equitability is acknowledged, but its consideration is likely limited to one's own context.

"If we are out of work and need work to keep us in business as the survival of Van Hattem & Blankevoort is at stake, then we might be willing to take a bit more risk and therefore agree to a different risk allocation than when business is at full capacity as it is right now."

4.3 Perception of Risk Allocation Process Equitability by Practitioners

When asked about their perception of equitability's role in allocation, its strengths and weaknesses, as with the recognition of equitability factors, the subjectivity of the matter is again evident. Perspectives and points of attention widely differ between interviewees, but many indicate that it is person-focused and that it is up to oneself to act equitably and safeguard equitability. Business processes are primarily concerned with maximising output by outsmarting the opponent, which is often not beneficial to collaborations. Some state this is a legacy of the construction collusion (see 1.1.1) and subsequent prejudices from both sides.

"To me, equitability is a somewhat more subjective concept. It is about how you perceive risk allocation has been handled. I've always considered risk allocation more of an economic endeavour, where a risk is fundamentally a 'probability x consequence'."

Usually, the setup of the risk management process, which relies heavily on UAC-IC2005 as a stable foundation, and the use of risks as a project management control tool are said to be strengths that improve project equitability. However, improvements can be made in collaboration: closer personal interaction between client and contractor from the start of the tender onwards to create mutual understanding (of each other and project intentions) and trust; tighter collaboration in risk management to benefit from each other's qualities and align perceptions of risk. Opinions on risk allocation specifically are conflicting, as some interviewees favour increased attention on allocation to overcome dig-ins over interests. In contrast, others state that in practice, risks and their consequential damages are never related to a single party only and that rigid allocation reduces communication between contractor and client. Both sides also indicate that UAC-IC2005 needs to be updated to clarify the allocation of incomplete and incorrect information and the risk related to subsurface elements like cables and conducts. However, during this study, it was announced that a new version of the UAC-IC2005 model contract had been agreed upon. This includes specific consideration of these objections (CROW, 2024). Two other minor objections from the contractor's side are extensions to the UAC-IC2005 and the client's lack of expertise. The extensions, like those of ProRail or Rijkswaterstaat, because these are said to reduce equitability by, for example, shifting the burden of proof to the contractor when the client accuses him. The client's lack of expertise, because it makes clients dependent on consultants' approval, who may have an interest in stretching discussions because of his hourly payment.

The contractor is also critical of its internal allocation process, stating that consideration, motivation, and embedding could be much improved, especially after the tender. Suggestions include: improving knowledge on what experts to involve in risk analysis, and documenting the connection between financial and risk management to determine the return on control measure costs. This could reduce unfairly demanding payment from the client.

"Of course, it would be best if you first identified your risks and embedded your control measures into your collaboration models, your structures and your designs, etc. But often risk identification and these setups happen in parallel and you actually need to be a forensic engineer to put risks back in the models, structures and designs."

4.4 Case Introduction & Contractual Risk Allocation

To enable analysis of equitability in projects from practice, it is important to understand these projects and uniformly describe them. Therefore, this section provides an overview frame of each of the five case projects. At the top of each frame, the project's name is displayed. Below it, from left to right, an overview of the contractual allocation (further explained in section 4.5), some key characteristics, and its geographical location are provided. This is followed by a description of the project's context and a comparison to both the client's and contractor's context, respectively, as described in appendices B and C. At the end, the related interview results are summarised to provide an overview of how practitioners have experienced equitability in this project.

Nijmegen – Construction of working pits

(see appendix D for the explanation of the numbers)	Allocated	Reasonably Assumed	Total
Client	20	2	22
Predominantly Client	10	0	10
Shared	8	1	9
Predominantly Contractor	15	3	18
Contractor	55	11	66
Undefined	14	0	14
Total	122	17	139

Key Characteristics:

- Client: ProRail
- Contractor: Van Hattum & Blankevoort Zuid
- State: Finished
- Contract price: ca. € 1 million (excl. VAT)
- Billed total: ca. € 1.45 million (excl. VAT)
- Start tender: Aug 7, 2020 (design to Arcadis)
- Contract signed: Jun 22, 2021
- Start construction: Oct 1, 2021
- Delivery: Apr 13, 2022 (131 days delayed)
- Contract type: Engineer & Construct
- Subcontractors: VolkerRail, VSKR, Gubbels



Project description:

The Nijmegen REP railyard in the city centre of Nijmegen contains two marshalling yards. As part of larger renewal efforts to improve service systems in this railyard, the southern marshalling yard had to be equipped to enable servicing and maintenance of bio-toilets in passenger wagons. This required the construction of two working pits beneath the rails to enable access to the wagon underside (1x 13m/53m³ & 1x 8m/42m³). Removing existing objects, connecting the required pipelines and constructing rail junctions were also part of the assignment. The bid submitted by VHB was financially tight, making close management and optimisation of remuneration important. ProRail, in turn, was put on a very tight schedule by its principals, and project delivery had to take place as soon as possible. The definitive design (DO), drawn up by ProRail and Arcadis, was developed and much improved into an executive design (UO) by VHB and subcontractors (VHB focusing on the concrete working pits). As a result, 50% less rebar has been applied. For the construction phase, the arrangement of some track deactivations (Dutch: spoorbuitendienststellingen) and permits had not been clearly organised by ProRail, which posed some problems and resistance. In the end, they could still be arranged in close cooperation by VHB, ProRail, and ProRail's principals. Construction took place on three weekends and some weekdays, minimising the hindrance of the users of the yards. Due to many requests for Modification (Dutch: VTWs), planning and budget overruns occurred. However, the project has been realised to the client's satisfaction.

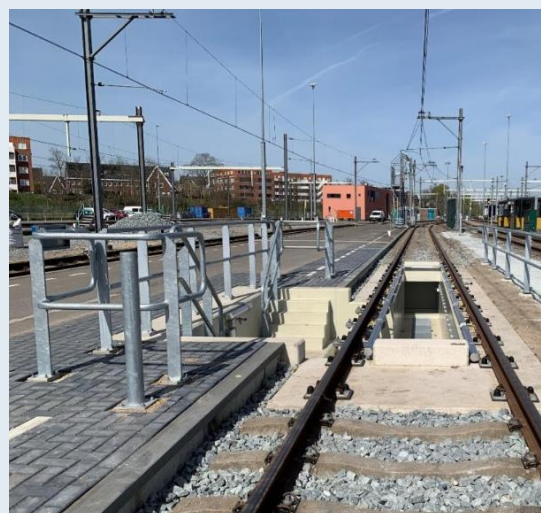


Figure 11: One of the constructed working pits at Nijmegen (VHB)

Comparison with Contexts (Appendices B & C):

For ProRail, this project does not seem to relate to ongoing programs or general developments. However, several yard improvement projects were started/ongoing at the same time. There also might be a relation to the pandemic and anticipation of resurging passenger numbers, but this is not certain.

For VHB, this project took place some years after the rebalancing of the attention for the regional divisions. The project is also situated at the transition from less profitable years to profitable years. Due to a change of the board and business growth efforts, VHB Zuid was eager to get some work and broaden its portfolio.

Experienced equitability

Interviewees indicated that this was a simple project, with few elements affecting equitability. For both client and contractor, the perceived equitability was most affected by the misunderstandings on responsibility for permits and track deactivation, as well as the time pressure for delivery. The personal relations enabled alignment on these matters, resulting in an agreement to be pragmatic about contractual (documentation) requirements to save time and money. Mutual flexibility is said to have made the project possible. Another equitability factor pointed out by the client was that the client took responsibility for the substandard design principles it had drawn up.

Nunspeet – Construction of station area underpasses

(see appendix D for the explanation of the numbers)	Allocated	Reasonably Assumed	Total
Client	18	2	20
Predominantly Client	8	0	8
Shared	7	1	8
Predominantly Contractor	18	6	24
Contractor	60	9	69
Undefined	12	0	12
Total	123	18	141

Key Characteristics:

- Client: ProRail & Municipality of Nunspeet
- Contractor: Van Hattum & Blankevoort
- State: In execution
- Contract price: ca. € 19 million (excl. VAT)
- Billed total: -
- Start tender: unknown
- Contract signed: Feb 17, 2022
- Start construction: Jan 2024
- Delivery: before Dec 31, 2025 (plan: Sep 2025)
- Contract type: Design & Construct
- Side contractor: BAM (area redevelopment)
- Subcontractors: VSKR, VolkerRail, Van Kessel, MOS



Project description:

This project in Nunspeet is part of a set of projects to improve the Nunspeet station area. The national and provincial governments and the EU made financial contributions. Side contractor BAM is responsible for the wider area's redevelopment, such as access infrastructure. The project of VHB is part of the Tunnel Alliance (see appendix B.3.2). It is focused on transforming the Elspeterweg level crossing next to the Nunspeet Station into an underpass and transforming the Nunspeet Station barrow crossing into a pedestrian and bicycle station underpass. Additionally, platforms and roofs have to be changed, track switches remediated, and a Road Rail Access Point has to be constructed. Later on, remediation of 600m track was added as Additional Work. As the Elspeterweg is an important local connection road, this project aims to improve the safety and accessibility of the station and the surrounding town. This also means special attention is required to minimise hindrance for travellers and locals. Considering the location in the Veluwe nature region, the Municipality of Nunspeet also required special attention for construction emission reduction efforts. The Technical Rail Traffic Design (RVTO) commissioned by ProRail was made by Sweco. For the construction, VHB planned to use only two of the four track deactivation periods that were made available. These would be enough to execute the chosen construction method: rolling-in locally preconstructed underpass elements. Soon after the contract had been awarded, ProRail had to change the planning of one of the track deactivation periods, putting tension on the new collaboration. Fortunately, plans could be adapted. Although project financing responsibility rests with the municipality, ProRail contributes to the replacement of system boxes, which was an Additional Work. Currently, the groundwater level is the most challenging project factor, requiring more than double the number of pumps designed to keep the underpasses dry due to the water table rising 40 cm.



Figure 12: Plan map Nunspeet station area with station and underpasses highlighted, adapted from Municipality of Nunspeet, 2021

Comparison with Contexts (Appendices B & C):

Tendering for this project took place while ProRail programs like Pleasant & Safe Waiting, High-Frequency Rail Transport Program, and National Level Crossings Improvement Program were in full swing, and many station renovation projects were being executed. The Nunspeet project, which aims to improve the station, increase (rail) traffic flow, and reduce accidents, fits right in with these. There might be a relation to 2019-2020 conclusions about level crossing safety. The construction emission reduction aligns with ProRail's 2021-2023 sustainability developments.

For VHB, this project is part of the financially good years since 2022. Its standard D&C delivery method as part of the Tunnel Alliance and technically somewhat complex nature, including design, make it a good fit for VHB's portfolio. The internal pressure to finally win its first Tunnel Alliance contract since VHB was certified in 2019 also played a role.

Experienced equitability

As with the Nijmegen case project, interviewees indicated that project simplicity benefits perceived equitability. Although both sides agree that the overall project is equitable, their perspectives on how it is locally reduced differ. For ProRail, the primary problem has been the contractor's ambiguous statements about the necessity of replacing soiled system boxes. Some people said they could still be worked on, while others refused to do so. Nonetheless, the client took its responsibility, unexpectedly replacing these boxes at considerable costs. The contractor's comments on equitability focused on the collaboration instead. It was said that the client was minimally involved in shared risk management, keeping cards close to the chest in fear of commercial exploitation by the contractor. However, this attitude also reduces the eagerness for shared risk management on both sides. Equitability was also said to be of importance for the contractor when the client unexpectedly changed a track deactivation period at the start of the project, just after the collaboration had started.

Ede Public Transport Hub – Construction of station and rail

(see appendix D for the explanation of the numbers)	Allocated	Reasonably Assumed	Total
Client	12	2	14
Predominantly Client	15	0	15
Shared	17	1	18
Predominantly Contractor	19	6	25
Contractor	51	8	59
Undefined	10	0	10
Total	124	17	141

Key Characteristics:

- Client: ProRail
- Contractor: EdesPoort (VHB + VolkerRail + Van Wijnen Oost)
- State: In execution
- Contract price: ca. € 95 million (excl. VAT)
- Billed total: -
- Start tender: May 2018 (1st try), ca. Apr 2020
- Contract signed: Apr 18, 2021
- Start construction: Sep 2021
- Delivery: before Mar 1, 2025
- Contract type: Design & Construct
- Subcontractors: ITL, Ingenieursbureau Arnhem, Van Kessel, HSVT, vshanab, De Groot Vroomshoop



Project description:

The station and rail construction project at Ede is part of a set of projects that aims to increase the Ede station capacity (both in the number of trains and passengers (+50%)) and redevelop the surrounding area. The most significant element is replacing the old station with a new one right next to it. The total set of projects is initiated and overseen collaboratively by ProRail, NS, the Nunspeet Municipality, and the Province of Gelderland. The total contract set consists of: construction of the station and rail infrastructure (1a); long term servicing/upkeep of the IXL interlocking system that is constructed as part of contract 1a (1b); development of the parking and bus terminal area (3); landscaping (4); and ground preparations and services (5). The content of what was to be contract 2 has been included in contract 1a/b. Of these contracts, only 1a/b is the responsibility of ProRail, and the others are the municipality's. VHB, as part of the contractors' combination EdesPoort, has been awarded all but contract 5. However, the scope of the current research is limited to only contract 1a. Additionally, a Relational Collaborative Contract has been signed between ProRail and EdesPoort to shape the collaborative relationship. The precise scope of contract 1a includes: removal of



Figure 13: Station and underpass at Ede under construction

two level crossings; constructing a new station building (incl. platform roofing, facilities, bicycle parking, and a pedestrian/bicycle station underpass) and demolition of the old one; modifying and renewing track, rail systems and platforms (incl. furniture); building two station squares; constructing sound barriers; replacing the pedestrian/bicycle Westtunnel underpass; and constructing a new pedestrian/bicycle bridge. Already in the early 2010s, the project was initiated. However, delays occurred when the first round of tendering in 2018/2019 was aborted as only one bid, which didn't even comply with the set price ceiling of ca. € 81 million, was submitted (Bos, 2019). This price ceiling was increased for the second round, and a different method of collaboration and risk allocation between the client and contractor was introduced. As other contract bidders objected to the awarding procedure, the definitive awarding of the contract was delayed by ca. 5 weeks. During tendering, VHB had already pointed out to ProRail that the time available between awarding the contract and the first crucial track deactivation period was short, posing a significant risk. Delayed contract awarding due to ProRail's procedural and planning mistakes further reduced this limited available time. The tender and the bid submitted by EdesPoort in the second round focused on esthetical quality, travel hindrances due to construction, and local satisfaction. This required frequent alignment of parties (including the original designer at Vakwerk Architecten) and client participation during the design phase. Collaboration has not always been smooth during construction, resulting in mutual distrust and legal discussions between client and contractor. However, in other cases, good consultation, demarcation and documentation have led to successful management of some subsurface risks. In total, ca. 300 Requests for Modification (Dutch: VTWs) have been submitted.

Comparison with Contexts (Appendices B & C):

As with the Nunspeet project, the Ede project tender and execution take place at a time when ProRail runs several programs to improve stations, train frequency, and level crossing safety. This fully aligns with the activities that constitute the Ede project. The attention to sustainability in design in especially the roofing, aligns with ProRail's 2017 sustainability plans. The failed first tender round and subsequent changes for the second round in collaboration and risk allocation can be related to the 2016 Market Vision and 2017 Future Proof Rail Works (Toekomstbestendig Werken aan het Spoor) approaches following market developments. The early stages of the second round of tendering might have been significantly affected by the pandemic.

Market developments, the contractor's attitude toward risk, and tender success also play a part in VHB's context. Tendering took place during VHB's financially less positive years, but the underpass construction parts perfectly fitted its expertise. Apparently, some negligence on VolkerRail's side resulted in a low bid price, mistakenly complying with the new price ceiling, and subsequently getting the project awarded.

Experienced equitability

Unfortunately, this research has only found interest in interviews on the contractor's side of this project, resulting in a somewhat one-sided perspective on the experienced equitability.

The contractor's equitability perception focuses on the client's attitude in risk management. The risk allocation distribution is not illogical or unfair, although ProRail is known to be harsh in its risk attitude. Both client and contractor have even had the opportunity to nominate risks for a small shared risk domain, but this has not been used. Although contractors and clients are used to parties pursuing a contractual interpretation in their own favour, the contractor's primary problem with the client in this project is its behaviour in risk management. Its apparent distrust, constantly bailing out, lack of expertise, negation of risks, and fear of disappointing its internal stakeholders obstruct effective collaborative risk management. This has already damaged collaboration from the start, as ProRail was unwilling to accommodate the contractor in any way for compensation for the unexpectedly delayed contract awarding while the contractor had already indicated that time was insufficient. This left the contractor with large, unexpected costs. As a result of the damaged relationship, the initial intentions to safeguard collaboration by investing in the relationship have been crippled and an 'every man for himself' mentality rules the project. The inability to communicate, discuss intentions, and understand each other has led to a negative spiral. As a result, ProRail is accused of obstructing payments, reactive risk management, and sluggish decision-making, while the contractor is accused of excluding ProRail from talks and of insufficient documentation quality. Although the contractor acknowledges ProRail's difficult internal accountability processes and the lack of nuance in the accusations, it also states the client's attitude is harsh, even for ProRail. And even though some Requests for Modification in this project have been collaboratively processed well, too often, the client applies its contractual right to force the contractor to act before an agreement is reached on compensation, according to the contractor.

ZwolleSpoort IJssel-Herfte

(see appendix D for the explanation of the numbers)	Allocated	Reasonably Assumed	Total
Client	7	0	7
Predominantly Client	6	0	6
Shared	42	5	47
Predominantly Contractor	14	6	20
Contractor	42	6	48
Undefined	9	0	9
Total	120	17	137

Key Characteristics:

- Client: ProRail
- Alliance: Zwolse Alliantie Zwaluw (ProRail (50%) + Noorderspoort (50%))
- Contractor: Noorderspoort (VolkerRail (60%) + VHB (25%) + KWS Infra (15%))
- State: Finished
- Contract price: ca. € 135 million (ex. VAT) execution
ca. € 25 million (ex. VAT) alliance
- Billed total: ca. € 172 million (ex. VAT) execution
ca. € 30 million (ex. VAT) alliance
- Start tender: Aug 28, 2017
- Contract signed: Mar 16, 2018
- Start construction: Oct 15, 2018
- Delivery: Apr 1, 2022 (Apr 3, 2024 after early maintenance)
- Contract type: Alliance with UAC-IC2005-based Basic Agreement



Project description:

This project in the Zwolle region was part of ProRail's Spoorplan Noord-Nederland program, aiming to improve rail travel between the Randstad region and the North of the Netherlands. Work in the Zwolle region was spread across two contracts: one to improve most of Zwolle Station and the ZwolleSpoort IJssel-Herfte contract. This last one consisted of: constructing a dive-under at Herfte junction (to eliminate waiting time); doubling the number of tracks between Zwolle Station and Herfte junction; expanding the RGS-marshalling yard (incl. systems); and installing a groundwater protection layer under the RGS-marshalling yard. The doubling of tracks also required: adapting a platform at Zwolle Station; expanding a bicycle underpass and two rail bridges; replacing two road bridges and two rail bridges; constructing a new underpass; replacing a level crossing at the Herfte junction; and renewing two other level crossings. As this project was procured in an alliance, two contracts were signed: an Alliance Agreement covering collaboration, responsibilities and sharing of financial results, and a Basic Agreement covering the contracting of (primarily) execution. The alliance was most active during the design phase and had less responsibility during the execution. Especially at the beginning, inexperience with alliancing posed some collaboration problems. During execution, full disruption of train services was sometimes required, occurring for a total of 1976 hours spread across 20 track deactivation periods. Although some project objectives, like optimising sustainability by reusing in-project material, were achieved on several occasions, the execution was far from problem-free. Almost all of the project KPIs defined for safety, connectivity, sustainability, time, and money have not been achieved, and more and more KPIs were discontinued later in the project. Between October 2018 and March 2020, performance was



Figure 14: Dive-Under at Herfte

reasonable, achieving ca. 50% success. Between April 2020 and September 2021, almost half of the KPIs were discontinued as their added value and support were too little, and only one KPI was fully achieved at the end. The total project cost also significantly increased due to many discussions and contract amendments to both the Alliance Agreement and Basic Agreement and the sharing of alliance losses.

Comparison with Contexts (Appendices B & C):

As stated, this project was part of the Spoorplan Noord-Nederland program. The influence of the High-Frequency Rail Transport program and the National Level Crossing Improvement program can also be seen. Most project objects are relatively standard, but the dive-under is a more unique object for ProRail. Combined with the large and various scale of the project, the increased complexity makes this project fit for alliancing. As with the Ede project, this project could relate to some general sustainability and contractor collaboration developments within the ProRail context, but this is never emphasised. Nor is the influence of the pandemic.

For VHB, the choice for an alliance is also rational, as tendering took place in a period of growing contractor discontentment about contract types like DBFM, and the budget of this project sits on the upper limit of D&C capabilities. It was also felt that due to the success of the OV-SAAL alliance and familiarity with the ProRail alliance, the Zwolle project would be a financial success. However, the collaboration in Zwolle was not as good as anticipated. Additionally, the project took place during financially harder years and internal reorganisations within VHB and VolkerWessels.

Experienced equitability

The main focus of equitability in risk management, again, is not on allocation but on attitude and behaviour within the collaboration: how to facilitate trust and transparency to do justice to the contract's intentions. As there wasn't much experience with alliancing, special attention was given to shaping this collaboration with the help of an advising external team coach. As a result, the client involved the contractor early on in the allocation process, and the contractor tried to actively involve the client in risk management. However, attention to shared risk management declined during the execution phase as most risks in that phase were allocated exclusively to the contractor. The alliance-developing character of the project can also be seen in the awareness of both the client and contractor about some of their actions that had been damaging to the collaborative aspect of the project's risk management. The client acknowledged that their tender selection process unintentionally favoured a low price, which threatens equitability in risk compensation and sharing. The contractor admits that it had been much less proactive in risk management than the client, as it had been too focused on safeguarding budgets. However, these acknowledgements don't align with the parties' primary equitability problem with one another. Although the contractor concludes that the project was generally equitable, it experienced some equitability problems when the client did not accept the delivery file, partly because ProRail's asset management department had added new requirements. On the client's side, the feeling of general equitability is much more disputed. The client had set up its delivery method such that the amount the contractor would have to contribute in case of a project loss in the alliance domain was capped. According to ProRail, the contractor exploited this by submitting a low bid, depleting the shared risk budget as quickly as possible, thereby making almost all costs for subsequently eventuating risks the client's responsibility. Although this was a legal move, ProRail felt it conflicted with the contract's intentions and that it was misleading, as the contractor kept denying that this was their strategy. The contractor claims that the client's discontent was communicated only after the project was finished.

OV-SAAL Southern-branch West

(see appendix D for the explanation of the numbers)	Allocated	Reasonably Assumed	Total
Client	9	2	11
Predominantly Client	8	0	8
Shared	32	1	33
Predominantly Contractor	23	2	25
Contractor	36	8	44
Undefined	16	0	16
Total	124	13	137

Key Characteristics:

- Client: ProRail
- Alliance: Alliantie Amsterdamse WALTZ (AAW) (ProRail + CNMS (50/50))
- Contractor: Combinatie Nieuwe Meer Sporen (VHB (70%) + VolkerRail (30%))
- State: Finished
- Contract price: ca. € 52.5 million (ex. VAT) execution
ca. € 7.5 million (ex. VAT) alliance
- Billed total: ca. € 101 million (ex. VAT) execution
ca. € 18 million (ex. VAT) alliance
- Start tender: ca. Apr 2010
- Contract signed: Sep 17, 2010
- Start construction: Sep 20, 2011
- Delivery: Dec 15, 2016
- Contract type: Alliance with UAC-IC2005-based Basic Agreement



Project description:

This project is part of the larger OV SAAL contract cluster, which aimed to increase rail capacity on the Schiphol-Amsterdam-Almere-Lelystad (SAAL) route necessary due to the growth of Almere and the opening of the Hanzelijn rail connection. It consists of doubling the number of tracks (substructure + superstructure + systems) between Amsterdam Riekerpolder and Amsterdam South (ca. 4 km); constructing a fly-over and modifying another (both crossing the A4 motorway); constructing an electronic-hydraulic rail bridge and electrifying another moving rail bridge; and constructing ca. 6 other rail bridges in complex environments. Further complexity in this project originated from combining the construction of superstructure and substructure in a single contract, the required contextual interactions, and the short-term high-priority character of the project. Additionally, the execution had to pose minimal disruption to train services and was therefore planned in short sprints (TVPs). These were 275 short ones (<12 hours) and 33 longer ones, of which only 2 were more than 200 hours long. All these conditions made alliancing an appealing option. However, both client and contractor were relatively inexperienced in alliancing and therefore the project was used by both to learn. For the client, it was the first project to be procured in an alliance from the start. The goal was to share risks, align interests, and combine expertise for optimisations, primarily during design and preparation, as there was insufficient time available during execution. The AAW alliance was tasked with the design, context management, construction supervision, delivery, and handover to asset management. This collaboration became a success. Although some amendments to the contracts have led to a budget increase (which could relate to the lowest-price bid selection procedure), the project has been twice as profitable as anticipated. All KPIs on money, time, collaboration, context awareness, and sustainability were achieved. Only on safety, the KPI was not achieved due to several minor impact incidents. However, the project still was the first ever to be safety level 4 certified.

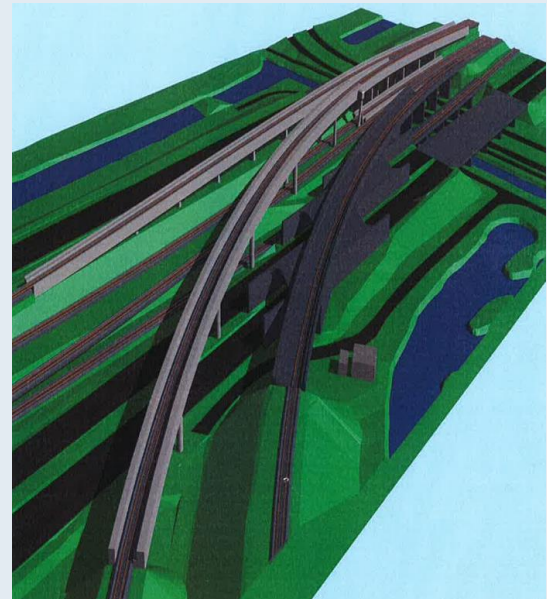


Figure 15: Part of the digital model for OV SAAL

Comparison with Contexts (Appendices B & C):

Unfortunately, the contracting process of this project predates the publication of ProRail's annual reports. As this project is relatively old, limited information and recollections are available. The only noteworthy aspect is that this procurement by alliancing was experimental at the time and could have functioned as an alternative for DBFM, replacing the initially not very profitable/successful introduction of D&C contracts.

Experienced equitability

As many of the collaboration-improving objectives for which the innovative alliance delivery method had been selected were achieved, both the client and contractor are positive about the perceived project equitability. Although parties had to get used to the alliance approach and each other's organisational cultures, and although organisational flexibility was consequently not always sufficient, transparency and trust ensured the numerous discussions were equitable. Candid discussions at the start led to a clear alliance risk domain, which enabled the submission of a clear bid. The alliance approach encouraged proactivity and efficiency in risk management. Even when problems arose as it became apparent that ProRail had forgotten to include certain requirements in the tender, proper discussions and consultation led to an equitable solution, albeit somewhat more hurtful to the contractor than the client. Another result of working closely together in an alliance is the insights it provides into the difficulties the other has to overcome and a subsequent better understanding of each other.

4.5 Equitability of the Case Projects

To determine the equitability of the case projects, two perspectives are considered (as described in section 1.4). These are the rational reasonableness of the actual risk distribution and the emotional fairness according to its perception.

4.5.1 Contractual Analysis

For the first, rational perspective, contract documents for all five projects have been analysed to determine the allocation of the ca. 140 most prominent construction project risks according to the *Construction Extension to the PMBOK® Guide* (Project Management Institute, 2016). A more detailed description of how this has been done and a resulting allocation overview for each project can be found in appendix D. The allocation overviews of the individual projects, as shown in each of their respective frames in section 4.4, show how risks are numerically allocated. To be able to interpret these, a benchmark is set by applying the same allocation assessment to the UAC-IC2005 Model Agreement that underlies most Dutch integrated construction contracts and to the combination of this model agreement with ProRail's standardised additional stipulations to this agreement, the so-called Yellow Book. The outcomes of this assessment are shown in Table 13.

Table 13: Numerical Allocation Assessment of Benchmark Model Agreements

Contractual allocations – Model Agreement Allocation Base Points						
(see appendix D for explanation)	UAC-IC2005 + TRUI2016 (UAV-GC2005 + ARN2016)			UAC-IC2005 + TRUI2016 + PRYB2016 (UAV-GC2005 + ARN2016 + ProRail Gele Boek)		
	Allocated	Reasonably Assumed	Total	Allocated	Reasonably Assumed	Total
Client	17	3	20	14	2	16
Predominantly Client	8	0	8	10	0	10
Shared	11	1	12	9	1	10
Predominantly Contractor	6	3	9	10	4	14
Contractor	54	11	65	54	11	65
Undefined	25	0	25	25	0	25
Total	121	18	139	122	18	140

However, the assessments do not consider the magnitude of the risks' probability and consequence or their perceived importance. Furthermore, they are based on the researcher's interpretation of generally quite nuanced, flexible, and interpretable descriptions of allocation. A factor related to this is the result of the evolving contract descriptions over the ten years between the first case project and the last one. As the clarity of stipulations is improved, its classification might shift from a 'predominantly' category to 'client' or 'contractor' or from 'reasonably assumed' to 'allocated'. The point at which this shift takes place is very much dependent on the researcher and his interpretation and, therefore, somewhat subjective. As a result, the analysis of the contracts does not provide an absolute quantified measure of project equitability. The large numerical difference between the 'client' and 'contractor' categories that can be seen in the assessments is more likely the result of the high specificity and variety of execution risks included in the PMBOK list. These risks are usually related to the contractor's work and, therefore, logically allocated to him. Therefore, the analysis shows a rough relative comparison between cases at best, if it is assumed that the number of risks considered enables a close enough approximation so that magnitude can be ignored. Another important note to make is that jurisprudence is not considered. Although this is less consequential in the Dutch legal system than in, for example, the Anglo-Saxon ones, it might significantly clarify certain allocation nuances.

Comparing the benchmark cases of UAC-IC2005 with and without ProRail's Yellow Book reveals that the Yellow Book primarily causes a small transfer of risk responsibility from the client's side to the contractor's side. It also slightly increases allocation ambiguity signalled by the 'predominantly' categories.

Generally, comparing the benchmark cases to the case projects shows two primary changes. First, the number of 'undefined' risks is almost halved in project contracts, primarily increasing the number of 'predominantly contractor' categories. Although this indicates improved completeness of contracts, it also results in a slight increase in allocation ambiguity, favouring the client more than the contractor. The second change relates to larger and especially alliance projects, which (in some cases logically) results in an increased number of 'shared' risks and a decreased number of 'contractor' risks. This could indicate that 'contractor' risks are more easily shared than 'client' risks.

Comparing the five project contracts, the previously mentioned 'shared' and 'contractor' related risks for larger and especially alliance projects still hold true. Similarly, the number of 'client' risks is significantly reduced for larger and especially alliance projects. The number of 'undefined' and 'reasonably assumed' is similar between the projects, but the distribution of 'reasonably assumed' between allocation categories differs somewhat. Still, most of them relate to the contractor's side. The number of 'predominantly client' and 'predominantly contractor' varies from project to project, the 'predominantly contractor' one being more volatile, but this seems unrelated to project size or form of collaboration. Besides these differences, the only other unexpected outlier is the 15 'predominantly client' risks at the Ede Public Transport Hub project. It does not fit a size or collaboration form distinction. Most likely, it is related to the client's initial intentions to increase collaboration and apply a mini-alliance but not a full alliance. Therefore, risks are moved towards the 'shared' category, but on their way there, they 'got stuck' in the 'predominantly client' category. This aligns with the comparison of 'shared' risks between this project and the alliance ones.

When looking at which specific risks are allocated to which party, it is apparent that certain risks are almost explicitly allocated to a certain party, while others vary in allocation between contracts. The most stable are risks where allocation is 'logical': construction contract and performance risks relate almost exclusively to the contractor's work and are, therefore, almost always his responsibility. For business risks like monitoring, controlling and land ownership, a relation to a single party's work or shareability also seems often logical, resulting in stable allocation. However, for risks related to requirement definition, social interaction, society, environment and politics, the opposite is true. Their allocation varies from contract to contract between client, contractor and sharing. The 'undefined' category is also relatively stable in the case projects, covering risks like corruption, environmental political pressure, culture, habits, Acts of God, and team/manager work overload.

For the contractual analysis, it can, therefore, be concluded that allocation is generally similar between the projects when taking the intentions of alliancing into account. Taking the UAC-IC2005 as a benchmark shows that the projects are relatively similar in allocation, although minor changes often favour the client. Most differences can be explained by the form of collaboration or relate to project size.

4.5.2 Contract & Perception

Comparing these contractual allocations to the equitability perceptions shared by practitioners, as defined in section 4.4, provides insight into the relationship between these two. Assessing the experiences shows that the equitability of the allocation distribution is usually not evaluated on a contractual basis but sometimes on a risk-specific basis. However, most of the time, the allocation distribution is not mentioned explicitly. Generally speaking, project size, complexity, and inexperience with the form of collaboration seem to influence the perceived equitability negatively.

Taking a more numerical approach to the comparison results in Table 14. Based on the shared experiences, the five projects are ranked from most equitably perceived to least, determining the severity of equitability issues and whether both client and contractor acknowledge these or only one of them. The coloured rows and columns contain the numerical allocation analysis, as explained in section 4.5.1. The added white rows and columns contain analysing values, such as sub-totals and comparative value differences.

Table 14 shows few trends even when looking at subtotals for risks allocated to the contractor's or client's side (a sum of their 'predominant' category with the full allocation category). Only three factors seem to show some relation to equitability perception. First, the non-specific (non-binary) allocation to contractor or client. However, this is mainly just a marking of the alliance projects, which might include many other influences that reduce perceived equitability. Second, the unclear allocation of risks compared to the UAC-IC2005 + TRUI, but ZwolleSpoort IJssel-Herfte conflicts with the trend. Third, the total number of allocation differences compared to UAC-IC2005 + TRUI. For this one, Ede conflicts with the trend. However, Ede's anomaly might also relate to the fact that its form of collaboration seems to float between D&C and alliance, not succeeding in combining the best of both but rather the worst. For each of these factors, it applies that they are not an exclusive influence and indicator for equitability perception, and therefore, other factors have to play a role. Practitioners have not mentioned explicitly assessing these three factors when evaluating project equitability. Also, it is unknown to what extent they can indicate the absolute level of perceived equitability. Therefore, it can be concluded that reduced allocation clarity compared to UAC-IC2005, allocation deviation from UAC-

IC2005, and non-alignment between contractual allocation and form of collaboration play a role in perceived equitability with undefined relations to absolute equitability.

Table 14: Allocation equitability comparison in order of perceived equitability

Allocation											
		UAC-IC + TRUI	Nijmegen – Construction of working pits		Nunspeet – Construction of station area underpasses		OV-SAAL Southern-branch West		ZwolleSpoort IJssel-Herfte		Ede Public Transport Hub – Construction of station and rail
Equitability summary		None has real equitability issues		Difference Nijmegen & UAC-IC + TRUI		Difference Nunspeet & UAC-IC + TRUI		Difference OV-SAAL & UAC-IC + TRUI		Difference Zwolle & UAC-IC + TRUI	
Client	20	22	2	20	0	11	9	7	13	14	6
Predominantly client	8	10	2	8	0	8	0	6	2	15	7
Sub-total client's side	28	32	4	28	0	19	9	13	15	29	1
Shared	12	9	3	8	4	33	21	47	35	18	6
Sub-total contractor's side	74	84	10	93	19	69	5	68	6	84	10
Predominantly contractor	9	18	9	24	15	25	16	20	11	25	16
Contractor	65	66	1	69	4	44	21	48	17	59	6
Undefined	25	14	11	12	13	16	9	9	16	10	15
Not binarily allocated (client or contractor)	54	51	3	52	2	82	32	82	28	68	14
'Predominantly' + Undefined	42	42	0	44	2	49	7	35	7*	50	8
Total	139	139	28	141	36	137	76	137	94	141	58

* In this case, the difference is positive, as clarity and completeness of the contract for ZwolleSpoort IJssel-Herfte is improved compared to UAC-IC2005 + TRUI.

4.6 Influence of Case Study Parameters on Equitability Perception

Up to this point, some comparison has been made between the client's perception and that of the contractor or between that on smaller/D&C or on larger/alliancing projects. This section focuses on such differences to determine whether these and other factors affect equitability perception.

The most prominent and influential differences can be found between client and contractor. Where an equitability perception of a specific project is usually shared between people from the same organisation, perceptions of client and contractor could even be opposite: one evaluates the project as equitable, the other absolutely not. The factors identified in the literature are recognised more by the client. Although both sides agree on the importance of factors like discussing expectations on equitability or establishing a shared social basis on which to define equitability, disagreement exists on how this is achieved. For the expectations, the contractor prioritises the model agreement and the client dialogue. For the social basis, the contractor points to the national/industry culture and the client to the model agreement. It is also primarily the contractor who indicates that interests and a shared social basis conflict. Regarding the UAC-IC2005 model agreement, the contractor emphasises its rigidity, dictated character, and therefore, irrelevance to equitability perception. At the same time, it is primarily the client who sees options to apply the contractual allocation more flexibly when required. Consequently, the contractor focuses more on attitude and behaviour in collaboration, and the client on acknowledging your mistakes and taking responsibility to fix them. Therefore it is primarily the contractor who believes that everyone has good intentions until project costs escalate. It is also only the contractor that indicates a relationship between organisational capacity or knowledge and equitability. Lastly, the contractor seems more critical about its own risk management process than the client is about its own.

Due to the selected case study projects, it is hard to distinguish between project size, project complexity, and project delivery method. Therefore, it is hard to say how these affect equitability perception but differences can be seen between smaller/simpler/D&C projects and larger/more complex/alliance projects. As allocation in D&C is primarily dictated, the influence of allocation on equitability perception is better recognised for alliance projects. The same goes for an equal level of proactivity in risk control and the importance of having experience with the project delivery method.

The least influential of all the case study parameters seems to be trade. Only minor changes in emphasis bring some distinction between project/construction, contract/tender, risk, and process managers. Almost exclusively contract managers focus on contractual/legal factors that require improvement for equitability, and primarily the client's construction managers emphasise taking responsibility for your mistakes.

In general, recognition of factors that contribute to equitability perception varies from person to person. Whether one works for the client or the contractor seems to be somewhat significant, and so is the distinction between D&C and alliance. The influence of trade seems negligible, and that of size is not clear.

4.7 Allocation Principles

As can be concluded from sections 4.2 and 4.3, several of the allocation principles described in section 1.2.3 are explicitly or implicitly recognised or applied. Most clear are the ability to control (probability or consequence of) the risk and the ability to bear the risk. However, intrinsic motivation aligns with Abrahamson's (1984) 'preponderant economic benefit' and Xu et al.'s (2010) 'willingness to take risk'. Additionally, foreseeing the risk is related to having the required knowledge/expertise. For the three primary sources of allocation principles, this means that Abrahamson's (1984) recognition score is 2/5, Bunni's (2009) 3/4, Lam et al.'s (2007) 5/7, and Xu et al.'s 2/4. Allocation principles that are not recognised include:

- the party that can most economically transfer the risk (e.g. by insurance) (Abrahamson, 1984)
- most efficient dealing with the risk with the least consequences for long-term industry health. (Abrahamson, 1984)
- first or most to benefit/suffer from the risk (Abrahamson, 1984; Bunni, 2009; Lam et al., 2007)
- acceptability of the risk-bearing-premium for the payer (Lam et al., 2007)
- bearing risk at the lowest price (Xu et al., 2010)

4.8 Conclusions

In answering the question *"How is equitability considered in the construction risk allocation process, and how does this relate to the allocation principles?"* it can therefore be concluded that about half of the principles are recognised, although this does not necessarily mean they are applied.

About the risk allocation process, it can be concluded that it consists of ten phases, starting with initial financing agreements between principals and ending with risk management during project execution. This process contains two situations where allocation is actively assessed and discussed between contractor and client. These are the contractor's contract scan in preparation for the 'Summary of Additional Information and Changes' and discussions about 'Requests for Modification'.

When it comes to the recognition of theoretical allocation equitability influencing factors in practice, interviews show perception in construction is very subjective. The distribution of risks is often imposed on the contractor and is based on mutually agreed-upon model agreements. It is, therefore, said to function as an equitable basis that isn't often evaluated on its own equitability. However, the often-used UAC-IC2005 has recently been updated to improve some of the primary equitability issues. The procedural, interpersonal, informational, and, to a lesser degree, risk allocation categories of equitability rules are better recognised. This is because the focus of perceived equitability is often directed at interactional factors like communication, alignment, clarity, transparency and interests. These interests should be acknowledged and mutually secured. The client's primary concern is the legitimacy of expenses, and for the contractor, it is project profitability, as signalled by the seventh allocation process step. Capping of exposure is one of the critical contributors to profitability. Experiences, proactivity, expectations, and a shared social basis are also considered important, although the precise contributions of the last two are unclear. The organisational-personal relation level distinction and power balance are not recognised as significant. In a quantitative approach to their recognition and importance, it appears that the number of positively evaluated factors provides some indication of whether the project is perceived as equitable. Although demarcation is not rigid, a project is likely to be positively evaluated when more than 67% of the 27 factors are evaluated as such. In alignment with the interviews, some distribution-related factors were the least reliable indicators for project equitability and factors like proactivity in risk control, being heard, and being treated well were the most reliable. Therefore, additional assessment factors from practice focus on attitude and behaviour on the interactional side of risk

allocation. This includes several of the allocation principles, prevention of opportunistic behaviour, an equitability-seeking attitude, transparently safeguarding interests, and realistic pricing. Of the three contexts defined in 3.6, only the economic one plays a clear, significant role, albeit only reliably assessable from one's own or an industry-wide perspective.

When assessing the equitability of the allocation process itself, subjectivity is again clear. Again, problems and improvements are primarily identified for the way parties interact, and only a limited number of comments are made about the allocation. UAC-IC2005 is used as a solid basis, acknowledged by both sides, with both stating that its current form is not perfect but generally usable.

About the contractual allocation, it can be concluded that on a general level, allocations are similar, although alliances have a logical shift towards more sharing of risks. The allocations are also relatively similar to the UAC-IC2005, although the minor changes often favour the client more than the contractor. A more detailed evaluation, however, shows that reduced allocation clarity compared to UAC-IC2005, allocation deviation from UAC-IC2005, and non-alignment between contractual allocation and form of collaboration can act as negative indicators for perceived equitability. However, these do not provide an absolute equitability score and cannot fully predict perceived equitability. Other factors should still be considered.

A comparison of project and interviewee characteristics again emphasises that recognition of factors that contribute to equitability perception varies from person to person. Whether one works for the client or the contractor seems to be somewhat significant, and so is the distinction between D&C and alliance. The influence of trade seems negligible, and that of size is not clear.

To summarise, an updated version of the table from section 3.6 is provided (Table 15):

Table 15: An updated overview of factors influencing equitability perception according to practice

Target	Outcomes Procedural	Decision-makers Interpersonal	Informational	Risk allocation	Other factors
Aspects	Opportunity for voice	Respectful enactment of procedures with sincerity and politeness	Candid, truthful and strategy-free collaboration and communication	Causation (only for simple projects)	Client's consideration of economic context (lowest price vs. risk identification completeness)
	Consistency across persons and time	Propriety and Bias Suppression	Thorough explanations of procedures	Organisational capacity and decisiveness for effective control	Contractor's consideration of economic context (limiting risk cost component in bid price)
	Limited masking of strategic behaviour	Minimal exploitation of exclusive contractual powers	Timely and specific answers/ communication	Knowledge, expertise and independence to make content-related decisions	Sufficient risk research and control budget
	Organisational/ personal alignment and inexperience with procedures	Not aggressively holding off risk responsibility; Balanced leniency; limited opportunistic behaviour	Unambiguous and definitive answers	Alignment between allocation approach and delivery method	Acceptable project time pressure
	Timely engagement of relevant parties		Reliability of risk research	Ability to control	Realistic compensation that considers changes
	Organisational alignment on expectations, interests, intentions, and motives.		Documentation over trust in daily agreements	Authority to decide	Continuous organisational alignment on intentions
	Working together in close proximity		Transparency of return on risk control costs	Intrinsic motivation to control	Mutual proactivity in risk control
	Candid sharing of relevant negative experiences			Access to information required for control	Acceptable level of secondary interests, preventing needless complication of collaboration
				For alliance: maximisation of alliance domain	Respecting and mutually securing interests

5 Framework

Based on the input provided by literature and research of practice, a framework has been drawn up to evaluate construction project risk equitability. To start, section 5.1 provides an overview of the groundwork for a prototype framework. In section 5.2, experts qualitatively evaluate this prototype framework. Section 5.3 takes inspiration from this evaluation to redevelop the framework and provide an explanation and example of its application. At the end, a conclusion is provided in section 5.4.

5.1 The Basis & Criteria for the Assessment Framework

Based on the comparison between practice and theory, it appears that of the identified factors, distributive equitability rules have little impact on the perceived equitability of a project. This is because allocation is already dictated by model agreements drawn up with the participation of interest groups from both the client and contractor sides. As a result, the allocation distribution is generally just accepted and not so much linked to equitability. However, it has been indicated that improvements can be made to allocation in terms of clarity about incomplete/incorrect information and cables/conduits in the subsurface, but that equitability focuses much more on cooperation in risk management and interaction on allocation than on distribution. Furthermore, factors related to the personal-organisational distinction, power balance, and legal context also appear not to play a significant role in the equitability perception of a project. The social context does, but it is highly person and project-dependent. Therefore, this framework focuses on procedural, interpersonal and informational equitability rules and attitudes in collaboration. The economic context can only be included reliably enough from one's own or the general market perspective.

Also, research of practice has shown that the main differences in equitability perceptions are related to whether one is a client or contractor rather than what position one holds, what form of collaboration is used or what the size/complexity of the project is. The latter aspects do bring points of interest that influence equitability (such as the fit of a collaboration form in usual organisational processes or the conduciveness of including causality) but do not significantly affect how equitability is perceived in a project. For this reason, it has been decided to create the framework from the contractor's perspective. Furthermore, practice shows that there are two moments in the risk allocation process when allocation is discussed between contractor and client: at the time of the 'Summary of Additional Information and Changes' (Dutch: NvI) and at that of the Requests for Modification (Dutch: VTW). This assessment framework, therefore, focuses on (the preparation for) these two moments: a contract scan and a substantiation for Request for Modification discussions. In doing so, no overlap should be created with the already existing legal or technical contract scans. The aim is to use the framework to create awareness about one's own equitability perception and to provide a starting point for discussions about it as team members among themselves or with the client. It can also be used to identify risks most in need of monitoring or addressing to the client to safeguard equitability. Lastly, it should provide a more objective substantiation than gut feeling and emotion, which might unintentionally affect equitability negatively.

Since the subjectivity of an equitability perception is also clearly underlined by the research of practice, the assessment framework cannot avoid including personality elements as well. To deal responsibly with subjectivity, the framework has been designed so that the distinction between predominantly objective and predominantly subjective factors is indicated. Predominant objectivity is defined here as an answer to a question that can be substantiated by documentation, communication, etc. and not only by emotion and feeling. This reduces the option to sidestep discussion by dismissing objections simply as "just someone's subjective feeling". A distinction has also been made between the contract scan phase and the Request for Modification phase, as well as between a project perspective and a risk-specific perspective. Questions in the risk-specific sections likely differ from risk to risk and should, therefore, be assessed on a risk-to-risk basis. These could, for example, be applied to the top most significant or top least equitable risks. The resulting pre-validation assessment framework can be found in Appendix E.

5.2 Validation of the Assessment Framework

To validate the use, usability, and value of the assessment framework and to identify opportunities for improvement, an expert panel has been consulted, as described in 2.2.5. Although the focus on the contract scan and 'Requests for Modification' was supported, most feedback pointed out weaknesses of the prototype framework. The most prominent remarks were focused on the framework's objective. As a clear definition of 'equitability' is lacking, it is hard to be sure that the contractor's and client's goals for a discussion are aligned. Often, 'alignment with standardised contractual conditions' (like UAC-IC2005) or 'controllability' are used as a proxy definition, but these are still somewhat too subjective. Only when you have a definition of 'equitability' can meaningful discussion and quantification take place, even if you do not necessarily agree with the definition. In addition to the definition-problem, questioning of equitability is said to be most likely a contractor-issue: the client knows it is pointless to put an inequitable contract on the market and if the client has an equitability-issue it is less likely to become a 'Request for Modification' discussion instead of a relatively smooth adoption. Therefore, the client might not have an incentive to use the framework. (It is important to state that all participating experts were from the contractor's side and that this perspective might be one-sided.) As a result of these definition and incentive problems, it is hard to draw a conclusion from a filled-out framework. This is not improved by the lack of compact visual feedback that can be understood and interpreted at a single glance.

To solve this problem, it was suggested that a framework-based grid-like heatmap be designed that shows the level of equitability for a limited set of categories (max. 9) on a scale of 1 to 5. Through comparison, this would provide a simple and meaningful interpretation. If used as a discussion starter, an equitability-definition and absolute equitability-measure are not necessary, and it only requires a two-sided application of the assessment framework by both client and contractor to identify differences of opinion to discuss. However, as previously stated, the client might lack incentive to cooperate, making framework usability entirely dependent on the client's willingness. Alternatively, the heatmap could be compared to a benchmark score that serves as the definition of equitability in a more absolute-like approach. The benchmark could be based on the often-mentioned UAC-IC2005 or on the average score of a set of recent, equitable projects to be evaluated by participants. This would provide a more useful and meaningful insight than just the personal overview of one's own equitability perception as a discussion starter the current framework provides. The more useful insight the heatmap provides would prevent the framework from becoming one of the (too) many lists used at VHB, resulting in neglect and getting ignored. It would also make it possible to make a selection of the framework-questions that are really relevant. However, to start with, it would be advisable to scrap all the ones not directly related to the contractor's equitability perception.

Another remark about the prototype framework is that the language used is too academic, indirect and complex, and it isn't tailored to the contractor's practice. This is partially caused by the inclusion of varying perspectives from interviews. It will likely result in varying interpretations of the question and incomparable, inconsistent use.

Some other relevant remarks made include:

- Knowledge required to fill out the form is sufficiently available with contract and project managers.
- The framework should more prominently show the balance between 'equitability', 'compensation', and 'controllability'.
- The objective and subjective categories are not clearly distinguished.
- The 7-step scale used for answering the questions is too unrelatable and unrecognisable.

5.3 Updated Equitability Assessment Framework & User Instructions

In response to the suggestions from the framework validation session, some minor changes have been made to the equitability assessment framework (see appendix F). First, phrasing has been somewhat adjusted to simplify the most complex questions, clarify intentions, and eliminate the objective/subjective confusion. It has been tried to balance the simplicity with the completeness of the question, which might still not be fully tailored to the contractor's practice. Second, the 7-step answering scale has been replaced with a more relatable 5-step scale. Third, the framework has been restructured to emphasise relevance, priority, and category. To be able to reach a more easily comprehensible conclusion and solve the visualisation-problem,

questions have been allocated to one of nine categories that make up a heatmap (see Table 16). These categories are based on the ‘equitability’, ‘compensation’, ‘controllability’, differentiation, and their target of influence (distribution, process, interaction). This distinction of targets is inspired by the equitability rules and underlying theories but does not fully align with them. For each of these categories, a single score can be calculated by taking the average of the answers to all questions related to the category. The 5-step scale results in a 0, 0.25, 0.5, 0.75, or 1 score, a ‘no’ in 0, and a ‘yes’ in 1.

Table 16: Overview of the heatmap based on the equitability assessment framework

Categories	Distribution	Process	Interaction
Equitability	1 (2 CSQs / 0 RMQs)	2 (6 CSQs / 5 RMQs)	3 (4 CSQs / 13 RMQs)
Compensation	4 (3 CSQs / 0 RMQs)	5 (2 CSQs / 1 RMQs)	6 (1 CSQs / 0 RMQs)
Controllability	7 (6 CSQs / 1 RMQs)	8 (2 CSQs / 1 RMQs)	9 (1 CSQs / 1 RMQs)

CSQs = contract scan questions; RMQs = Request for Modification questions

As section 4.5.2 indicates, UAC-IC2005 can be used as an approximation of equitability, but it doesn’t fully define it. Therefore, to solve the definition-problem, the benchmark has to be defined by applying the framework and heatmap to a set of equitable projects. Unfortunately, this research lacks the time to do so.

Application of the framework could start at the beginning of the contract phase. A contract manager (optionally supported by a project manager) could fill out the contract scan assessment framework based on tender documents. For the top most significant risks, the risk-specific questions can be answered. Next, the average per category is calculated. This could, for example, result in an evaluation as depicted in Table 17.A. These can be colourised (table 17.B) to simplify and clarify the result. Which colour to assign could depend on the benchmark values. If these have not yet been defined, colour changes could be set at 0.33 and 0.67 scores (Table 17.B). However, if a study shows higher or lower sensitivity to a certain category, these changes could be set at lower or higher scores, respectively (see Table 17.C). Red-indicated categories need to be discussed between client and contractor, as the risk allocation that influences them is perceived to be inequitable. For orange categories, the project team can devise a monitoring approach to prevent them from turning red due to project or context changes. In preparation for Requests for Modification, the contract scan assessment can be expanded by including the second half of the assessment framework and recalculating the averages. This can help substantiate why allocating the new risk to a specific party is equitable.

Table 17: Processing steps for equitability scores

16.A				16.B				16.C			
	Distribution	Process	Interaction		Distr.	Process	Inter.		Distr.	Process	Inter.
Equitability	0.37	0.74	0.03	Equit.	0.37	0.74	0.03	Equit.	0.37	0.74	0.03
Compensation	0.85	0.29	1.00		0.33/0.67	0.33/0.67	0.33/0.67		0.40/0.75	0.20/0.60	0.33/0.67
Controllability	0.72	0.44	0.72	Comp.	0.85	0.29	1.00	Comp.	0.85	0.29	1.00
					0.33/0.67	0.33/0.67	0.33/0.67		0.15/0.50	0.25/0.60	0.33/0.67
				Contr.	0.72	0.44	0.72	Contr.	0.72	0.44	0.72
					0.33/0.67	0.33/0.67	0.33/0.67		0.33/0.67	0.33/0.67	0.40/0.75

5.4 Conclusion

The last two research sub-questions can be answered with the knowledge from this and the previous chapter. First is how risk allocation can be conceptualised and operationalised for equitability assessment. Due to the subjectivity of the matter that became apparent in chapter 4, it is hard to conceptualise risk allocation in a way that respects all different perspectives on equitability from both the client’s and contractor’s side. In the current practice, a better approximation of a mutually acceptable, ‘objective’ equitability definition than UAC-IC is unlikely to be found. However, as the contractual analysis (4.5) and case studies have revealed, it does not cover all factors contributing to one’s equitability perception. Based on the interviews (4.2 and 4.3), it can be concluded that equitability is more about whether certain perception-influencing aspects are present in risk allocation. Therefore, the most logical way to assess equitability would be to measure the extent of the presence of these aspects. An overview of these is given in the table in section 4.8. As the qualitative validation of the prototype framework showed, such an assessment does not provide clear, valuable insights

for practitioners. Optimally, the assessment should result in a concise, comprehensible visual that provides an absolute score of the project's equitability. A heatmap, as drawn up in this chapter, is one of the possible options for this. However, this does require a benchmark value for comparison, which has to be based on the scores of a set of equitable projects from the past. Still, the practitioners' desire for an absolute score is dubious. Multiple times, findings have indicated that it is aimless to try to capture equitability in a single score, as this does not do justice to the multi-faceted, subjective nature of equitability.

Validation with experts has also provided an answer to the fourth research sub-question: How does the application of an equitability assessment framework improve the risk allocation process? Only when the input and the outcome of the framework are balanced, it stands any chance of being used in practice. As this research has indicated several times, the assessment of equitability is, for a large part, subjective. Application of the framework could, therefore, substantiate and clarify one's perception, but the outcome is unlikely to be powerful enough to alter one's feelings. It would only serve as a confirmation of what one is already feeling and expecting. This makes the value of the output relatively low, while the input effort would be relatively high. This decreases the probability of application significantly. It would be different for the case where both client and contractor fill out the form to compare their results and define discussion points, but according to the contractor, the incentive to do so is small for the client. However, the low level of probability that the framework will be applied does not mean that it has no value in the risk allocation process's equitability. Both the client and contractor have shown interest in the topic and emphasised its relevance. If both the client and contractor acknowledge that the framework holds some truth about the factors that affect equitability perception, it will provide a basis for a frank conversation about project equitability. As clear communication is related to a significant part of the factors that influence perceived equitability, this conversation in itself would already increase project equitability. Therefore, the added value of this risk allocation equitability assessment framework lies in:

- showing what relevant factors can be considered in equitability discussions,
- identifying in what fields most inequity is experienced,
- providing a communicational guide for clients and contractors.

6 Discussion

To define this research's position in its academic field, findings are compared and interpreted with other literature. The findings have been grouped based on their relevance to equitability perception.

6.1 General Remarks

The combined findings from theoretical and practical research, as described in section 4.8, and the evaluation of the framework, as described in section 5.4, provide some new insights into allocation equitability perception. Although some parts of Lee's (1978) and Levinson's (2002) equitability concept structure, such as the normative aspect and process equity (see section 1.2.1), can be recognised from interviews, many of its contents are not considered as such in the construction practice. Similarly, Fleurbaey's (2023) approach to equitability is too theoretical for application in the construction practice. Equitability considerations in this industry much more align with Adam's (1963) description as the (non-)alignment of the perceived worth of an input by one and the reward by another. However, the translation of this description into distributive justice is not. The best alignment of research outcomes with existing equitability concepts is with the legal approach as described by Wolters (2013), amongst others. Although of the factors distinguished by Wolters, the power balance plays a less significant role in practice, factors such as 'behaviour & events', 'party characteristics', and 'interests' do come up in one way or another.

Research outcomes show that UAC-IC2005 plays an important role as a solid basis for equitability, acknowledged by both client and contractor. This is supported by the fact that the analysed contractual allocations are generally found to be relatively similar to the UAC-IC2005. Furthermore, that reduced allocation clarity compared to UAC-IC2005, allocation deviation from UAC-IC2005, and non-alignment between contractual allocation and form of collaboration can act as an approximate indicator for perceived equitability. However, both the client and contractor also state that UAC-IC2005's current form is not perfect. And although the significance Jansen (2021a) ascribes to information risks (see section 1.2.2) has not been clearly observed, it does relate to the primary objections of insufficient coverage of information correctness/completeness and cable/conduit risks indicated by interviewees. Objections that have been resolved in the recently updated UAC-IC2025. Jansen's comment that the Dutch contractual liability for one's own decisions hampers collaborative risk management (section 1.2.3) can also be seen in practice, where interviews have indicated an 'every man for his own' mentality.

6.2 Insignificant Factors to Equitability Perception

As risk allocation distribution appeared not to be of great significance due to its dictated character in construction practice, allocation methods as described by Corea Galdeano (2022), Peckiene et al. (2013), Li et al. (2016), Xu et al. (2010), or Jin & Zhang (2011) are hardly recognised in practice. And because legal responsibilities, as described in section 3.2.3 by Jansen (2021b), amongst others, are already incorporated in the dictated standardised contracts, they are also not considered anymore in risk allocation processes. The dictated allocation also aligns with Blake Dawson's (2011) and Perez et al.'s (2017) findings. However, their finding that this characteristic is significantly less recognised by clients than contractors has not been reproduced as clearly in this research, but patterns are similar. Another distribution-related factor suggested by the literature was the comparison of responsibility-compensation ratios between actors and projects. Although time constraints limited the explicit evaluation of Colquitt & Zipay's (2015) distinction of three fairness perceptions (deliberate cognitive, heuristic cognitive, and automatic emotion) related to these comparisons, interviews have shown that the comparisons are not really conducted in practice due to information unavailability.

The finding that the organisational relationship and personal relationship are not distinguished in a relevant way for perceived equitability does not align with Hornibrook et al.'s (2009) and Bouazzaoui et al.'s (2020) conclusions. With large construction organisations, it is not very likely that the same individuals work together on a new project. Therefore, this difference is not that explicitly applied and experienced. Neither is the

importance of the power balance on equitability perception. Although some factors of the power balance from Zhu & Cheung (2022) and Ward et al. (1991), like strategic use of information asymmetry, are clearly recognised, some interviewees stated that the balance is accepted as it is. Furthermore, that both sides use their power advantage such that their misuses cancel each other out. The relation between contract and accountability for public clients, as found by Chen & Hubbard (2012), does not seem to magnify the shift of power balance between project phases explicitly. However, it was found to increase the client's leniency and drive to control significantly. Further findings from the interviews have also failed to confirm the positive equitability contribution of risk allocation principles like first or most to benefit/suffer from the risk (Abrahamson, 1984; Bunni, 2009; Lam et al., 2007), most economical risk transfer (Abrahamson, 1984), efficient risk dealing with least long-term consequences (Abrahamson, 1984), risk-bearing-premium acceptability (Lam et al., 2007), and lowest price (Xu et al., 2010).

6.3 Important Factors to Equitability Perception

Several factors found to be relevant are classified similarly in the literature. The relevance of the prevention of opportunistic behaviour confirms Chen & Hubbard's (2012) and Zhu & Cheung's (2022) conclusions that opportunistic behaviour and non-cooperation are consequences of inequity. Regarding the relevance of realistic pricing, recognised by both client and contractor, both sides state that risk allocation to the contractor is not always accompanied by sufficient time, information, or recognition to control. This signals the client's careless behaviour and inconsiderate flexibility, as warned by Ward et al. (1991). This also relates to the requirement for transparent safeguarding of interests: the client does acknowledge that contractors might not be honest about the risk component in their bid price, but procedures are not often adjusted to explicitly assess Ward et al.'s (1991) conditions for risk acceptance. The importance of interactional factors, such as communication, alignment, clarity, transparency, interests, attitude, and behaviour, confirms the findings of Friday et al. (2018) and Doloi (2009). They similarly emphasise information sharing, decision synchronisation, incentive alignment, and communication.

The different expectations between parties and their effect on justice perception, as indicated by Nyaga et al. (2010), can be clearly recognised in the interests of the client and contractor found in this study. However, these parties don't seem as convinced as Nyaga et al. about the necessity of a shared perception of justice: it would be helpful, but it is not a requirement. For Liu et al.'s (2017) statement on past experiences affecting current willingness to collaborate, there seems to be more agreement, as is the case with Poppo et al.'s (2016) relation between experiences and trust.

Agreement is also found on the importance of allocation principles, especially the ability to control. In line with Chen et al. (2023), Ke et al. (2010), and Zhang et al. (2016), practitioners have emphasised this to be an important factor for allocation. And as stated in section 4.7, intrinsic motivation aligns with Abrahamson's (1984) 'preponderant economic benefit' and Xu et al.'s (2010) 'willingness to take risk'. As the principle of foreseeing risks is related to having knowledge or expertise, it is also related to the moral blameworthiness conditions by Van de Poel et al. (2012) and Van de Poel & Fahlquist (2013). Of these conditions, only causality is explicitly considered in the allocation process, but knowledge and expertise are acknowledged as important, although less explicitly by the client. Generally, the moral side of allocation is not considered. The Problem of Many Hands (PMH) (see section 3.2.2) does seem to be considered by some individual interviewees when it comes to preconditional responsibilities: efforts required from one party that enable the other to control its allocated risks. This also includes a client's (unsubstantiated) negation of contractor-observed risks. Although the impossibility of retribution, lack of motivation for forward-looking responsibility, and prevention to learn are all mentioned as observed problems in risk allocation and management, only the relation between the first one and the PMH is explicitly established. Of the three solutions for the PMH by Van de Poel & Fahlquist (2013), only the responsibility-as-virtue has been suggested by practitioners.

Lastly, the equitability-compensation-controllability balance applied to the framework is in line with Colquitt's (2001) and Cohen-Charash & Spector's (2001) contribution to distributive justice (see section 3.1.1).

7 Limitations & Recommendations

Although this study provides extensive insights into risk allocation and equitability in the construction context, some parts of the research have faced issues or contain unexplored elements. This chapter has grouped these limitations and recommendations into three categories: research method, participants, and framework.

Starting with the research method, this study has focused on the qualitative aspects of the topic. The sample sizes have been small, with only 15 interviewees, 5 case projects, 1 contractor, and 1 client. Furthermore, the scope was limited to recent Dutch rail infrastructure projects.

- Limitations

- Small sample sizes diminish the reliability of the more quantitative findings of this research, such as the influence of factors on perceived equitability or the contractual analysis.
- Generalisability of findings due to small sample sizes.
- Small sample sizes have led to overlap in research parameters, such as project size, level of project complexity, and delivery method. Therefore, the individual effects of these parameters on project equitability perception are hard to distinguish reliably.

- Recommendations

- Substantiating the more qualitative findings of this research with larger sample sizes.
- Further quantifying the research by considering the probability and size of consequences of risks assessed in the contractual analysis to deepen the understanding of the relationship between contractual allocation and perceived equitability.
- Investigating other delivery methods, such as the traditional, Bouwteam/ECI or others, besides the D&C and Alliance methods covered in this study.
- Using a different scope by assessing other industries, project types, or countries.

To gather the data required for this research, 15 interviewees have been selected. Their characteristics significantly influence the research outcomes.

- Limitations

- The trades of the interviewees were limited to process, project, contract, risk, tender, and construction managers.
- The selection of trades participating in this study has also resulted in a limited level of knowledge on the considerations of risk allocation to insurers. An in-depth assessment of Bunni's (2003) insurance equitability criteria was, therefore, not possible.
- Interviewees have been exclusively male.

- Recommendations

- Assessment of other contractors, clients (especially private ones), or consultants to investigate their perspectives and influence on equitability perception might identify other factors contributing to equitability perception.
- Remarks made about insurance in this study did not show any consideration of Bunni's (2003) criteria, as it is probably thought that it is up to the insurer to consider them and consequently provide insurance or not. A study based on the insurer's perspective would better answer questions about these criteria.
- Interviewees have indicated that, for example, technical and design managers might experience different risks or deal with them differently. Investigating these or other trades could help substantiate whether trade does indeed not affect project equitability perception.
- Although the percentage of women working in the Dutch construction industry is small, they might have a different perception of equitability.

To validate the prototype framework, it was decided to select primarily participants who had not been interviewees. Although this enabled triangulation validation, it has proven difficult to profit from it as some participants lacked prior knowledge. It was difficult to balance appealing preparatory study material and sufficient knowledge to provide participants with sufficient understanding in little time. There was also little

time available for the validation session. As a result, definitions and/or explanations of concepts for this session were not always sufficiently provided. (Something that has also, to some extent, been the case for earlier research phases where this enabled varying interpretations through ambiguity.) This caused some misunderstanding of intentions, requiring explanations at the expense of the limited available time and depth and thoroughness of the discussion.

- Limitations

- Validation of the prototype framework had to be done in little time, requiring a trade-off between efficiency and thoroughness. As a result, the session did provide insight into improvements but less so into validation and evaluation.
- Both the prototype and the redeveloped version of the framework have not been validated through application and subsequent quantitative comparative analysis of how different practitioners assess different projects.
- The redeveloped framework has not been validated.

- Recommendations

- Although it was decided to validate the prototype framework with exclusively the contractor based on section 4.6, the contents of this framework are also based on data provided by the client. Validation of the framework with the client would, therefore, be valuable.
- A last research recommendation would be to apply the resulting framework and heatmap to real-world projects to define benchmark values and determine whether these are organisation-specific or whether they approximate some level of objectivity.

8 Conclusion

This study's main research question has been: *"How can equitability in the risk allocation process of construction projects be defined, applied, evaluated, and improved?"* To come to an answer the following four sub-questions have been answered in previous chapters:

- *What factors in construction projects influence equitability? (section 3.6)*
- *How is equitability considered in the construction risk allocation process, and how does this relate to the allocation principles? (section 4.8)*
- *How can risk allocation be conceptualised and operationalised for equitability assessment? (section 5.4)*
- *How does the application of an equitability assessment framework improve the risk allocation process? (section 5.4)*

First, the answers to these four sub-questions will be summarised. Then, the main research question will be answered by taking a look at each of its four components: defining, applying, evaluating, and improving.

8.1 Summarised Answers to the Research Sub-Questions

1. *What factors in construction projects influence equitability?*

According to the literature, there are five categories of factors to consider when assessing equitability:

1. Context: Projects are influenced by legal, economic, and social contexts. These contexts affect risk and responsibility allocation, as well as perceptions of equitability.
2. Relationship Type: The nature of relationships, whether transactional or collaborative, impacts power dynamics and the proactivity in risk management shown by both sides. These should be balanced.
3. Equitability Rules: Five types of rules are used to evaluate aspects of equitability. These are:
 - Distributive: how are risk responsibility and compensation balanced for each party?
 - Procedural: how has the risk distribution been defined?
 - Interpersonal: how were people treated during the allocation process?
 - Informational: how was information about the allocation shared?
 - Risk allocation-specific: some risk-related aspects

In practice, these are often interconnected and influencing one another.

4. Evolution of Experience: Past experiences and collaborations shape current perceptions of equitability. Continuous alignment and reassessment of expectations and trust are important.
5. Assessment: Good assessment practices considering scope and formulations are essential for correctly documenting perceived equitability.

Overall, these categories are interrelated and need to be managed collectively to ensure equitable outcomes in construction projects.

2. *How is equitability considered in the construction risk allocation process, and how does this relate to the allocation principles?*

Comparing the factors identified by literature to practice shows the subjectivity of the topic. However, some general trends can be identified. These can be structured in a ten-step process, in which the 'Summary of Additional Information and Changes' and discussions about 'Requests for Modification' are most relevant for equitability assessment. The use of dictated risk allocations, as defined in, for example, the UAC-IC2005, diminishes the relevance of the distributive equitability rules and the legal context. Instead, emphasis is placed on interactional factors like communication, alignment, clarity, transparency and interests, where, for example, the capping of exposure is important for the contractor. Most non-distributive equitability rules, risk management proactivity, experiences, and sharing of expectations are also recognised to be important, but most of the other factors from the literature are not. Instead, attitude and behaviour on the interactional side of risk allocation are especially emphasised. Furthermore, contractual analysis shows that there are three indicators for equitability perception:

- reduced allocation clarity compared to UAC-IC2005
- allocation deviation from UAC-IC2005
- non-alignment between contractual allocation and form of collaboration

However, these do not cover all factors that contribute to one's equitability perception. Comparing findings to the allocation principles shows that the ability to control and bear the risk and the willingness and expertise related to it are recognised. (Personal) characteristics that are most influential in the perception of allocation equitability are the project delivery method and whether one is a client or contractor.

3. *How can risk allocation be conceptualised and operationalised for equitability assessment?*

Due to the subjectivity of the matter, it is hard to conceptualise and operationalise risk allocation equitability objectively in an undisputed way. The UAC-IC seems to be the most practical approximation, but the interviews show it does not cover all relevant factors for equitability. Therefore, the multi-faceted, objective nature of equitability can best be assessed in a list of questions. However, practical application requires a more concise, comprehensible visual result. This has resulted in a translation of the list into a grid-like heatmap.

4. *How does the application of an equitability assessment framework improve the risk allocation process?*

As the answer to the previous sub-questions shows, it is difficult to apply the framework objectively, absolutely, and undisputedly. Therefore, the outcome is most likely a confirmation and explanation of what is already felt. Consequently, the input requirement is likely too large compared to the value of the output to justify practical application. However, the framework does provide added value when it is used as a method to discuss the equitability topic between parties. It is a starting point that helps to guide conversations, secure attention, and give a deeper understanding of risk allocation equitability.

8.2 Answering the Research Question

With these four sub-questions answered, the four-part main research question can be answered. First, the definition of equitability in construction risk allocation. All parts of the research show that the perception of equitability is subjective, and every perceiver has its own topics to assess while evaluating equitability. Most don't even do this explicitly. Both client and contractor use the UAC-IC2005 model agreement as a benchmark for equitability without necessarily questioning its equitability. As it has been tirelessly drawn up by interest groups from both sides, it is deemed and accepted to be the most equitable risk allocation achievable. Consequently, when practitioners are asked about allocation equitability, the distribution is just accepted as it is, and the perception is much more focused on attitude and behaviour in procedures and interactions. Due to the subjectivity of the matter, indicators and emphasis for equitability vary between individuals. This makes it hard to come up with a single definition accepted and supported by all. The UAC-IC2005 functions as the de facto proxy for the 'objective' equitability definition, but this study shows that it does not cover all factors contributing to one's equitability perception. Therefore, equitability assessment can be better defined by a list of factors to evaluate that generally aligns with those of most individuals. Partially, these are recognised from literature (e.g. several procedural, interpersonal, and informational factors), some are emphasised by practitioners (e.g. safeguarding interests without damaging the collaboration through complexity), and others are based on contractual analysis (e.g. risk allocation similarity compared to UAC-IC2005). An overview of these factors can be found in Table 18, copied from section 4.8.

For the topic of its application, several moments in the entire allocation process can be selected. Often, these processes are one-sided. Moments when allocation equitability is primarily discussed between client and contractor are during the 'Summary of Additional Information and Changes' (Dutch: NvI) or during the 'Requests for Modification' (Dutch: VTW). Therefore, preparations for these moments are the most useful to assess allocation equitability. This would be during the contract scan and keeping a log while construction proceeds. However, the subjectivity of the matter poses a threat to its validity, providing an easy way out for one party by discarding the other's objections as 'just a subjective opinion'. Therefore, the application of equitability assessment should distinguish between perceptions that can be substantiated by documentation and communication and those which are primarily feeling-based. These are important as well but might better function as definition and clarification for oneself.

The multi-faceted approach to equitability makes its evaluation multi-faceted as well. Therefore, the most clear and easy would be to use a list of the factors that influence allocation equitability as questions to be answered by rating on a scale. Such a list would only be acceptable for practitioners if the outcome is compactly comprehensible and ideally absolute. Therefore, a method is defined to process answers into a nine-part heatmap grid, defining points of attention to be discussed between client and contractor. Although it would be best if both client and contractor put effort into assessing allocation equitability, the contractor states that the client might be significantly less incentivised to do so during the selected two evaluation moments. A comparison of heatmap-outcomes between organisations would be nice, but it is more likely that this assessment framework is used by only the contractor. For best use, the contractor wants an absolute measure of allocation equitability. An equitability benchmark could be defined for each factor based on a set of projects to enable this. However, this is likely to be subjective as well. A single equitability score does not do justice to the multi-faceted, subjective nature of equitability, as this study has found.

Improving the risk allocation equitability project in construction can be done in many ways. Practitioners indicate that the topic is currently not explicitly addressed. This makes its integration into other processes often an afterthought and its application a personal matter. Therefore, even starting a discussion inspired by this research would already improve the current state. This would be helped by closer personal interaction between clients and contractors from the start to increase mutual understanding and alignment of perspectives. Explicit consideration of risk allocation equitability would also enable learning, development, and standardisation of decisions, which are currently non-existent. To contribute to this effort, application of the framework developed during this research can help to

- show what relevant factors can be considered in equitability discussions,
- identify in what fields most inequity is experienced,
- provide a communicational guide for clients and contractors.

The improved version of the UAC-IC, clarifying risk allocation for incomplete/incorrect information and subsurface cables/conduits, is also expected to help. Its implementation in the coming months and years has to prove itself. The contractor would also like the client to reconsider some of its additional stipulations to the UAC-IC2005.

Table 18: Overview of factors influencing equitability perception according to practice

Target	Outcomes	Decision-makers		Risk allocation	Other factors
	Procedural	Interpersonal	Informational		
Aspects	Opportunity for voice	Respectful enactment of procedures with sincerity and politeness	Candid, truthful and strategy-free collaboration and communication	Causation (only for simple projects)	Client's consideration of economic context (lowest price vs. risk identification completeness)
	Consistency across persons and time	Propriety and Bias Suppression	Thorough explanations of procedures	Organisational capacity and decisiveness for effective control	Contractor's consideration of economic context (limiting risk cost component in bid price)
	Limited masking of strategic behaviour	Minimal exploitation of exclusive contractual powers	Timely and specific answers/ communication	Knowledge, expertise and independence to make content-related decisions	Sufficient risk research and control budget
	Organisational/ personal alignment and inexperience with procedures	Not aggressively holding off risk responsibility; Balanced leniency; limited opportunistic behaviour	Unambiguous and definitive answers	Alignment between allocation approach and delivery method	Acceptable project time pressure
	Timely engagement of relevant parties		Reliability of risk research	Ability to control	Realistic compensation that considers changes
	Organisational alignment on expectations, interests, intentions, and motives.		Documentation over trust in daily agreements	Authority to decide	Continuous organisational alignment on intentions
	Working together in close proximity		Transparency of return on risk control costs	Intrinsic motivation to control	Mutual proactivity in risk control
	Candid sharing of relevant negative experiences			Access to information required for control	Acceptable level of secondary interests, preventing needless complication of collaboration
				For alliance: maximisation of alliance domain	Respecting and mutually securing interests

9 References

- Abrahamson, M. (1984). Risk management. *International Construction Law Review* 1(3), 241–264.
- Adams, J. S. (1963). Towards an understanding of inequity. *Journal of Abnormal and Social Psychology*, 67(5), 422-436. <https://psycnet.apa.org/doi/10.1037/h0040968>
- Adams, J. S. (1965). Inequity in social exchange. *Advances in Experimental Social Psychology*, 2, 267-299. [https://doi.org/10.1016/S0065-2601\(08\)60108-2](https://doi.org/10.1016/S0065-2601(08)60108-2)
- Aspers, P., & Corte, U. (2019). What is Qualitative in Qualitative Research. *Qualitative Sociology*, 42(2), 139–160. <https://doi.org/10.1007/s11133-019-9413-7>
- Baker, E., Hill, R., & Hakim, I. (2020). *Allocation of risk in construction contracts*. White & Case. <https://www.whitecase.com/sites/default/files/2020-01/allocation-risk-construction-contracts-2020.pdf>
- Bammer G., Smithson, M. and the Goolabri Group. (2008). The nature of uncertainty. In G. Bammer & M. Smithson (Eds.), *Uncertainty and risk: Multidisciplinary perspectives*. (pp. 289-303). Taylor & Francis Group. <https://ebookcentral-proquest-com.tudelft.idm.oclc.org/lib/delft/reader.action?docID=430048>
- Blake Dawson. (2011). *Scope for improvement 2011: project risk – getting the right balance and outcomes*. https://www.disputeboard.org/wp-content/uploads/2016/02/Scope_for_Improvement_2011.pdf
- Boes, H. & Dorée, A. (2008). Public Procurement of local authorities in The Netherlands: A case of breaking tradition for a more strategic approach?!. In A. Dainty (Ed.), *24th Annual ARCOM Conference*. (pp. 477-486). Association of Researchers in Construction Management.
- Bos, E. K. (2019, September 11). Start of the construction of the new Ede Station in 2021 at the earliest (Bouwstart nieuw station Ede op z'n vroegst in 2021). <https://www.edestad.nl/lokaal/verkeer-en-vervoer/271443/bureau-spotlight-bouwstart-nieuw-station-edo-op-zn-vroegst-2021-637478>
- Bouazzaoui, M., Wu, H., Roehrich, J. K., Squire, B., & Roath, A. S. (2020). Justice in inter-organizational relationships: A literature review and future research agenda. *Industrial Marketing Management*, 87, 128-137. <https://doi.org/10.1016/j.indmarman.2020.02.003>
- Bunni, N. G. (2003). *Risk and insurance in construction* (2nd ed.). Spon Press.
- Bunni, N. G. (2009). The four criteria of risk allocation in construction contracts. *International Construction Law Review*, 26, 4.
- Cartwright, J. (2016). Redelijkheid en billijkheid: a view from English law. *BW-krant Jaarboek*, 30(1), 39-60.
- Chao, A., Cheung, L., De Koning, J., De Koe, D., Lauret, N., Merema, J., Van Rooden, F., & Wouda, M. (2021, November 5). NEC4 as inspiration for new construction contracts (NEC4 als inspiratie voor nieuwe bouwcontracten). <https://www-cobouw-nl.tudelft.idm.oclc.org/300073/nec4-als-inspiratie-voor-nieuwe-bouwcontracten>
- Chao-Duvis, M. A. B. (2019). *The case of the melting dinosaur (De zaak van de smeltende dinosaur)*. Delft University of Technology. <http://resolver.tudelft.nl/uuid:ee737886-70d4-4fc2-bf27-42c5f2718d66>
- Chen, C. & Hubbard, M. (2012). Power relations and risk allocation in the governance of public private partnerships: A case study from China. *Policy and Society*, 31(1), 39-49. <https://doi.org/10.1016/j.polsoc.2012.01.003>
- Chen, C., Lv, L., Wang, Z., & Qiao, R. (2023). Bargaining optimization model for risk renegotiation with fairness concerns in infrastructure PPP projects. *Engineering, Construction and Architectural Management*, 30(9), 3876-3894. <https://doi.org/10.1108/ECAM-11-2021-1006>
- Cohen-Charash, Y. & Spector, P. E. (2001). The Role of Justice in Organizations: A Meta-Analysis. *Organizational Behavior and Human Decision Processes*, 86(2), 278-321. <https://doi.org/10.1006/obhd.2001.2958>
- Colquitt, J. A. (2001). On the Dimensionality of Organizational Justice: A Construct Validation of a Measure. *Journal of Applied Psychology*, 86(3), 386-400. <https://doi.org/10.1037/0021-9010.86.3.386>
- Colquitt, J. A. & Rodell, J. B. (2015). Measuring Justice and Fairness. In R. S. Cropanzano & M. L. Ambrose (Ed.), *The Oxford Handbook of Justice in the Workplace*. (pp. 187-202). Oxford University Press
- Colquitt, J. A., & Zipay, K. P. (2015). Justice, Fairness, and Employee Reactions. *Annual Review of Organizational Psychology and Organizational Behavior*, 2(1), 75-99. <https://doi.org/10.1146/annurev-orgpsych-032414-111457>
- Correa Galdeano, F. E. (2022). *Risk for the bouwteam - developing an empirical case-based model for risks, their allocation and control strategies when bouwteams are used as project delivery method*. [Master's thesis, Delft University of Technology]. <http://resolver.tudelft.nl/uuid:10ded59c-fe0f-4dcc-8f8a-41db573d366b>
- CROW. (2024, September 26). Announcement new version UAC-IC: the standard for integrated collaboration in the civil engineering industry (Aankondiging nieuwe versie UAV-GC: de standaard voor geïntegreerde samenwerking in de GWW-sector). <https://www-crow-nl.tudelft.idm.oclc.org/actueel/aankondiging-nieuwe-versie-uav-gc-de-standaard-voor-geintegreerde-samenwerking-in-de-gww-sector/>
- De Koning, J. (2022, April 28). Brick or paper? (Baksteen of papier?) <https://www-cobouw-nl.tudelft.idm.oclc.org/304827/baksteen-of-papier>

- De Leeuwe, T. (2024, March 12). Design & Build-contracten: hoe verder? <https://www-cobouw-nl.tudelft.idm.oclc.org/319379/design-build-contracten-hoe-verder>
- Doloi, H. (2009). Relational partnerships: the importance of communication, trust and confidence and joint risk management in achieving project success. *Construction Management and Economics*, 27(11), 1099-1109. <https://doi.org/10.1080/01446190903286564>
- Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review*, 14(4), 532-550. <https://doi.org/10.5465/amr.1989.4308385>
- Friday, D., Ryan, S., Sridharan, R., & Collins, D. (2018). Collaborative risk management: a systematic literature review. *International Journal of Physical Distribution & Logistics Management*, 48(3), 231-253. <https://doi.org/10.1108/IJPDLM-01-2017-0035>
- Fleurbaey, M. (2023). Normative Economics and Economic Justice. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Fall 2023 Edition). Stanford University
- Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12(2), 219-245. <https://doi.org/10.1177/1077800405284363>
- Hammer, D., & Wildavsky, A. (2018). *The Open-Ended, Semistructured Interview: An (Almost) Operational Guide*. <https://doi.org/10.4324/9780203794517-5>
- Hausknecht, J. P., Sturman, M. C., & Roberson, Q. M. (2011). Justice as a Dynamic Construct: Effects of Individual Trajectories on Distal Work Outcomes. *Journal of Applied Psychology*, 96(4), 872-880. <https://psycnet.apa.org/doi/10.1037/a0022991>
- Hermans, M. (2021, May 2). Time for different public client decisions (Tijd voor andere keuzes bij publieke opdrachtgevers). <https://www-cobouw-nl.tudelft.idm.oclc.org/295231/tijd-voor-andere-keuzes-bij-publieke-opdrachtgevers>
- Hilverda, O. (2023, September 26). The Dutch construction industry in precarious times, 2019-2023 (De Nederlandse bouwnijverheid in onzekere tijden, 2019-2023). <https://www.cbs.nl/nl-nl/longread/de-nederlandse-economie/2023/de-nederlandse-bouwnijverheid-in-onzekere-tijden-2019-2023?onepage=true>
- HM Government. (2022). *The Construction Playbook* (V1.1). OGL. https://assets.publishing.service.gov.uk/media/6312222de90e075880923330/14.116_CO_Construction_Playbook_Web.pdf
- HM Treasury & Infrastructure UK. (2013). *Infrastructure procurement routemap: a guide to improving delivery capability*. https://assets.publishing.service.gov.uk/media/5a7ddd6d40f0b65d8b4e3f97/iuk_procurement_routemap_guide_to_improving_delivery_capability_280113.pdf
- Hornibrook, S., Fearne, A., Lazzarin, M. (2009). Exploring the association between fairness and organisational outcomes in supply chain relationships. *International Journal of Retail & Distribution Management*, 37(9), 790-803. <https://doi.org/10.1108/09590550910975826>
- House of Representatives. (2023). *Annual report and closing law on the Mobility Fund 2022 (Jaarverslag en slotwet Mobiliteitsfonds 2022)* (2022/23, 36 360 A, nr. 1).
- Hubbell, A. P. & Chory-Assad, R. M. (2005). Motivating factors: perceptions of justice and their relationship with managerial and organizational trust. *Communication Studies*, 56(1), 47-70. <https://doi.org/10.1080/0008957042000332241>
- Huitema, S., Wolfert, R., Van Spengen, J., & Amperse, D. (2018). *Gate Reviews: Uniform Project Approach (Gate Reviews: Uniforme Projectaanpak)* (strip version 1.0). [Unpublished]. VolkerWessels.
- Infrastructure Australia. (2022). *Delivering outcomes – a roadmap to improve infrastructure industry productivity and innovation*. https://www.infrastructureaustralia.gov.au/sites/default/files/2022-03/IA%20Delivering%20Outcomes%20March%202022%20Final_1.pdf
- Inspection Social Affairs and Employment. (2017). Constructing safely and healthily together (Samen veilig en gezond bouwen) [Brochure]. https://www.nlarbeidsinspectie.nl/binaries/nlarbeidsinspectie/documenten/brochures/2017/05/17/samen-veilig-en-gezond-bouwen/Samen_veilig_en_gezond_bouwen.pdf
- Jansen, C. E. C. (2021a). On 'two-phase-proces', 'ECI with UAC-IC' and 'alliance': possible solutions to improve management of information risk in procuring and realising integrated projects (Over 'twee-fasen-proces', 'bouwteam met UAV-GC' en 'alliantie': mogelijke oplossingen voor een verbeterde beheersing van het informatierisico bij de aanbesteding en realisatie van geïntegreerde projecten). *Tijdschrift voor Bouwrecht*, 14(8), TBR 2021/94.
- Jansen, Y. (2021b, July 12). What are the rights, duties and liabilities of contractors and clients with the contracting of work? (Wat zijn de rechten, verplichtingen en aansprakelijkheden van aannemers en opdrachtgevers bij aanneming van werk?) <https://lvh-advocaten.nl/artikelen/wat-zijn-de-rechten-verplichtingen-en-aansprakelijkheden-van-aannemers-en-opdrachtgevers-bij-aanneming-van-werk/#:~:text=Op%20grond%20van%20de%20wettelijke,afkomstig%20zijn%20van%20de%20opdrachtgever>
- Jarkas, A. M. & Haupt, T. C. (2015). Major construction risk factors considered by general contractors in Qatar. *Journal of Engineering, Design and Technology*, 13(1), 165-194. <http://dx.doi.org/10.1108/JEDT-03-2014-0012>
- Jin, X. & Doloi, H. (2007). Interpreting risk allocation mechanism in public-private partnership projects: an empirical study in a transaction cost economics perspective. *Construction Management and Economics*, 26(7), 707-721. <https://doi.org/10.1080/01446190801998682>
- Jin, X. & Zhang, G. (2011). Modelling optimal risk allocation in PPP projects using artificial neural networks. *International Journal of Project Management*, 29(5), 591-603. <https://doi.org/10.1016/j.ijproman.2010.07.011>
- Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of advanced nursing*, 72(12), 2954-2965. <https://doi.org/10.1111/jan.13031>
- Ke, Y., Wang, S., Chan, A. P. C., & Lam, P. T. I. (2010). Preferred risk allocation in China's public-private partnership (PPP) projects. *International Journal of Project Management*, 28(5), 482-492. <https://doi.org/10.1016/j.ijproman.2009.08.007>

- Kerwin, A. (1993). None Too Solid: Medical Ignorance. *Knowledge*, 15(2), 166-185. <https://doi.org/10.1177/107554709301500204>
- Knott, E., Rao, A. H., Summers, K., & Teeger, C. (2022). Interviews in the social sciences. *Nature Reviews Methods Primers*, 2(1). <https://doi.org/10.1038/s43586-022-00150-6>
- Koppenjan, J. F. M., Klijn, E. H., Duijn, M., Klaassen, H. L., Meerkerk, I. F., Metselaar, S. A., Warsen, R. & Verweij, S. (2020). *Learning from 15 years of DBFM-projects at RWS (Leren van 15 jaar DBFM-projecten bij RWS)* (Final report). Rijkswaterstaat & Bouwend Nederland. <https://www.eur.nl/essb/media/2020-10-dbfmeindrapport15digitaal0>
- Krane, H. P., Rolstadås, A., & Olsson, N. O. E. (2009). *Categorizing risks in seven large projects - what risks do the projects focus on?* Project Management Institute.
- Krosnick, J. A. & Presser, S. (2010). Question and Questionnaire Design. In P. V. Marsden & J. D. Wright (Eds.), *Handbook of Survey Research* (2nd ed.) (pp. 263-314). Emerald.
- Lam, K. C., Wang, D., Lee, P. T. K., & Tsang, Y. T. (2007). Modelling risk allocation decision in construction contracts. *International Journal of Project Management*, 25, 485-493. <https://doi.org/10.1016/j.ijproman.2006.11.005>
- Latham, M. (1994). *Constructing the Team* (Final report). HMSO.
- Lee, D. B. (1978). Making the concept of equity operational. *Transportation Research Record*, 677, 48-53. National Research Council. <https://onlinepubs.trb.org/Onlinepubs/trr/1978/677/677-008.pdf>
- Levinson, D. (2002). Identifying winners and losers in transportation. *Transportation Research Record*, 1812, 179-185. <https://doi.org/10.3141/1812-22>
- Li, Y., Wang, X., & Wang, Y. (2016). Using Bargaining Game Theory for Risk Allocation of Public-Private Partnership Projects: Insights from Different Alternating Offer Sequences of Participants. *Journal of Construction Engineering and Management*, 143(3). [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001249](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001249)
- Lim, B. T. H. & Loosemore, M. (2017). The effect of inter-organizational justice perceptions on organizational citizenship behaviors in construction projects. *International Journal of Project Management*, 35(2), 95-106. <https://doi.org/10.1016/j.ijproman.2016.10.016>
- Liu, Y., Huang, Y., Luo, Y., & Zhao, Y. (2012). How does justice matter in achieving buyer-supplier relationship performance? *Journal of Operations Management*, 30(5), 355-367. <https://doi.org/10.1016/j.jom.2012.03.003>
- Liu, J., Yang, P., Xia, B., & Skitmore, M. (2017). Effect of Perceived Justice on Subcontractor Willingness to Cooperate: The Mediating Role of Relationship Value. *Journal of Construction Engineering and Management*, 143(9). [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001350](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001350)
- Loosemore, M. & McCarthy, C. S. (2008). Perceptions of contractual risk allocation in construction supply chains. *Journal of Professional Issues in Engineering Education and Practice*, 134(1), 95-105. [https://doi.org/10.1061/\(ASCE\)1052-3928\(2008\)134:1\(95\)](https://doi.org/10.1061/(ASCE)1052-3928(2008)134:1(95))
- Lu, W., Li, Z., & Wang, S. (2017). The role of justice for cooperation and contract's moderating effect in construction dispute negotiation. *Engineering, Construction and Architectural Management*, 24(1), 133-153. <https://doi.org/10.1108/ECAM-01-2015-0002>
- Mastop, R. (2010). Characterising Responsibility in Organisational Structures: The Problem of Many Hands. In G. Governatori & G. Sartor (Eds.). *Deontic Logic in Computer Science (DEON 2010)*. (pp. 274-287). Springer. https://doi.org/10.1007/978-3-642-14183-6_20
- Ministry of Infrastructure and Water Management. (2023). *National Circular Economy Programme 2023-2030*. <https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/beleidsnotas/2023/02/03/nationaal-programma-circulaire-economie-2023-2030/NPCE+Cirulaire+Economie+rapport+Engels.pdf>
- Municipality of Nunspeet. (2021). *L-1102 Overzichtsplan DO ontwerp*. Retrieved September 9, 2021, from https://www.nunspeet.nl/fileadmin/Nunspeet_documenten/Producten/Over_Nunspeet/Stationsomgeving/definitieve_ontwerp_v2021.pdf
- Nyaga, G. N., Whipple, J. N., & Lynch, D. F. (2010). Examining supply chain relationships: Do buyer and supplier perspectives on collaborative relationships differ? *Journal of Operations Management*, 28(2), 101-114. <https://doi.org/10.1016/j.jom.2009.07.005>
- Opdrachtgeversforum in de bouw & Bouwend Nederland. (2016). *Leading principles for improved collaboration between client and contractor in 2020 (Leidende principes voor een betere samenwerking tussen opdrachtgever en opdrachtnemer in 2020)*. Marktvisie. <https://www.opdrachtgeversforum.nl/wp-content/uploads/Leidende-Principes-OGF-BN.pdf>
- Patten, M. L. (2017). *Questionnaire Research: a practical guide* (4th ed.). Routledge.
- Peckiene, A., Komarovska, A., & Ustinovicus, L. (2013). Overview of risk allocation between construction parties. *Procedia Engineering*, 57, 889-894. <https://doi.org/10.1016/j.proeng.2013.04.113>
- Perez, D., Gray, J., & Skitmore, M. (2017). Perceptions of risk allocation methods and equitable risk distribution: a study of medium to large Southeast Queensland commercial construction projects. *International Journal of Construction Management*, 17(2), 132-141. <https://doi.org/10.1080/15623599.2016.1233087>
- Pinto, J. K., Slevin, D. P., & English, B. (2009). Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management*, 27(6), 638-648. <https://doi.org/10.1016/j.ijproman.2008.09.010>
- Poppo, L., Zhou, K. Z., & Li, J. J. (2016). When can you trust "trust"? Calculative trust, relational trust, and supplier performance. *Strategic Management Journal*, 37(4), 724-741. <https://doi.org/10.1002/smj.2374>
- Project Management Institute. (2016). *Construction Extension to the PMBOK® Guide*. (p. 189-194)

- ProRail. (2013). *The ProRail alliance (De ProRail-alliantie)* [Brochure]. <https://www.yumpu.com/nl/document/view/20129273/brochure-de-prorail-alliantie>
- Rasker, P. C., Bletsis, A. J., Brongers, B., Vervuurt, A. H. J. M., & Verweij, E. D. N. (2023). *Renewal task infrastructure (Vernieuwingsopgave infrastructuur)* National prognosis report 2023 (Landelijk prognoserapport 2023). TNO. <https://publications.tno.nl/publication/34641584/8AVcEq/rasker-2023-vernieuwingsopgave.pdf>
- Rijkswaterstaat. (2019). *Future challenge Rijkswaterstaat: perspective on challenges and opportunities for improvement in the infra sector (Toekomstige opgave Rijkswaterstaat: perspectief op de uitdagingen en verbetermogelijkheden in de GWW-sector)*. <https://open.overheid.nl/documenten/ronl-a930e821-77ec-43bf-a074-512610034bcd/pdf+C36>
- Rijkswaterstaat. (2021). *Towards a vibrant infrastructure industry (Op weg naar een vitale infrasector)*. <https://zoek.officielebekendmakingen.nl/blg-1037023.pdf>
- Rijkswaterstaat, Rijksvastgoedbedrijf, ProRail, Bouwend Nederland, NL Ingenieurs, Vereniging van Waterbouwers, MKB Infra, Uneto VNI, & Astrin. (2016). *The vision for the sector (De Marktvisie)*. Marktvisie. <https://www.marktvisie.nu/wp-content/uploads/2016/12/De-Marktvisie-1.pdf>
- Rubenstein, A. L., Allen, D. G., Bosco, F. A. (2019). What's Past (and Present) Is Prologue: Interactions Between Justice Levels and Trajectories Predicting Behavioral Reciprocity. *Journal of Management*, 45(4), 1569-1594. <https://doi.org/10.1177/0149206317728107>
- Sastoque, L. M., Arboleda, C. A., & Ponz, J. L. (2016). A Proposal for Risk Allocation in Social Infrastructure Projects Applying PPP in Colombia. *Procedia Engineering*, 145, 1354-1361. <https://doi.org/10.1016/j.proeng.2016.04.174>
- SEB. (2023). *Roadmap Clean and Zero-Emission construction (Routekaart Schoon en Emissieloos bouwen)*. <https://cdn.opwegnaarseb.nl/media/Routekaart%20SEB%20-%20definitief.pdf>
- Seawright, J., & Gerring, J. (2008). Case Selection Techniques in Case Study Research. *Political Research Quarterly*, 61(2), 294-308. <https://doi.org/10.1177/1065912907313077>
- Sireci, S. G. (1998). The construct of content validity. *Social Indicators Research*, 45, 83-117.
- Skarlicki, D. P. & Folger, R. (1997). Retaliation in the Workplace: The Roles of Distributive, Procedural, and Interactional Justice. *Journal of Applied Psychology*, 82(3), 434-443. <https://psycnet.apa.org/doi/10.1037/0021-9010.82.3.434>
- Snyder, H. (2019). Literature review as a research methodology: an overview and guidelines. *Journal of Business Research*, 104, 333-339. <https://doi.org/10.1016/j.jbusres.2019.07.039>
- Thomopoulos, N. & Grant-Muller, S. (2013). Incorporating equity as part of the wider impacts in transport infrastructure assessment: an application of the SUMINI approach. *Transportation*, 40, 315-345. <https://doi.org/10.1007/s11116-012-9418-5>
- Thompson, D. F. (2014). Responsibility for Failures of Government: The Problem of Many Hands. *The American Review of Public Administration*, 44(3), 259-273. <https://doi.org/10.1177/0275074014524013>
- Turner & Townsend. (2023). *International construction market survey 2023*. <https://publications.turnerandtowntsend.com/international-construction-market-survey-2023/>
- Van Belzen, T. (Host). (2024, February 6). Mislukte aanbesteding Van Brienenoordbrug staat niet op zich (No. 99) [Audio podcast episode]. Cobouw. <https://open.spotify.com/episode/6fPeDwspohr9lqifeAnSXc>
- Van de Poel, I. & Fahlquist, J. N. (2013). Risk and responsibility. In S. Roeser, R. Hillerbrand, P. Sandrin, & M. Peterson (Eds.). *Essentials of Risk Theory*. (pp. 107-143). Springer. https://doi.org/10.1007/978-94-007-5455-3_5
- Van de Poel, I. & Royakkers, L. (2011). The Distribution of Responsibility in Engineering. In *Ethics, Technology, and Engineering*. (pp. 249-272). Wiley-Blackwell.
- Van de Poel, I., Nihlén Fahlquist, J., Doorn, N. Zwart, S., & Royakkers, L. (2012) The Problem of Many Hands: Climate Change as an Example. *Science & Engineering Ethics* 18, 49-67. <https://doi.org/10.1007/s11948-011-9276-0>
- Van Hattum & Blankevoort. (2023). *Work Instruction Risk Management (Werkinstructie Risicomanagement)* (version 3.0). [Unpublished].
- Van Lochem, J. Ph. (2019). *Open norms in tenancy law (Open normen in het huurrecht)*. Kluwer.
- Van Staveren, M. (2023, November 16). Contractors and clients need each other for risk assessment (Bouwers en opdrachtgevers hebben elkaar hard nodig bij het inschatten van risico's). <https://www-cobouw-nl.tudelft.idm.oclc.org/317178/bouwers-en-opdrachtgevers-hebben-elkaar-hard-nodig-bij-het-inschatten-van-risicos>
- VolkerInfra. (2013). *Risk management: key success factors for tenders and projects (Risicomanagement: kritieke succesfactoren bij tenders en projecten)*. [Unpublished].
- Ward, S. C., Chapman, C. B., & Curtis, B. (1991). On the allocation of risk in construction projects. *International Journal of Project Management*, 9(3), 140-147. [https://doi.org/10.1016/0263-7863\(91\)90038-W](https://doi.org/10.1016/0263-7863(91)90038-W)
- Weaver, P. (2008). *The meaning of risk in an uncertain world*. Project Management Institute
- Wibowo, A. & Mohamed, S. (2010). Risk criticality and allocation in privatised water supply projects in Indonesia. *International Journal of Project Management*, 28(5), 504-513. <https://doi.org/10.1016/j.ijproman.2009.08.003>
- Wolters, P. T. J. (2013). *All the circumstances of the case. An examination of the circumstances affecting the operation of reasonableness and equitability (Alle omstandigheden van het geval. Een onderzoek naar de omstandigheden die de werking van de redelijkheid en billijkheid beïnvloeden)* [Doctoral dissertation]. Kluwer. <https://hdl.handle.net/2066/111126>

- Xu, Y., Chan, A. P. C., & Yeung, J. F. Y. (2010). Developing a fuzzy risk allocation model for PPP projects in China. *Journal of Construction Engineering and Management*, 136(8), 894-903. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000189](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000189)
- Zhang, Z. & Jia, M. (2010). Procedural fairness and cooperation in public-private partnerships in China. *Journal of Managerial Psychology*, 25(5), 513-538. <https://doi.org/10.1108/02683941011048409>
- Zhang, S., Zhang, S., Gao, Y., & Ding, X. (2016). Contractual Governance: Effects of Risk Allocation on Contractors' Cooperative Behavior in Construction Projects. *Journal of Construction Engineering and Management*, 142(6). [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001111](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001111)
- Zhu, L. & Cheung, S. O. (2022). Equity gap in construction contracting: identification and ramifications. *Engineering, Construction and Architectural Management*, 29(1), 262-286. <https://doi.org/10.1108/ECAM-09-2020-0725>
- Zwitser, R. (2020). Reasonableness and equitability, two routes in the viewfinder (Redelijkheid en billijkheid, twee wegen in de zoeker). In C. G. Breedveldde Voogd, A. G. Castermans, H. B. Krans, & A. E. C. Wissink (Eds.), *Sluiterijd: Reflecties op het werk van Jaap Hijma* (pp. 229-241). Kluwer.

Appendix A: Interview Design

All interviews, questionnaires, and communications were in Dutch. This appendix provides an English translation.

A.1 Shared Literature Summary as Interview Preparation

The academic literature identifies 4 factors that influence how equitability in risk allocation is perceived:

- The social, economic and legal context: what are the prevailing local cooperation norms and values? To what extent is there competition, and can the client/contractor easily partner with another party? Is one party already responsible by law for a particular risk or management activity?
- The type of cooperative relationship between client/contractor: is it just a transaction or are there joint development activities? Is one of the parties able to manipulate the other because of the existing power balance, and how is this dealt with? To what extent are both parties equally proactive in managing risks?
- Equitability rules: this is a variety of aspects that, according to the literature, determine how an observer evaluates the equitability of a given situation. This involves looking at the own risk cost-benefit balance compared to that of other participating or similar parties. It furthermore looks at the process used to allocate risks as well as how people were treated and informed throughout that process.
- The collection of different scenario valuations using the equitability rules: these together form the evaluator's experiences. These may be from previous projects (with the same or a different client/contractor than the current project) or from earlier moments in the current project. These experiences affect self-perception and expectations. This may also influence sensitivity or resilience towards unfair risk allocation. In addition, expectations of equitability may differ between parties.

When considering such factors, it is important to look at 1 single situation/moment/event at a time, as the equitability evaluation may differ from one situation to another. Furthermore, there may be differences between how one views the personal relationship between organisational representatives and how one views the relationship between organisations.

A.2 Interview Protocol

(Red indicates collected data, blue indicates tools to use, purple indicates optional elements)

[Short chatter & introduction and signing of Informed Consent Form]

The interview consists of 4 parts. After some questions about who you are, we will look at your opinion on the theoretical concepts you were sent in preparation for this interview. Next, the general application of risk allocation in projects is addressed, followed by a look at your personal handling of equitability in risk allocation in the [PROJECT NAME] project. At the end, there is a short wrap-up.

- 1) Introduction of the interviewee:
 - a) Could you introduce yourself: what is your name, age category and current position, and by what previous risk allocation or management-related positions did you get to your current position?
- 2) Validation of literature (Keeping the equitability rules and pre-shared literature summary available for viewing):
 - a) SQ1v - In the interview preparations, I've shared a short summary of the literature I've found, addressing the topics of context, type of relationship, experiences, and equitability rules. Have you been able to take a look at that? [If necessary, provide further explanation.] The equitability rules can be further categorised as follows: [Explain equitability rules table]. Do you recognise the elements and distinctions made by literature? Would you use the same elements when assessing equitability in your profession, would you add or omit some, and why?

- b) SQ1v - The preparation stated that it is important for the characterisation of the relationship to look at the extent to which all parties are **equally** (voluntarily) **proactive** regarding risk management. Do you endorse this importance from your experience?
- c) SQ1v - On the collaboration between VHB and ProRail: Can one speak of a **shared social basis** on what "equitability" means? How could this be defined and how does it differ from other principals?
- 3) General use and application of risk allocation:
 - a) SQ2 - What does the **risk allocation process** look like in practice? Which parties, positions, criteria, activities and documents are typically used for this?
 - b) SQ2/3 - Which **criteria** are used as input to decide on the risk distribution? (As an option to aid continuation: mention reasonableness & fairness or allocation principles like Bunni's.)
 - c) SQ3 - **How** and by **whom** is the risk allocation **used** during the project and risk management? (Optional after explanation of the intended final framework: Do you think this is **beneficial**?)
 - d) SQ2 - Are **expectations** about equitability in risk allocation discussed beforehand, or does the client usually set a risk allocation in alignment with its own expectations, leaving it to the contractor to try to negotiate its own expectations into consideration?
 - e) SQ3 - How are **risk insurances** usually dealt with and what happens with **residual risks**? To what degree is this applied in the [PROJECT NAME] project?
 - f) SQ2 - (When there is time): Does **project change** lead to a renegotiation of the risk allocation, is this desired? What role does the **Power Balance** play in this?
- 4) Personal approach:
 - a) SQ2 - What **role** did equitability play in the risk allocation process you participated in on the [PROJECT NAME] project? Was this based on **your experiences**, which?
 - b) SQ2 - (If not yet covered): How did the risk allocation **expectations** between the parties initially relate in the [PROJECT NAME] project? And what about the (voluntary) **proactivity** in risk management?
 - c) SQ2 - How did your **approach** for risk allocation, considering equitability, differ from that of your other projects?
 - d) SQ2 - How did your opinion on the equitability of the other party differ between your **personal relationship** with the representative(s) of ProRail/VHB compared to the **professional relationship** between ProRail and VHB as organisations?
- 5) Wrap-up:
 - a) If you could redesign the current way risks are allocated, aiming for equitability, what element would you **keep** because it works nicely, what element would you **omit** because it always causes problems, and what element would you **add** because it requires improvement?
 - b) These were my questions. Do you have questions, comments, or suggestions about this interview or the entire research?
 - c) [Thank you for participating, a short online questionnaire will follow soon.]

A.3 Questionnaire Questions

The questionnaire focused on evaluating the equitability rules in the case-study projects. Participants were first asked to take a single situation/event or project phase to evaluate in mind and briefly describe it. Every question had to be answered with either agree or disagree and facilitated optional elaboration when deemed necessary by the participant. The *cursive* questions had to be answered for both the personal and the professional relationship. The formulation of the questions follows a random positive/negative pattern as explained in 3.1.2). Finally, general comments and suggestions could be submitted.

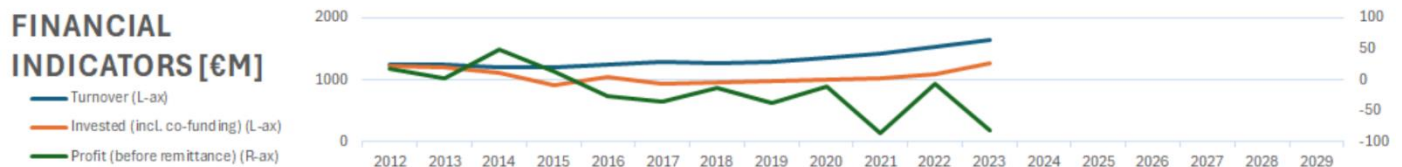
- The allocation balance clearly shows that it is based on equity, equitability and/or necessity.
- The ratio of assigned risks and the (financial) compensation in return for the efforts that arise from this responsibility was not comparable for the different parties. (In this, for example, different (sub)contractors in a project could be considered, the extent to which the client was willing to pay for transferring risks to the contractor or the extent to which the contractor demanded acceptable compensation for the risks borne).
- Besides the financial aspect, the resulting risk allocation had added value for my organisation (e.g. it provided a reason to initiate a certain organisational development or it provided useful experience with a particular risk).

- *In risk management, one party got off easier than the other.*
- Compared to other projects, the compensation for the risks borne is not equivalent.
- *In the risk allocation, the other party listened attentively to my opinions and arguments.*
- I or my organisation influenced the risk allocation.
- *I think the counterparty behaved significantly differently towards my organisation during the risk allocation process than it would probably behave towards my competitor.*
- *The counterparty behaved significantly differently during the risk allocation process for this project than in other projects in which we collaborated.*
- The risk allocation process was neutral and free of bias.
- Risk allocation was based on inaccurate and only partially available information.
- The risk allocation could not be appealed.
- The risk allocation procedure did not reflect the usual business practices of all parties involved.
- In the proceedings, ethical considerations played a role in assigning risk.
- The risk allocation contributed responsibly to achieving the project goals.
- In allocation negotiations, it was not allowed to act freely to avoid misallocation (e.g. the organisation prohibited its representative from raising the point that, from a management perspective, a risk might be better allocated to its own party for fear that the risk will indeed be allocated to its own organisation).
- *Parties were treated with respect, sincerity and courtesy.*
- Inappropriate comments were made during the negotiations.
- *The position my organisation had in the collaboration was reflected in the way my party was treated.*
- Disclosure of risk allocation procedures is distrustful and untrue.
- Information on risk allocation procedures is superficial.
- Communication on risk allocation is often late rather than early.
- Communication on risk allocation matches the requirements and wishes of me and my organisation.
- The starting point for risk allocation is which party causes the risk.
- Risks were not accepted by parties under financial pressure or out of ignorance.
- (To the best of my knowledge:) The insured risks were uncertain, quantifiable, testable and fitting to the insurer's portfolio.
- Throughout the project, efforts were made to align and level expectations regarding fairness in risk allocation between parties regularly.

Appendix B: Context Overview ProRail

Over the last years, ProRail has executed a large number of projects. An overview of some of these is published on ProRail's online project page (ProRail, n.d.a). However, when compared to their annual reports (ProRail, n.d.c), this appears to be only a limited part of the actually executed projects. Nonetheless, it might provide a limited view of the general trends and context in ProRail, which can help substantiate ProRail's decision-making on the case study projects. As the diagrams show, turnover and investment costs are slowly increasing, although they have diverged slowly. Their change has not been volatile. This is not the case for the profit. Although ProRail, technically speaking, cannot make a profit because its balance is set to 0 by an inflow from or outflow to the Dutch treasury (remittance), significant changes have been seen over the last few years. While ProRail was profitable up to 2015, both unprofitability and its volatility have been increasing ever since. This roughly aligns with the increasing intensity of many programs and the total number of executed projects. However, the absolute reliability of these numbers is very limited, as this likely is partially caused by the more structural publication of projects on ProRail's online platforms. The bell curve of the projects worked on is likely caused by the fact that the publications apparently only really started around 2018 and not all projects are already published during their planning phase. Additionally, based on the annual reports (ProRail, n.d.c), the number of projects is actually more numerous.

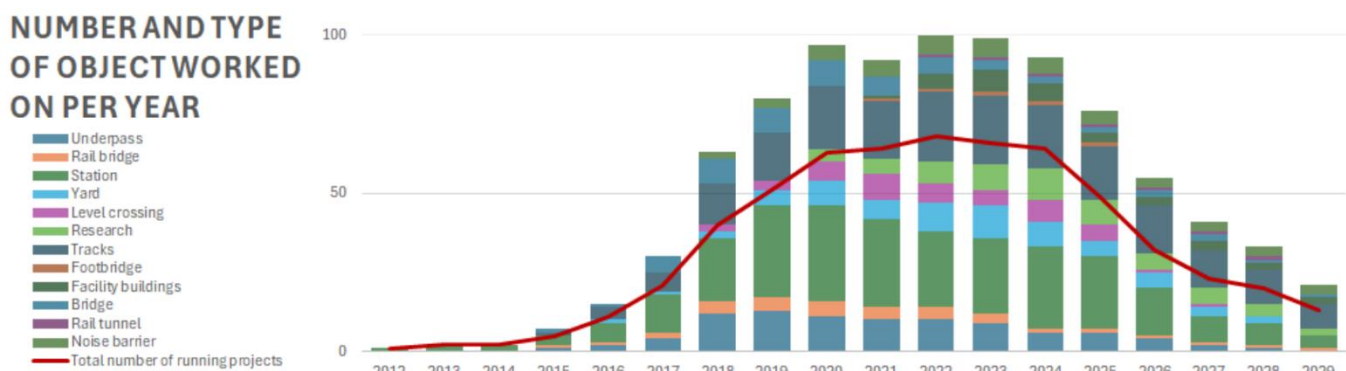
FINANCIAL INDICATORS [€M]



RUNNING PROGRAMS AND INTENSITY



NUMBER AND TYPE OF OBJECT WORKED ON PER YEAR



B.1 Programs

Although the programs shown above are not the full list of ProRail's programs, they are the majority and include the most important ones. A short description of these programs as defined on ProRail's website (ProRail, n.d.b) and its annual reports between 2012 and 2023 (ProRail, n.d.c) is as follows:

- The **Multiannual Disfragmentation Program** or Meerjarenprogramma Ontsnippering (MJPO) aims to reconnect natural areas and habitats. In the Netherlands, animals and their habitats are threatened by infrastructure at around 215 locations. 79 of these cases are related to the railway network. Several green bridges and some 100 smaller fauna-passages have been realised, and habitats have been enriched where possible.
- The **Multiannual Noise Remediation Program** or Meerjarenprogramma Geluidsanering (MJPG) is based on the 2012 Environment Management Act that defines the limits of acceptable noise levels. By measuring, modelling and calculating noise levels close to railroad tracks, noise limiting measures, such as noise barriers, track dampeners, façade insulation, and rail bridge reinforcement, can be planned. Up to now, 50.000 houses have been modelled, resulting in 52 remediation plans. These add up to 250km of track dampeners, 62km of noise barriers, and an assessment of 2900 houses for façade insulation. The **Implementation Program for Noise on Yards** or Uitvoeringsprogramma Geluid op Emplacementen (UPGE) was initiated years earlier, focusing on areas near rail yards, and has almost been completed.
- The **Railway Plan North-Netherlands** or Spoorplan Noord-Nederland aims to improve travel options in the northern provinces and their connection with the Randstad area. Measures include new stations, higher frequency, improved transfers, new railway connections, higher speeds, and increased yard capacity and quality.
- The **Pleasant & Safe Waiting** program, or Prettig & Veilig Wachten, is similar to the so-called Platform Program, or Perron Programma. The first one aims to improve waiting rooms, station facilities, and platform furniture to make waiting more comfortable. The second one is a partial crossover with the Better & More program and includes releveling platforms to eliminate uneven train boarding.
- The **Better & More** program, or Beter & Meer, is a collaborative effort of ProRail and NS, the largest Dutch rail operator, to align their performance indicators. These are categorised in three subprograms. The Improvement Approach Train (Verbeteraanpak Trein) focuses on reliable and high-frequency rail service. The Improvement Approach Safety (Verbeteraanpak Veiligheid) focuses on improving the shared organisational safety cultures. Improvement Approach Stations (Verbeteraanpak Stations) focuses on improving information provision, station safety, transfer capacity, and traveller satisfaction.
- The **High-Frequency Rail Transport Program** or Programma Hoogfrequent Spoorvervoer (PHS) aims to prepare six passenger railway lines and one freight line in anticipation of a future increase in demand. This should be achieved through optimising efficiency and construction of as few as possible new tracks. Measures include new safety and rail traffic control systems, new railway signals, and removing railroad switches and level crossings. Underpasses and grade-separated junctions can replace these. Additionally, noise or vibration remedies, increased power supply, and yard optimisation can be included. Stations and platforms are also upgraded to improve safety and capacity (c.f. Better & More).
- The **National Level Crossing Improvement Program** or Landelijk Verbeterprogramma Overwegen (LVO) is based on the Third Policy Framework Railroad Safety, which aims to improve safety and flow on protected level crossings in anticipation of increasing road mobility. General measures include limiting closure duration by equipping the conductor of a station-leaving train with a countdown timer, behaviour-influencing cameras, and traffic enforcement cameras. With the road authority's co-funding, specific measures could be included when desired.
- The **Unprotected Level Crossings** or Niet Actief Beveiligde Overwegen (NABO) program aims to remove, replace, or upgrade (to protected) the 180 unprotected level crossings in the Dutch passenger rail network. Examples for replacements are parallel roads, footbridges, or simple pedestrian tunnels. Due to (contextual) complexities, the first deadline in 2023 has not been met.
- The **Modular & Circular Buildings** or Modulaire & Circulaire Gebouwen program aims to design a multifunctional, modular, circular building for track technologies and systems, which are currently

housed in approximately 1500 substations, communications boxes, and signal equipment rooms. As of 2024, the prototype has been approved, and the first delivery is expected for February 2025.

- The **ERTMS** (European Rail Traffic Management System) program aims to completely replace the old ATB train safety system with the digital ERTMS platform for rail traffic management. This large rail network transformation also affects many stakeholders, but the result should ease crossing borders with trains, improve rail safety, and increase rail speed. To improve implementation, the ASAP ERTMS (Aanbesteding Snellere Aanpak ERTMS) subprogram has been created to research innovative solutions.
- The **Innovation Agenda Source Control Track Vibrations** or Innovatieagenda Bronaanpak Spoortrillingen (IBS) program develops knowledge collected in the STE-Model (STEM). It implements pilots to research affordable and effective measures to limit track vibrations.
- The **Research Subgrade Stability** or Onderzoek Baanstabieliteit program investigates what measures are to be taken to maintain subgrade stability in light of climate change and the upcoming arrival of more, faster, longer, and heavier trains. To safeguard future rail safety, the LNA (Landelijke NetwerkAnalyse) subprogram measures, models, and analyses the current situation. The RESET (Research Embankments for Safe Expansion of Traintraffic) subprogram does academic, forward-looking research.
- The **GSM-R** program will replace an old safety communications system alongside the ERTMS program. This system facilitates the communication between the train driver and the rail traffic control centre, enables infrastructure monitoring, and controls the departure information screens. Measures include the renewal of 300 communications poles and the construction of 70 new ones.

B.2 Yearly Overview of Performance & Development

ProRail is under ministerial responsibility and financially tied to the government, which is indirectly the sole shareholder. Therefore, ProRail has to account for its performance in its annual reports (see ProRail, n.d.c). These also provide an overview of general developments, which include present-day trends like digitalisation, modelling, and (European) collaboration, but also more ProRail-specific ones.

The report was not yet very elaborate in **2012**, but ProRail's strategy is defined: focus on safety, reliability, punctuality, and sustainability of the rail network. Because of a train collision and derailment, planning, warning, and intervention systems are improved to increase safety. Reliability requires further attention due to significant disruptions caused by winter weather.

In **2013**, it was concluded that punctuality and reliability goals were not fully achieved due to technical problems and renewal efforts. The new train schedule is expected to facilitate better absorption of delays and restart of the schedule, improving performance. It has also been decided that train crossings are to be phased out. Performance on organisational safety has resulted in ProRail being rewarded the next level of certified organisational safety, shifting focus from correction to prevention. ProRail also started demanding this certificate from rail contractors. Rail construction safety should be improved in combination with a new track-closing procedure. For sustainability, a multiannual sustainability plan has been improved. Although ministerial investments limited the consequences of the financial crisis that hit the rail sector hard, ProRail is asked to decrease its spending by € 48 m in 2018 by eliminating 600 jobs over 3 years.

In **2014**, the performance of the four strategic foci improved, and for the first time, KPI-thresholds were published. Only performance on delays and cancellations did not clear their threshold. The spending cut and job reduction announced in 2013 is still in action. Looking forward, the Dutch government has regranted the rail concession to ProRail for the 2015-2025 period. Additionally, the minister approved the Amsterdam and Meteren projects for the PHS-program but postponed the Eastern Region project. Furthermore, ProRail has decided to shift from outcome-based maintenance contracts towards performance-based ones (PBM-contracts). The shift should be completed in 2018.

In **2015**, again, most KPI-thresholds were achieved, but performance decreased compared to 2014. Although the phasing out of red signs from the schedules has resulted in fewer overlooked red signs, the number of accidents has increased. Therefore, the Unprotected Level Crossing program is started. The phased implementation of PBM-contracts has been delayed due to pilot-project problems. A pilot project did successfully start for a project to systematically exchange rail asset data between organisations. Another

initiated long-term endeavour is the restructuring of the decision-organisation between 2015 and 2020 as organisational efficiency barriers for the whole of ProRail are being identified. The next step has been set on the sustainability focus front by mapping ProRail's waste material flows. Additionally, digitalisation efforts and updates are intensified, while some performance indicators are published daily to improve transparency. Furthermore, the daily management of the Betuwelijn rail freight line has been organisationally incorporated from 2015 onwards.

In **2016**, again, most KPI-thresholds were achieved despite a continued decrease compared to 2015. One strategic focus that has improved was reliability as technical failures decreased. Safety was also slightly improved despite two severe accidents, emphasising the importance of safety and protected level crossings. Furthermore, it is concluded that the measuring and management of punctuality for rail freight and high-speed trains require attention. After some delay, the first phase of implementing PBM-contracts has started. Improvements to ICT systems are also continued. The Multiannual Noise Remediation Program appears to be more extensive than initially estimated. Besides ongoing organisational restructuring, the ministry is preparing a bill to transform ProRail into an Independent Administrative Body (IAB). Additionally, the number of employees is increasing again. A monitoring system has been introduced to prioritise desired station alterations (cf. Better & More).

In **2017**, all KPI-thresholds were achieved, and most strategic foci have been improved, especially on topics like frequency and punctuality. Safety was further improved by implementing Rail Works Safety Enforcement Officers and an improved version of the safety rules. However, the long-term strategy is rebranded from 'safety, reliability, punctuality & sustainability' to 'ProRail connects, improves, and makes sustainable'. Besides general performance, sustainability has also improved due to reduced energy consumption, amongst others, and has received much attention in the newly formulated Multiannual Sustainability Plan 2016-2030. ProRail's improvements and general performance also stand out in an international comparison of infrastructure management organisations, although freight, post-accident restart speed and costs per km could use more attention. To improve freight transport, ProRail has created more flexibility in its systems. While PBM-contracts are still being phased in, an audit has awarded ProRail's procurement strategy as being socially responsible, partly due to the Market Vision. Additionally, a vision for Future Proof Rail Works (TWAS) has been drawn up to improve collaboration within the rail sector. This is in anticipation of organisational difficulties and increasing works to keep the network available, reliable and affordable.

In **2018**, KPI-thresholds were achieved, and performance mainly improved compared to 2017. The high-speed KPI was down for various reasons, emphasising the need for attention to the HSL South service, especially with the introduction of the Amsterdam-Londen Eurostar. Sustainability has been further improved by reducing consumption and incorporating requirements in management and maintenance contracts. The TWAS-measures are also slowly phased in, and efforts to improve procurement and ICT are ongoing. A fatal accident with several children on a level crossing again shows the required attention for level crossings. Furthermore, with the Eindhoven-Amsterdam PHS subprogram delivered, the focus can be shifted to the Schiphol-Nijmegen subprogram. In general, ProRail also shifts focus from maintenance to renewal in planning in anticipation of significant demand growth in both passengers and freight. Plans for the ERTMS implementation are finalised.

In **2019**, performance stabilised or improved compared to 2018. Sustainability has been improved by reduced consumption and increased green power generation. Safety is again improved by demanding higher levels of safety from contractors. Nonetheless, an investigation has been started to study the recent increase in level crossing accidents. In an international comparison, ProRail's leading role has again been shown. On programs and projects, there are also several remarks: the government has approved national implementation of ERTMS; many PHS projects entered the execution phase; the Schiphol-Nijmegen PHS subprogram is extended to include Rotterdam and Arnhem; ICT replacement projects are delayed due to longer contract negotiations. Nonetheless, work on PBM-contracts continued. ProRail has also published several inspirational manuals to visualise the ProRail perspective and ambitions for future-ready stations.

In **2020**, performance improved in every aspect, partially due to the pandemic causing the first passenger and freight reduction in years. It also allowed for the acceleration of maintenance but required an expansion of the workforce to keep up services. Sustainability efforts continued by using only 100% green gas and planning the first emission-free construction site. ProRail's certified safety level had been reduced and two

fatal accidents occurred on unprotected level crossings. As the implementation process for PBM-contracts was finalised, the implementation for TWAS-measures was stretched to enable co-implementation with other efficiency improvement measures. Besides the continuous attention to upgrading assets and reducing noise and vibrations, special attention is directed to public transport nodes, sustainability, social safety and transfer safety. Additionally, efforts are made to analyse the Port of Rotterdam rail freight problem and to solve the HSL South problems. Tests with hydrogen and autonomous trains were done, and ERTMS started to be implemented. The government has promised a budget increase of €1.4 bn for all projects.

In **2021**, the European Year of Rails to promote and advance rail traffic as a sustainable transport alternative, the pandemic again led to some improved performance. Due to system failures and strikes, reliability decreased, and some other aspects did too, but KPI-thresholds were achieved. Despite a workforce extension, a tight labour market and the pandemic increased the understaffing problem. The transformation of ProRail into an IAB has been politically delayed. Both the TWAS and PBM approaches have been adjusted, the first to improve early market alignment and try two-phased tendering and the second to improve collaboration, effectivity, and risk pricing. Project option selections will also start considering nuisance. Developments on autonomous trains, European collaboration, emission-free construction, material reduction, and circularity were ongoing, and special attention was addressed to silica dust and worker safety. Some of these were incorporated into the procurement strategy. The first energy-neutral station and the Rotterdam-Schiphol-Arnhem high-frequency service have been put in use. The use of more silent rolling stock has resulted in less noise nuisance.

In **2022**, the continued understaffing problem and the post-pandemic rail usage revival led to a lower performance, although most KPI-thresholds had been achieved. Similar issues and the Russo-Ukraine war also caused delays in maintenance and other projects. Nonetheless, the 20% growth in active projects is expected to continue. Therefore, the organisational strategy and ambition are extended to include a solution for the labour shortage. The sustainability strategy has also been structurally improved by preparing for the EU Corporate Sustainability Reporting Directive (CSRD) introduction. The introduction of electrified machinery and a tree replanting scheme are also contributing. The political process for the IAB transformation has been restarted, and in the political-legal field, more developments have affected ProRail: a ministerial order to only use silica-free ballast has been appealed due to insufficient supply; project delays are expected to occur due to the scrapping of the partial construction exemption for nitrogen emissions. The implementation of the new PBM-contracts has also been delayed due to problems. Procurement has also been adjusted to balance continuation and price fluctuations due to war. Other noticeable developments and decisions this year include: the postponement of a large power supply network change due to necessary prioritisation; the introduction of a program to address the Port of Rotterdam-Zevenaar rail freight problems and increase facilities for 740m long trains; introduction of Safety & Health Officers to assess contractor health & safety measures; start of planning and procurement for ERTMS even though its planned realisation will exceed initially estimated budget; introduction of a PPP between ProRail and NS to improve collaborative works on stations.

In **2023**, performance decreased again on every front to levels just above and even below the KPI-thresholds. The variety of causes includes system failure, large rail works, subsidence by rain or badgers and subsequent speed limitations, increased demand, limited rolling stock availability, freight diversions, and strikes. Sustainability performance also decreased, although a clean energy generation plan has been approved, and construction of a circular bicycle parking and pilots for sustainable nature management has started. With the occurrence of one significant and fatal rail work accident, ProRail concluded that safety, performance, and cost reduction require attention, adding affordability to the strategy that already contained safety and performance, amongst others. Additionally, cyber security and nitrogen emissions also require attention. Despite shortages in labour and materials and the still increasing number of projects, almost all planned projects have been delivered, including several freight-focused ones. Although digital innovations and implementation of ERTMS continue, advice has been given to change the ERTMS program design to reduce costs. A Digitalisation Vision for ProRail has also been drawn up. The IAB transformation process has again been delayed by politics, requiring some workarounds. However, ProRail has realised some internal organisational alignment improvements and has finished submission for the obligatory noise nuisance improvement plans.

B.3 Important Collaborative Approaches

Over the last 15 years, ProRail has made several significant changes in how it collaborates with contractors. Two of these new approaches relevant to the case study projects are highlighted here.

B.3.1 ProRail Alliance

After two decades of alliance application in various rail construction projects with varying experiences, Van den Berg (2023) has written an evaluation and approach for ProRail on the matter. ProRail's alliance aims to prevent a situation in which profit for one means a loss for the other, and instead aims for a sink or swim together win-win situation. Although D&C is ProRail's standard delivery method, an alliance is selected when it benefits both client and contractor. This is usually the case when close collaboration improves the management of complexity, dynamicity, and unpredictability, and the project is still in an early phase to enable optimisation. With many stakeholders, intricate environments, project interfaces, and other uncertainties, assumptions will likely change. Alliancing enables the client to participate and forces him to build up and maintain knowledge to navigate these uncertainties. This also benefits the contractor by enabling risk sharing. Alliancing also requires sufficient room for change regarding budget, design options, risk management, and context. The client should show serious collaborative efforts to make alliancing appealing to contractors.

ProRail's alliance contract is based on the UAC-IC2005, taking the allocation of tasks and risks from UAC-IC2005 as input. However, this integrated D&C contract (UAC-IC2005) positions the client and contractor in opposition concerning risks, as risk responsibility is based on somewhat subjective 'reasonable effort' and can be transferred to the other party. Opposing perceptions and conflict then easily occur, and risk management focuses more on risk transfer than effective mitigation. Alliancing combines the knowledge of both parties, enabling optimised risk management. Sharing of profit or losses considers the pre-agreed commitment limits, of which the lower bound is a threshold set by ProRail, and the upper bound is a percentage of the alliance funds. Out-of-bound results accrue to ProRail.

Alliancing has the potential to facilitate successful collaboration in terms of time, money, and quality, but also job satisfaction, collegiality, and trust. The main advantages of alliancing based on alliance evaluations by ProRail include:

- Improved collaboration by aligning interests
- Construction cost savings by design and execution optimisation
- Organisational cost savings by physical proximity
- Risk managing flexibility by stimulation of collaborative management regardless of initial risk occurrence
- Certainty of goal realisation by stimulation of effective collaboration
- Reduction of cost overrun risk by shared risk responsibility
- Increased client decision speed by partial ownership

However, alliancing is not free of limitations. ProRail doesn't see a role for contractors in the exploration and pre-design phases, as experience shows that delay is likely, threatening the contractor's profit margins.

B.3.2 Tunnel Alliance

Since 2015 ProRail has collaborated with initiators and prequalified contractors in the Tunnel Alliance to improve the process of realising underpasses and their surroundings. These projects' initiators (and financiers) are often third parties like road authorities. Their participation provides them with control of budgets, interests and decision-making.

The (financing) initiator is responsible for project preparations like land ownership, surveys and variants. He also procures the engineering, sets the conditions, and approves plans. ProRail provides the financing initiator with an advising and connecting project team. They communicate with ProRail departments, enable asset management, and, upon request, perform preparative investigations. They are also responsible for procurement, minimal quality, execution, and delivery. The prequalified contractor bids in a mini-tender phase and provides the design and realisation of the project up to the delivery based on UAC-IC2005. During tendering, only 5 contractors can actively participate, so with more contractors interested, a ranking is made. Tender cost compensation is also provided. Contractors also help continuously improve the Tunnel Alliance

Approach. The Tunnel Alliance Program Team does not participate in a specific project but qualifies contractors, improves the approach, and facilitates quality and safety control.

The Tunnel Alliance focuses on detecting and mitigating risks timely in every project phase by combining each participant's knowledge, reducing project duration and increasing quality. Risks are considered as follows:

- Risk discussion during the intake session between ProRail and the initiator based on initial requirements
- Forehanded delivery of information by the initiator to prevent delay due to insufficient quality and requirement changes
- The mini-tender phase only starts after the zoning plan has been irrevocably approved and all necessary land is owned. Cables and ducts must be correctly located before the contractor starts.
- Optional consultation of the contractor during the initiation phase for risk identification. Otherwise, the initiator can seek consultation during the contract preparation phase.
- Risk (allocation) discussion between ProRail and the initiator during contract preparations
- Risk discussion between ProRail and contractors during contract preparations
- Audits and tests are planned based on the risk portfolio
- All participants aim to manage risks dynamically and collaboratively

B.4 Sources

Meijneken, C. (2020). *Workings of the Tunnel Alliance (De Werking van de TunnelAlliantie)* (version 5.0). ProRail.

ProRail. (n.d.a). *Projects (Projecten)*. Retrieved July 11, 2024, from <https://www.prorail.nl/projecten>

ProRail. (n.d.b). *Programs (Programma's)*. Retrieved July 11, 2024, from <https://www.prorail.nl/programmas>

ProRail. (n.d.c). *Annual Reports (Jaarverslagen)*. Retrieved July 15, 2024, from <https://www.prorail.nl/over-ons/organisatie/jaarverslagen>

Van den Berg, B. C. L. (2023). *Memorandum 'the ProRail Project Alliance' (Notitie 'de ProRail Projectalliantie)* (version 2.0). ProRail.

Appendix C: Context overview VHB

To provide an overview of the context on the contractor's side at the time of tendering and procuring the five case study projects, an interview was conducted with someone in the upper management of Van Hattum & Blankevoort (VHB) with many years of experience within the VolkerWessels group management. This appendix contains a description of the result.

C.1 Market Context & Contract Types

Over the last three decades, changes in the market-economic context have somewhat altered VHB's business. For the Dutch infra-contracting business, **the end of the previous century** was marked by large projects like the HSL South and the Betuwelijn. This provided the contractors with sufficient work, revenue, and profits. After their finalisation, contractors entered a more difficult period of stiff competition, accepting unfair contractual conditions and bidding far lower than the price proposed by the client just to stay in business, as is seen with the Hanzelijn project. During the same period (**ca. 1995-2005**), the D&C-type contract was introduced to provide an alternative to the RAW construction specification type of contract, which was often used. This made it possible for contractors to become a part of the project before drawings were finalised, and it aligned with their conviction that errors or ineptitude in drawings and planning would be omitted once designing and construction had been merged under the contractor's responsibility. It was also thought to be cheaper for the client, less risky, and therefore more profitable. However, it turned out that contractors underestimated the efforts required to make a design, as this used to be the client's responsibility and related struggles and delays were kept out of the contractor's sight. Taking integration even further by including a maintenance period and financing through an external financier into the contractor's responsibility was seen by contractors as a way to still make integrated contracts profitable. Such DBFM contracts were primarily applied during the **2010-2015** period in projects like SAA, Afsluitdijk, or road projects like N18. However, these contracts proved even less profitable, posing significant problems in managing, handling, and overseeing the complex, multifaceted scope. Repositioning the design responsibility during these decades has also led many of the large Dutch public clients, VHB's core clientele, to decrease their technical capability. Instead, they have been focusing more and more on the legal side of collaboration. This has required VHB to improve its contract management capabilities as well.

However, the period also had some upsides. Although **2005-2010** cost Dutch infra-contractors money due to inexperience with the D&C contracts, a lot of money was made during the **2010-2015** period due to the Spedwet-approach. This meant that a special temporary law was passed to speed up much-needed infrastructure projects by simplifying some legal requirements. For the projects covered under this law, standardised unit prices were used, and the project budget was reevaluated between design and realisation. Despite the integration of design and construction under the contractor's responsibility, these projects were acceptable by reducing pricing risks for the contractor, while also providing some stability and boundaries for the client. However, even with the use of unit prices, total costs could be 20-30% higher than the client initially thought due to an increased number of units or an extended scope. This approach was almost exclusively applied to road projects and sporadic engineering works.

Despite the short success of D&C contracts, problems with them remain, limiting their applicability. The primary limit is the project size. An infrastructure project up to ca. € 150 million can still be grasped by one person and managed by one project team in which the manager still knows most people. It conforms to a human scale. Larger projects are much harder to control in all their facets, and only through control, planning, and knowledge of risks and possible measures is money made by a contractor. Simply pricing risk as a percentage of the total costs is not possible in the very competitive Dutch infra-construction market as it would be in some other markets, as this only results in an uncompetitive bid. The same goes for pricing every conceivable risk. And although clients often emphasise that EMAT (Economically Most Advantageous Tender, EMVI in Dutch) is used, the usually small scoring differences between contractors on qualitative criteria often make the price decisive. Another D&C problem is caused by the complexity of construction contracts. This usually results in inconsistencies in client requirements, which need clarification and reparation. This

obstructs the contractor's process flow, resulting in delays to be paid by the client, or it poses risks that might have to be paid later on by the contractor.

The **current Dutch infra-construction context** is characterised by high demand, combining a national road infrastructure renewal program, the national energy transition development, and a large dike strengthening program (HWBP). This wide varying demand by many different clients diminishes the importance and power of the large public clients (RWS and ProRail) in the field, although they stay somewhat important. Combined with the earlier stated D&C problems, a drive towards other types of contracts is the result. Contractors have the position to ignore high-risk, low-profit projects, resulting in increased compensation and price and contract types like frame contracts or 2-phase contracts. These 2-phase contracts are just as beneficial to the client by addressing the requirement clarification problem described in the previous paragraph. It enables much better alignment between the client's wishes and the contractor's interpretation, which strips as much luxury as possible to optimise profit. It improves clarity and understanding on both sides, resulting in increased design stability.

C.2 Organisational Context

VHB is an operating company of VolkerWessels, a decentrally organised Dutch construction group containing many more operating companies. Within this group, VHB, KWS, Vialis, Aveko and VolkerRail are grouped under InfraNL. Because of the decentralised organisation, responsibilities are widely distributed, and subsidiaries are allowed to choose their own direction. As long as VHB is financially stable, interference of VolkerWessels in VHB-activities is minimal, but in case of instability, boards can be dissolved, and other organisational changes can be made. **Currently**, there is little interference, but a profit percentage requirement is set to transition from 2.5% a few years ago to 5% in a few years.

Due to the decentralised organisation and individual freedom of subsidiaries, collaboration between these parties in the same project can have the negative consequence of each party chasing its own objectives. To improve alignment among VolkerWessels-subsidiaries in multidisciplinary infrastructure projects, the VolkerInfra entity was established in **2009**. Initially, it did little more than manage alignment without financial responsibility, only using personnel seconded from other subsidiaries. After some success, it was transformed into a limited liability company with its own personnel. It also tried to centralise design activities between the infra-operating companies taking over design personnel, but this failed due to a lack of clarity regarding design responsibility. At the start of the financially difficult years **2018-2021**, design personnel were sent back, and VolkerInfra was cut up and renamed VWICC (VolkerWessels Infra Competence Centre). **Between 2018 and 2023**, the newly established EPC took over the alignment tasks. Still, it was dissolved because it could not contract any projects (partially due to competition with the other operating companies for the most capable employees). It was concluded that an inter-alignment organisation of this kind just didn't function well and that these tasks should be left to the different operating companies when they collaborate on a project.

Internally, VHB has also changed somewhat. In **2016**, it appeared that the time of larger projects had ended. Therefore, attention was given to the 3 regional divisions of VHB, trying to improve the balance of activities between these and the national Integral Projects division that handled the large (>€ 30 million) projects.

C.3 State of Finances & Tendering

Thanks to its internal design department, VHB has always been one of the few Dutch contractors specialising in complex projects. Up to approximately **2015**, it participated in as many tenders as possible. However, at the InfraNL level, it was then decided to better align projects and operating companies amongst the InfraNL parties. Initial non-competitive return percentages required by the board, decisiveness of lowest-price instead of EMVI, stiff competition, and suspected backroom politics on the client's side have since led to the loss of several large tenders, costing significant time and money. Some tenders were even left prematurely. In several cases, it has appeared that VHB excels in technical capability but has a harder time connecting with the client's vision.

Around **2017**, VHB changed its tender strategy, establishing seven 'value flows' (waardestromen) or PMCs (Product-Market Combinations). These form categories of areas of expertise and the clients and projects that belong to them (e.g. rail projects and ProRail; large infrastructure and RWS; water safety and waterboards).

These provide a focus on projects that fit VHB's capability, knowledge, and references. Tenders that don't fit these categories are not taken part in. These PMCs are periodically assessed on whether they still fit the VHB organisation.

Between 2018 and 2021, VHB had a financially difficult time with several projects with negative results (e.g. Sealock IJmuiden resulting in a € 100 million loss). Being a part of a group like VolkerWessels with a wide variety of target markets guarantees VHB a stable safety net. Nevertheless, VolkerWessels' recent financial stability has been somewhat remarkable considering the financial problems its Dutch competition has experienced. This financial performance has been a point of attention for the VolkerWessels board, demanding better profit margins over the last years. Therefore, the focus within VHB is on profit and not on revenue. **During the last two years**, both the regional and Integral Projects divisions have generally won many or large tenders.

Besides the requirement of fitting the PMCs, VHB also requires projects to have a design element because that is the most important way in which it can profit from its skill, knowledge and cunningness. D&C contracts do not always provide sufficient margins, but the 2-phase contract development of design collaboration and efficiency improvements shows promise. However, the first phase usually takes longer than anticipated due to the client's inability to make quick decisions while sufficiently managing and aligning stakeholders like management organisations or asset owners, resulting in increased development costs and scope creep.

Additionally, some considerations on the tender decisions made for the five case study projects were shared:

- ZwolleSpoort IJssel-Herfte: The OV-SAAL alliancing contract and project with ProRail had been a success, and it was felt that familiarity with the contract type and client promised good money. The experiences from OV-SAAL helped win the tender. Unfortunately, the collaboration with ProRail on the Zwolle project was not as good as anticipated.
- OV-SAAL Southern-branch West: no specifications
- Ede Public Transport Hub – Construction of station and rail: VHB has much experience with rolling-in underpasses, so it was a fitting project. Due to some shortcomings on VolkerRail's side, the bid price wrongly cleared the client's budget threshold after the threshold had been raised because no bid cleared it in the first run.
- Nunspeet – Construction of station area underpasses: This is a 'tunnel alliance' project for which VHB has been approved since 2019 but has never contracted a project, so there was some pressure to go for it. As these projects are usually won on cunning solutions and not on price, a lean and mean approach helped win the tender.
- Nijmegen – Construction of working pits: There had been a change of management in the VHB-Zuid division due to a difference of opinion on the direction, resulting in varying activities to grow the business. During this ambitious experimental phase, every possible tender was used. In 2024, it is unlikely that VHB-Zuid would take part in such tenders.

Appendix D: Quantitative Risk Comparison

This appendix contains the full lists of the contractual allocation of risks. These describe how, according to the researcher's interpretation, the risks are divided in contractual documents between client and contractor. This analysis is structured around the most important construction project risks listed in the *Construction Extension to the PMBOK® Guide* (Project Management Institute, 2016). Allocation is categorised as either:

- to the client: (practically) all (financial) responsibility for that risk resides with the client.
- predominantly to the client: the most significant (financial) responsibilities for that risk reside with the client, but parts reside with the contractor.
- shared: (financial) responsibilities reside collaboratively with both parties. This is different from both parties having independent responsibilities for the same risks.
- predominantly to the contractor: the most significant (financial) responsibilities for that risk reside with the contractor, but parts reside with the client.
- to the contractor: (practically) all (financial) responsibility for that risk resides with the contractor.
- or undefined: the contractual text does not clearly allocate the risk mentioned by PMBOK.

Sometimes, the PMBOK risk is not literally stated in the contractual documents. However, its similarities to other risks or its relation to more ambiguous definitions in contractual documents have sometimes let the researcher reasonably assume its allocation. These are stated in grey italics. When necessary for nuance, understanding, or variability, notes are provided. All allocations are supported by their source (see Table 19 for explanation), where in some cases multiple sources provide improved specifications and in others they are contradictory. Allocation is then based on the sequence of overruling as stated in contractual documents. To clarify the contractual allocation, it was decided to ignore the 'duty to warn' (UAC-IC2005 §4.7) as it applies to every risk. Furthermore, a clear distinction has been applied to power to control and responsibility (UAC-IC2005 §20; §21.8,10). Stipulations about the final delivery check (UAC-IC2005 §20; §24) and multi-annual maintenance (UAC-IC2005 §29-32) are (mostly) out of scope.

Table 19: Explanation of the sources used for the contractual risk allocation analysis

Abbreviation	Title	Abr. (Dutch)	Title (Dutch)
UAC-IC2005	Uniform Administrative Conditions for Integrated Contracts 2005	UAV-GC2005	Uniforme Administratieve Voorwaarden voor Geïntegreerde Contractvormen 2005
TRUI2016	Tender Regulations Utilities Industry 2016	ARN2016	Aanbestedingsreglement Nutssectoren 2016
PRYB2008	ProRail Yellow Book 2008 (version 002)	PRGB2008	ProRail Gele Boekje (versie 002)
PRYB2016	ProRail Yellow Book 2016 (version 006)	PRGB2016	ProRail Gele Boekje (versie 006)
BA	Basic Agreement*	BO	Basisovereenkomst
A	Annex (to the BA)		
AA	Alliance Agreement	AO	Alliantieovereenkomst
AA-AC	(AA) Attachment C – Design-level demarcation by technical component		(AO) Bijlage C: Afbakening ontwerpniveau vanuit techniekvelden
AA-AD	(AA) Attachment D – Risk Register		(AO) Bijlage D: Risicoregister: opsomming van risico's die tot het Werkgebied van de Alliantie behoren
AA-AE	(AA) Attachment E – Activity Demarcation		(AO) Bijlage E: Afbakening van activiteiten opgenomen in het procesdeel van de vraagspecificatie die tot het Werkgebied van de Alliantie behoren
RCC	Relational Collaborative Contract**	RSC	Relationeel Samenwerkingscontract
PPD&C	Procedural Part D&C	PDD&C	Procesdeel D&C
PPE&C	Procedural Part E&C	PDE&C	Procesdeel E&C
MCHW	Measures Cold & Warm Weather matrix		Maatregelen koud en warm weer matrix

* For the Ede Public Transport project, the Basic Agreement is split into two parts. Part one (BA-A) is the Construction Agreement, part two (BA-B) is the Maintenance Agreement. Only BA-A is considered to be part of the scope of this analysis.

** Due to document unavailability, the summary of the RCC, printed on the 'Sporzone Ede' paper desk-pad, was used.

The order of the lists below is:

1. Contractual risk allocation according to UAC-IC2005 + TRUI2016 (the base for most integrated construction contracts in the Netherlands)
2. Contractual risk allocation according to UAC-IC2005 + TRUI2016 + PRYB2016 (the base for most ProRail construction contracts)

3. Contractual risk allocation for Nijmegen REP – Construction of working pits (based on 2)
4. Contractual risk allocation for Nunspeet – Construction of station area underpasses (based on 2)
5. Contractual risk allocation for Ede Public Transport Hub – Construction of station and rail (based on 2)
6. Contractual risk allocation for ZwolleSpoort IJssel-Herfte (based on 2)
7. Contractual risk allocation for OV-SAAL Southern-branch West (based on an older version of 2)

D.1 UAC-IC2005 + TRUI2016

Risk Category	Risk Subcategory	Risk	Allocation (=Reasonably Assumed)	Notes	Source
Design/ Technical Risks		Inadequate and incomplete design	Contractor		UAC-IC2005 \$4.5.9; \$19; \$21.2;
		Incomplete knowledge of local site conditions	Shared		UAC-IC2005 \$4.5.9; \$13.1.4.6;
		Inaccurate technical assumptions	Contractor		UAC-IC2005 \$4.5.9; \$21.2;
		Insufficient technical background and experience on specific project type and local characteristics	Contractor		UAC-IC2005 \$4.5.9; \$21.2;
		Incorrect selection of equipment, materials, and building techniques	Contractor		UAC-IC2005 \$19; \$21.2;
		Incorrect geotechnical and foundation estimations and structural design	Contractor		UAC-IC2005 \$4.5.9; \$13.1; \$19; \$21.2;
		Errors and omissions by consultants	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 \$44.1a)	UAC-IC2005 \$4.5.9; \$5; \$6.1;
		Lack of specialised technical consultants on critical aspects of the project	Contractor		UAC-IC2005 \$4.5.9;
		Over-involvement of the owner in design	Predominantly Contractor		UAC-IC2005 \$23.11.12.13.16;
		Continuous changes to the project scope	Client		UAC-IC2005 \$3.3; \$14; \$15; \$16;
Construction Risks	Contractual Factors	Delays in obtaining client concurrence	Predominantly Client		UAC-IC2005 \$23.5.6.7.16; \$45.13;
		Design scope exceeding available budget	Contractor		UAC-IC2005 \$4.4;
		Uncertainty in the total cost estimate due to uncertain quantities and unit prices during the planning and initial design phase	Shared	contractor unless a provisional sum has been agreed upfront	UAC-IC2005 \$34;
		Incomplete project cost estimate and inaccurate project schedule	Predominantly Contractor		UAC-IC2005 \$4.4; \$7; \$34; \$36.1;
		Contractor and/or subcontractor capability	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 \$44.1a)	UAC-IC2005 \$4.1.3.5; \$5; \$6.1; \$43.2;
		Inefficient coordination of project plans	Contractor		UAC-IC2005 \$21.2; \$36.1;
		Unavailability of sufficient and skilled human resources	Contractor		UAC-IC2005 \$4.5.9; \$21.2;
		Unavailability in time of special materials and construction equipment and equipment breakdowns	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c.2.5; \$4.1.3.5.9;
		Equipment commissioning	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c.2.5; \$4.1.3.5.9;
		Unsuitable equipment and materials	Contractor		UAC-IC2005 \$19; \$21.2;
Construction Risks	Technical Factors	Low level of competency in management (especially subcontractors)	Contractor		UAC-IC2005 \$19; \$21.2;
		Incomplete knowledge and training on specific construction techniques	Contractor		UAC-IC2005 \$12.1;
		Construction occupational safety	Contractor		UAC-IC2005 \$12.1;
		Lack of environmental training and knowledge of workers on site	Contractor		UAC-IC2005 \$17.1;
		Restricted work hours	Undefined		UAC-IC2005 \$17.1;
		Health and safety regulations and responsibilities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1.3; \$12.1;
		Changes in work orders	Client		UAC-IC2005 \$14; \$16; \$45;
		Low level of documented detail design	Contractor		UAC-IC2005 \$19;
		Lack of scheduled instructions and drawing documents	Contractor		UAC-IC2005 \$12.2.3.5; \$19;
		Gap between theory and actual quantities of work	Shared		UAC-IC2005 \$3.1a.2; \$36.1; \$44;
Construction Risks	Site & Layout Conditions	Unexpected costs of tests and samples	Predominantly Contractor	but very nuanced	UAC-IC2005 \$4.4;
		Site access	Client		UAC-IC2005 \$3.1b;
		Site security	Contractor		UAC-IC2005 \$12.1;
		Availability of resources	Contractor		UAC-IC2005 \$6.1;
		Availability and capacity of utility services	Undefined		UAC-IC2005 \$17.1.2;
		Resource overloading	Contractor		UAC-IC2005 \$12.1;
		Interference between task fronts	Contractor	compensation in case of hindering side-contractor (UAC-IC2005 \$44.1a)	UAC-IC2005 \$8;
		Geological and geotechnical conditions	Shared		UAC-IC2005 \$3.1a.2; \$13.1.4.6;
		Sufficient and representative geotechnical and geological tests and samples	Contractor		UAC-IC2005 \$13.1;
		Groundwater level	Contractor		UAC-IC2005 \$13.1;
Construction Risks	Physical Factors	Topography	Contractor		UAC-IC2005 \$13.1;
		Unforeseen subsurface conditions	Shared		UAC-IC2005 \$13.1.4.6;
		Unexpected climate conditions not covered under force majeure	Undefined		
		Corruption	Undefined		
		Assault, vandalism, sabotage, and theft	Contractor		UAC-IC2005 \$12.1; \$41;
		Intrusion and illegal occupancy of site	Undefined		
		Inaccurate contract time estimates	Contractor		UAC-IC2005 \$7; \$36.1;
		Insolvency of contractor, subcontractor, or supplier	Predominantly Contractor		UAC-IC2005 \$4.4; \$6.1; \$33.9; \$43.3;
		Inadequate change orders procedure	Predominantly Client		UAC-IC2005 \$14; \$15; \$16; \$22; \$23; \$44; \$45;
		Change orders negotiation	Predominantly Client		UAC-IC2005 \$14; \$15; \$23; \$44.7;
Construction Risks	Contractual Factors	Unexpected work and extras	Predominantly Contractor	the question "unexpected for whom" is left aside	UAC-IC2005 \$13.4.5; \$14; \$24.7; \$25.1; \$36.1; \$44;
		Delayed deliveries and disruptions	Predominantly Contractor		UAC-IC2005 \$7; \$16.7.9.10; \$36.1;
		Delayed payment on contracts	Client	only considering the main contract	UAC-IC2005 \$3.9; \$33.4.7; \$38.7; \$42.1;
		Vendor appraisals	Shared		UAC-IC2005 \$6.1.2.3;
		Reliance on a single source	Contractor		UAC-IC2005 \$38.1;
		Defective work	Contractor		UAC-IC2005 \$4.5.9; \$21.2; \$41;
		Unskillfulness	Contractor		UAC-IC2005 \$21.2;
		Negligence and malicious acts	Contractor		UAC-IC2005 \$12.1; \$41;
		Labor disputes	Shared		UAC-IC2005 \$38.1; \$47;
		Unsuitable materials	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c.2.5; \$4.1.3.5.9; \$21.2;
External Risks	Contractual Factors	Construction productivity (labor and equipment)	Contractor		UAC-IC2005 \$4.1; \$21.2;
		Accidents and injuries	Contractor		UAC-IC2005 \$12.1; \$41;
		Critical lead times	Contractor		UAC-IC2005 \$7; \$21.2; \$36.1;
		Tight project schedule	Contractor		UAC-IC2005 \$7; \$21.2; \$36.1;
		Client's quality and performance expectations higher than documented	Client		UAC-IC2005 \$3.3.4; \$21.4;
		Weak definition and documentation of project objectives (cost, schedule, scope, quality)	Predominantly Client		UAC-IC2005 \$3.3.4; \$21.2;
		Overlooked or new powerful and influencing stakeholders	Undefined		
		Influencing late changes in stakeholders' requirements	Undefined		
		Market changes	Contractor		UAC-IC2005 \$4.4; \$34;
		Economic and political instability	Contractor		UAC-IC2005 \$4.4; \$34;
External Risks	Force Majeure Factors	Changes in regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1.3;
		Labor strikes	Contractor		UAC-IC2005 \$4.4; \$36.1;
		Adverse weather	Undefined		UAC-IC2005 \$36.1;
		Natural calamities	Undefined		UAC-IC2005 \$36.1;
		Acts of God	Undefined		UAC-IC2005 \$36.1; \$41.4;
		Competing interests between project and local communities	Undefined		
		Working patterns linked to local cultural and religious factors	Contractor		UAC-IC2005 \$36.1;
		Culture and habits	Undefined		
		Neighboring citizens rejecting the project	Undefined		
		Nongovernment organisations (NGOs) and environmental organisation opposing the project	Undefined		
External Risks	Public Involvement	Public perception distorted by media	Undefined		
		Public exposure	Contractor		UAC-IC2005 \$4.6.11; \$12.1; \$18
		Citizen interest	Undefined		
		Unexpected additional environmental regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1.3;
		Environmental impact statement or assessment	Contractor		UAC-IC2005 \$4.6;
		Historical and artistic patrimony and archeological patrimony protection	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1.3; \$13.7;
		Anthropological or biological interest (protection of endangered species, flora, and fauna)	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1.3;
		Hazardous waste, noise, contamination, and emissions	Contractor		UAC-IC2005 \$4.6.11; \$12.1;
		Authorities with jurisdiction and vulnerability of political support	Undefined		
		Regulatory institutions, government, and administration's statutory requirements or clearances	Client		UAC-IC2005 \$9.1;
External Risks	Political Visibility & Regulatory Factors	Changes in law, procedures, subsidies, policies and regulations, or project priorities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1.3;
		Complex administrative approval procedures	Client		UAC-IC2005 \$9.1.5;
		Obstruction of approvals	Contractor		UAC-IC2005 \$10.1.4;
		Bureaucracy	Undefined		
		Environmental political pressures	Undefined		
		Political sensitivity and climate	Undefined		

Organisational Risks		Culture Attitudes Disagreement about objectives Insufficient resources Inexperienced, inadequate, or undertrained staff Internal approval complexities Inconsistent cost, time, scope, and quality objectives Changes to prioritization of existing program	Undefined Undefined Predominantly Client Predominantly Contractor Shared Predominantly Client Predominantly Client Client		UAC-IC2005 §38.1; UAC-IC2005 §3.3.4; §14; §47; UAC-IC2005 §38.1.7; UAC-IC2005 §2.1.4, 5.7.8; §4.1.5.9; §23.9; UAC-IC2005 §22; §23; UAC-IC2005 §3.3.4; UAC-IC2005 §3.3.4; §14; UAC-IC2005 §4.6.11;
		Incomplete stakeholder identification Overloaded team project portfolio Insufficient resources assigned to the management of the project Insufficient time to plan Unanticipated project manager workload Project team stability (lack of project team continuity, high rotation) Inadequate change request procedure Communication breakdown within project team Project purpose definition, needs, objectives, costs, and deliverables that are poorly defined or understood	Contractor Undefined <i>Contractor</i> <i>Contractor</i> Undefined Shared Predominantly Client Shared Shared		UAC-IC2005 §38.1; UAC-IC2005 §7; UAC-IC2005 §2.1.2, 7.8; UAC-IC2005 §14; §15; §22; §23; §44; §45; UAC-IC2005 §47; UAC-IC2005 §3.3.4; §21.2;
Business Risks	Financial & Economical	Funding and financing Inflation rate volatility Currency exchange rate fluctuations National economic growth and recessions Loan interest rates	Client Contractor Contractor Contractor Contractor Predominantly Contractor		UAC-IC2005 §3.9; UAC-IC2005 §4.4; UAC-IC2005 §4.4; UAC-IC2005 §4.4; UAC-IC2005 §4.4; UAC-IC2005 §4.4; §42.1; UAC-IC2005 §22; §23;
		Number of key sponsors for decision making and management Contractor selection procedure Designer selection procedure Selection of insurance Priorities of the project	Client Client Client Shared Contractor		TRUI2016 §19.3; TRUI2016 §19.3; UAC-IC2005 §39.1; UAC-IC2005 §7;
		Control of key issues of the project Project management information systems	Predominantly Contractor Contractor Client		UAC-IC2005 §19; §21.2.4; UAC-IC2005 §19; UAC-IC2005 §3.1b;
		Land acquisition Clear title to land with appropriate zoning	Client <i>Client</i> <i>Client</i>	based on UAC-IC-2005 §3.1b based on UAC-IC-2005 §3.1b based on UAC-IC-2005 §3.1b	
		Expropriation Rights of way Delay in land access agreements Damage to neighboring properties	Client Contractor Client Contractor		UAC-IC2005 §3.1b; UAC-IC2005 §4.10.11; §11.4; UAC-IC2005 §9.1; UAC-IC2005 §10.1;
	Land & Property, Statutory Clearance	Clearance from regulatory institutions, governments, and administrations	Client Contractor		UAC-IC2005 §26; UAC-IC2005 §27.3; §28; UAC-IC2005 §35;
		Early Use Early Maintenance & Warranty Sales tax rate change	Client Contractor Client		
Others					

Risk Category	Risk Subcategory	Risk	Allocation (=Reasonably Assumed)	Notes	Source
Design/ Technical Risks		Inadequate and incomplete design	Contractor		UAC-IC2005 \$4.5,9; \$19; \$21.2; PRYB2016 \$20/21;
		Incomplete knowledge of local site conditions	Shared		UAC-IC2005 \$4.5,9; \$13.1,4,6;
		Inaccurate technical assumptions	Contractor		UAC-IC2005 \$4.5,9; \$21.2; PRYB2016 \$20/21;
		Insufficient technical background and experience on specific project type and local characteristics	Contractor		UAC-IC2005 \$4.5,9; \$21.2; PRYB2016 \$20/21;
		Incorrect selection of equipment, materials, and building techniques	Contractor		UAC-IC2005 \$19; \$21.2; PRYB2016 \$20/21;
		Incorrect geotechnical and foundation estimations and structural design	Contractor		UAC-IC2005 \$4.5,9; \$13.1; \$19; \$21.2; PRYB2016 \$20/21;
		Errors and omissions by consultants	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 \$44.1a)	UAC-IC2005 \$4.5,9; \$5; \$6.1;
Construction Risks	Contractual Factors	Lack of specialised technical consultants on critical aspects of the project	Contractor		UAC-IC2005 \$4.5,9;
		Over-involvement of the owner in design	Predominantly Contractor		UAC-IC2005 \$23.11,12,13,16; PRYB2016 \$20/21;
		Continuous changes to the project scope	Client		UAC-IC2005 \$3.3; \$14; \$15; \$16;
		Delays in obtaining client concurrence	Predominantly Client		UAC-IC2005 \$23.5,6,7,16; \$45.13;
		Design scope exceeding available budget	Contractor		UAC-IC2005 \$4.4;
		Uncertainty in the total cost estimate due to uncertain quantities and unit prices during the planning and initial design phase	Shared	contractor unless a provisional sum has been agreed upfront	UAC-IC2005 \$34;
		Incomplete project cost estimate and inaccurate project schedule	Predominantly Contractor		UAC-IC2005 \$4.4; \$7; \$34; \$36.1; PRYB2016 \$7.01;
		Contractor and/or subcontractor capability	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 \$44.1a)	UAC-IC2005 \$4.1,3,5; \$5; \$6.1; \$43.2; PRYB2016 \$6.01;
		Inefficient coordination of project plans	Contractor		UAC-IC2005 \$21.2; \$36.1; PRYB2016 \$7.01; \$20/21;
		Unavailability of sufficient and skilled human resources	Contractor		UAC-IC2005 \$4.5,9; \$21.2; PRYB2016 \$4.13; \$20/21;
	Technical Factors	Unavailability in time of special materials and construction equipment and equipment breakdowns	Contractor		UAC-IC2005 \$3.1c,2,5; \$4.1,3,5,9; PRYB2016 \$4.10; \$7.01;
		Equipment commissioning	Contractor		UAC-IC2005 \$3.1c,2,5; \$4.1,3,5,9;
		Unsuitable equipment and materials	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c,2,5; \$4.1,3,5,9;
		Low level of competency in management (especially subcontractors)	Contractor		UAC-IC2005 \$19; \$21.2; PRYB2016 \$20/21;
		Incomplete knowledge and training on specific construction techniques	Contractor		UAC-IC2005 \$19; \$21.2; PRYB2016 \$4.12; \$20/21;
		Construction occupational safety	Contractor		UAC-IC2005 \$12.1; PRYB2016 \$4.06,08;
		Lack of environmental training and knowledge of workers on site	Contractor		UAC-IC2005 \$12.1; PRYB2016 \$4.12;
		Restricted work hours	Undefined		UAC-IC2005 \$17.1;
		Health and safety regulations and responsibilities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1,3; \$12.1;
		Site & Layout Conditions	Changes in work orders	Predominantly Client	
	Low level of documented detail design		Contractor		UAC-IC2005 \$19;
	Lack of scheduled instructions and drawing documents		Contractor		UAC-IC2005 \$12.2,3,5; \$19;
	Gap between theory and actual quantities of work		Shared	but very nuanced	UAC-IC2005 \$3.1a,2; \$36.1; \$44; PRYB2016 \$44;
	Unexpected costs of tests and samples		Predominantly Contractor		UAC-IC2005 \$4.4; PRYB2016 \$4.01a;
	Site access		Predominantly Client		UAC-IC2005 \$3.1b; PRYB2016 \$3.01; \$4.09;
	Site security		Contractor		UAC-IC2005 \$12.1;
	Availability of resources		Contractor		UAC-IC2005 \$6.1; PRYB2016 \$4.10;
	Availability and capacity of utility services		Undefined		UAC-IC2005 \$17.1,2;
	Resource overloading		Contractor		UAC-IC2005 \$12.1;
	Physical Factors	Interference between task fronts	Contractor	compensation in case of hindering side-contractor (UAC-IC2005 \$44.1a)	UAC-IC2005 \$8;
		Geological and geotechnical conditions	Shared		UAC-IC2005 \$3.1a,2; \$13.1,4,6;
		Sufficient and representative geotechnical and geological tests and samples	Contractor		UAC-IC2005 \$13.1;
		Groundwater level	Contractor		UAC-IC2005 \$13.1;
		Topography	Contractor		UAC-IC2005 \$13.1;
		Unforeseen subsurface conditions	Shared		UAC-IC2005 \$13.1,4,6;
		Unexpected climate conditions not covered under force majeure	Undefined		PRYB2016 \$4.14;
		Corruption	Undefined		UAC-IC2005 \$12.1; \$41; PRYB2016 \$17;
		Assault, vandalism, sabotage, and theft	Contractor		
		Intrusion and illegal occupancy of site	Undefined		
	Contractual Factors	Inaccurate contract time estimates	Contractor		UAC-IC2005 \$7; \$36.1; PRYB2016 \$7.01;
Insolvency of contractor, subcontractor, or supplier		Predominantly Contractor		UAC-IC2005 \$4.4; \$6.1; \$33.9; \$43.3;	
Inadequate change orders procedure		Predominantly Client		UAC-IC2005 \$14; \$15; \$16; \$22; \$23; \$44; \$45;	
Change orders negotiation		Predominantly Client		PRYB2016 \$14; \$44/45;	
Unexpected work and extras		Predominantly Contractor	the question "unexpected for whom" is left aside	UAC-IC2005 \$13.4,5; \$14; \$24.7; \$25.1; \$36.1; \$44; PRYB2016 \$14; \$44;	
Delayed deliveries and disruptions		Predominantly Contractor		UAC-IC2005 \$7; \$16.9,10; \$36.1; PRYB2016 \$7.01;	
Delayed payment on contracts		Client	only considering the main contract, for subcontracts: PRYB2016 \$4b;	UAC-IC2005 \$3.9; \$33.4,7; \$38.7; \$42.1;	
Vendor appraisals		Predominantly Contractor		UAC-IC2005 \$6.1,2,3; PRYB2016 \$4.14b2,14b3;	
Reliance on a single source		Contractor		UAC-IC2005 \$38.1;	
Performance Factors		Defective work	Contractor		UAC-IC2005 \$4.5,9; \$21.2; \$41; PRYB2016 \$4.01; \$20/21;
	Unskillfulness	Contractor		UAC-IC2005 \$21.2; PRYB2016 \$4.12; \$20/21;	
	Negligence and malicious acts	Contractor		UAC-IC2005 \$12.1; \$41; PRYB2016 \$4.01;	
	Labor disputes	Predominantly Contractor	for subcontracts: PRYB2016 \$4b;	UAC-IC2005 \$38.1; \$47; PRYB2016 \$14; \$38; \$47;	
	Unsuitable materials	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c,2,5; \$4.1,3,5,9; PRYB2016 \$20/21;	
	Construction productivity (labor and equipment)	Contractor		UAC-IC2005 \$4.1; \$21.2; PRYB2016 \$20/21;	
	Accidents and injuries	Contractor		UAC-IC2005 \$12.1; \$41; PRYB2016 \$4.07;	
	Critical lead times	Contractor		UAC-IC2005 \$7; \$21.2; \$36.1; PRYB2016 \$7.01; \$20/21;	

External Risks	Contractual Factors	Tight project schedule	Contractor		UAC-IC2005 §7; §21.2; §36.1; PRYB2016 §7.01; §20/21; UAC-IC2005 §3.3.4; §21.4; PRYB2016 §20/21; UAC-IC2005 §3.3.4; §21.2; PRYB2016 §20/21;
		Client's quality and performance expectations higher than documented	Client		
		Weak definition and documentation of project objectives (cost, schedule, scope, quality)	Predominantly Client		
	Force Majeure Factors	Overlooked or new powerful and influencing stakeholders	Undefined		
		Influencing late changes in stakeholders' requirements	Undefined		
		Market changes	Contractor		UAC-IC2005 §4.4; §34;
		Economic and political instability	Contractor		UAC-IC2005 §4.4; §34;
		Changes in regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1.3;
	Social Factors	Labor strikes	Contractor		UAC-IC2005 §4.4; §36.1;
		Adverse weather	Undefined		UAC-IC2005 §36.1;
		Natural calamities	Undefined		UAC-IC2005 §36.1;
		Acts of God	Undefined		UAC-IC2005 §36.1; §41.4;
		Competing interests between project and local communities	Undefined		
	Public Involvement	Working patterns linked to local cultural and religious factors	Contractor		UAC-IC2005 §36.1;
		Culture and habits	Undefined		
		Neighboring citizens rejecting the project	Undefined		
		Nongovernment organisations (NGOs) and environmental organisation opposing the project	Undefined		
		Public perception distorted by media	Undefined		
	Environmental Factors	Public exposure	Predominantly Contractor		UAC-IC2005 §4.6.11; §12.1; §18; PRYB2016 §18;
		Citizen interest	Undefined		
		Unexpected additional environmental regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1.3;
		Environmental impact statement or assessment	Contractor		UAC-IC2005 §4.6;
		Historical and artistic patrimony and archeological patrimony protection	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1.3; §13.7;
	Political Visibility & Regulatory Factors	Anthropological or biological interest (protection of endangered species, flora, and fauna)	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1.3;
		Hazardous waste, noise, contamination, and emissions	Contractor		UAC-IC2005 §4.6.11; §12.1; PRYB2016 §4.11d;
		Authorities with jurisdiction and vulnerability of political support	Undefined		
		Regulatory institutions, government, and administration's statutory requirements or clearances	Client		UAC-IC2005 §9.1; PRYB2016 §10;
		Changes in law, procedures, subsidies, policies and regulations, or project priorities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §10.1; PRYB2016 §4.13.14; §10;
Organisational Risks		Complex administrative approval procedures	Client		UAC-IC2005 §11.1.3;
		Obstruction of approvals	Contractor		UAC-IC2005 §9.1.5;
		Bureaucracy	Undefined		UAC-IC2005 §10.1.4;
		Environmental political pressures	Undefined		PRYB2016 §10.1;
		Political sensitivity and climate	Undefined		
		Culture	Undefined		
		Attitudes	Undefined		
		Disagreement about objectives	Predominantly Client		UAC-IC2005 §38.1; PRYB2016 §38;
		Insufficient resources	Predominantly Contractor		UAC-IC2005 §3.3.4; §14; §47; PRYB2016 §47;
		Inexperienced, inadequate, or undertrained staff	Predominantly Contractor		UAC-IC2005 §38.1.7;
Project Management Risks		Internal approval complexities	Predominantly Client		UAC-IC2005 §2.1.4.5.7.8; §4.1.5.9; §23.9; PRYB2016 §4.12;
		Inconsistent cost, time, scope, and quality objectives	Predominantly Client		UAC-IC2005 §22; §23;
		Changes to prioritization of existing program	Client		UAC-IC2005 §3.3.4;
		Incomplete stakeholder identification	Contractor		UAC-IC2005 §3.3.4; §14;
		Overloaded team project portfolio	Undefined		UAC-IC2005 §4.6.11;
		Insufficient resources assigned to the management of the project	Contractor		UAC-IC2005 §38.1;
		Insufficient time to plan	Contractor		UAC-IC2005 §7;
		Unanticipated project manager workload	Undefined		
		Project team stability (lack of project team continuity, high rotation)	Shared		UAC-IC2005 §2.1.2.7.8;
		Inadequate change request procedure	Predominantly Client		UAC-IC2005 §14; §15; §22; §23; §44; §45;
Business Risks	Financial & Economical	Communication breakdown within project team	Shared		UAC-IC2005 §47; PRYB2016 §47;
		Project purpose definition, needs, objectives, costs, and deliverables that are poorly defined or understood	Shared		UAC-IC2005 §3.3.4; §21.2; PRYB2016 §20/21;
		Funding and financing	Client		UAC-IC2005 §3.9;
		Inflation rate volatility	Contractor		UAC-IC2005 §4.4;
		Currency exchange rate fluctuations	Contractor		UAC-IC2005 §4.4;
	Planning, Monitoring, & Controlling	National economic growth and recessions	Contractor		UAC-IC2005 §4.4;
		Loan interest rates	Contractor		UAC-IC2005 §4.4;
		Number of key sponsors for decision making and management	Predominantly Contractor		UAC-IC2005 §4.4; §42.1;
		Contractor selection procedure	Client		UAC-IC2005 §22; §23;
		Designer selection procedure	Client		TRUI2016 §19.3;
Others		Selection of insurance	Shared		UAC-IC2005 §19.3;
		Priorities of the project	Contractor		UAC-IC2005 §38.1;
		Control of key issues of the project	Predominantly Contractor		UAC-IC2005 §7;
		Project management information systems	Contractor		UAC-IC2005 §19; §21.2.4;
		Land acquisition	Client		UAC-IC2005 §19; PRYB2016 §4.13.14b1;
	Land & Property, Statutory Clearance	Clear title to land with appropriate zoning	Client		UAC-IC2005 §3.1b;
		Expropriation	Client	based on UAC-IC-2005 §3.1b	
		Rights of way	Shared	based on UAC-IC-2005 §3.1b	
		Delay in land access agreements	Client		PRYB2016 §3.01;
		Damage to neighboring properties	Contractor		UAC-IC2005 §3.1b;
		Clearance from regulatory institutions, governments, and administrations	Client		UAC-IC2005 §4.10.11; §11.4; PRYB2016 §4.02.03;
		Early Use	Contractor		UAC-IC2005 §9.1; PRYB2016 §10;
		Early Maintenance & Warranty	Predominantly Contractor		UAC-IC2005 §10.1; PRYB2016 §10;
		Sales tax rate change	Contractor		UAC-IC2005 §26; PRYB2016 §26;
		Construction damages	Client		UAC-IC2005 §27.3; §28; PRYB2016 §27.02; §28;
			Contractor		UAC-IC2005 §35;
					PRYB2016 §4.01; §41;

D.3 Nijmegen – Construction of Working Pits

Risk Category	Risk Subcategory	Risk	Allocation (=Reasonably Assumed)	Notes	Source
Design/ Technical Risks		Inadequate and incomplete design	Contractor		UAC-IC2005 §4.5.9; §19; §21.2; PRYB2016 §20/21; BA §3.3; §27; PPE&C 3.1.2.1;
		Incomplete knowledge of local site conditions	Predominantly Contractor		UAC-IC2005 §4.5.9; §13.1.4.6; PPE&C 3.1.2.1;
		Inaccurate technical assumptions	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; BA §3.3;
		Insufficient technical background and experience on specific project type and local characteristics	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; PPE&C 3.1.2.1;
		Incorrect selection of equipment, materials, and building techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA §3.3;
		Incorrect geotechnical and foundation estimations and structural design	Contractor		UAC-IC2005 §4.5.9; §13.1; §19; §21.2; PRYB2016 §20/21; BA §3.3; PPE&C 3.1.2.1;
		Errors and omissions by consultants	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.5.9; §5; §6.1;
		Lack of specialised technical consultants on critical aspects of the project	Contractor		UAC-IC2005 §4.5.9; BA §3.3; PPE&C 3.1.2.1;
		Over-involvement of the owner in design	Contractor		UAC-IC2005 §23.11.12.13.16; PRYB2016 §20/21; BA §3.3;
		Continuous changes to the project scope	Client		UAC-IC2005 §3.3; §14; §15; §16;
		Delays in obtaining client concurrence	Predominantly Client		UAC-IC2005 §23.5.6.7.16; §45.13; A3;
		Design scope exceeding available budget	Contractor		UAC-IC2005 §4.4;
		Uncertainty in the total cost estimate due to uncertain quantities and unit prices during the planning and initial design phase	Shared	contractor unless a provisional sum has been agreed upfront	UAC-IC2005 §34; BA §3.3; §15a; A7;
		Incomplete project cost estimate and inaccurate project schedule	Predominantly Contractor		UAC-IC2005 §4.4; §7; §34; §36.1; PRYB2016 §7.01; BA §3.3; §15a; §16.2.3;

Construction Risks	Contractual Factors	Contractor and/or subcontractor capability	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 \$44.1a)	UAC-IC2005 \$4.1,3.5; \$5; \$6.1; \$43.2; PRYB2016 \$6.01; PPE&C 7;
		Inefficient coordination of project plans	Contractor		UAC-IC2005 \$21.2; \$36.1; PRYB2016 \$7.01; \$20/21; PPE&C 7.1;
		Unavailability of sufficient and skilled human resources	Predominantly Contractor		UAC-IC2005 \$4.5,9; \$21.2; PRYB2016 \$4.13; \$20/21; A15;
		Unavailability in time of special materials and construction equipment and equipment breakdowns	Contractor		UAC-IC2005 \$3.1c,2.5; \$4.1,3.5,9; PRYB2016 \$4.10; \$7.01; PPE&C 4.2,2;
		Equipment commissioning	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c,2.5; \$4.1,3.5,9;
		Unsuitable equipment and materials	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c,2.5; \$4.1,3.5,9; PPE&C 4.2,2;
		Low level of competency in management (especially subcontractors)	Contractor		UAC-IC2005 \$19; \$21.2; PRYB2016 \$20/21; BA \$24.1; PPE&C 7;
	Technical Factors	Incomplete knowledge and training on specific construction techniques	Contractor		UAC-IC2005 \$19; \$21.2; PRYB2016 \$4.12; \$20/21;
		Construction occupational safety	Contractor		UAC-IC2005 \$12.1; PRYB2016 \$4.06,08; A15;
		Lack of environmental training and knowledge of workers on site	Contractor		UAC-IC2005 \$12.1; PRYB2016 \$4.12;
		Restricted work hours	Contractor		UAC-IC2005 \$17.1; BA \$24.2;
	Site & Layout Conditions	Health and safety regulations and responsibilities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1,3; \$12.1; A15;
		Changes in work orders	Predominantly Client		UAC-IC2005 \$14; \$16; \$45; PRYB2016 \$14; \$44/45;
		Low level of documented detail design	Contractor		UAC-IC2005 \$19; BA \$3.3; PPE&C 3.1.3.1;
		Lack of scheduled instructions and drawing documents	Contractor		UAC-IC2005 \$12.2,3,5; \$19; BA \$3.3; PPE&C 3.1.3.1; 7.1;
	Physical Factors	Gap between theory and actual quantities of work	Shared		UAC-IC2005 \$3.1a,2; \$36.1; \$44; PRYB2016 \$44; BA \$3.3,4;
		Unexpected costs of tests and samples	Predominantly Contractor	but very nuanced	UAC-IC2005 \$4.4; PRYB2016 \$4.01a; A15;
		Site access	Predominantly Client		UAC-IC2005 \$3.1b; PRYB2016 \$3.01a; \$4.09; A14,1; PPE&C 6.2,1;
		Site security	Contractor		UAC-IC2005 \$12.1; PPE&C 5.1.1;
	Security Factors	Availability of resources	Contractor		UAC-IC2005 \$6.1; PRYB2016 \$4.10;
		Availability and capacity of utility services	Contractor		UAC-IC2005 \$17.1,2; PPE&C 5.1.1;
		Resource overloading	Contractor		UAC-IC2005 \$12.1;
		Interference between task fronts	Contractor	compensation in case of hindering side-contractor (UAC-IC2005 \$44.1a)	UAC-IC2005 \$8; PPE&C 3.1.3,4;
	Contractual Factors	Geological and geotechnical conditions	Predominantly Contractor		UAC-IC2005 \$3.1a,2; \$13.1,4,6; PPE&C 3.1.2,1;
		Sufficient and representative geotechnical and geological tests and samples	Contractor		UAC-IC2005 \$13.1; A15;
		Groundwater level	Contractor		UAC-IC2005 \$13.1;
		Topography	Contractor		UAC-IC2005 \$13.1; PPE&C 3.1.2,1;
	Performance Factors	Unforeseen subsurface conditions	Predominantly Contractor		UAC-IC2005 \$13.1,4,6; PPE&C 6.3,2;
		Unexpected climate conditions not covered under force majeure	Undefined		
		Corruption	Undefined		
		Assault, vandalism, sabotage, and theft	Contractor		PRYB2016 \$4.14;
External Risks	Contractual Factors	Intrusion and illegal occupancy of site	Contractor		UAC-IC2005 \$12.1; \$41; PRYB2016 \$17;
		Inaccurate contract time estimates	Contractor		PPE&C 5.1.1;
		Insolvency of contractor, subcontractor, or supplier	Predominantly Contractor		UAC-IC2005 \$7; \$36.1; PRYB2016 \$7.01; BA \$16.2,3;
		Inadequate change orders procedure	Predominantly Client		UAC-IC2005 \$4.4; \$6.1; \$33.9; \$43.3;
	Contractual Factors	Change orders negotiation	Predominantly Client		UAC-IC2005 \$14; \$15; \$16; \$22; \$23; \$44; \$45; PRYB2016 \$14; \$44/45;
		Unexpected work and extras	Predominantly Contractor	the question "unexpected for whom" is left aside	UAC-IC2005 \$14; \$15; \$23; \$44.7; PRYB2016 \$44;
		Delayed deliveries and disruptions	Predominantly Contractor		UAC-IC2005 \$13.4,5; \$14; \$24.7; \$25.1; \$36.1; \$44; PRYB2016 \$14; \$44;
		Delayed payment on contracts	Client	only considering the main contract, for subcontracts: PRYB2016 \$4b;	UAC-IC2005 \$7; \$16.7,9,10; \$36.1; PRYB2016 \$7.01; BA \$16.2,3; \$24.1,2; A14.1; A15;
	Performance Factors	Vendor appraisals	Predominantly Contractor		UAC-IC2005 \$3.9; \$33.4,7; \$38.7; \$42.1; BA \$14;
		Reliance on a single source	Contractor		UAC-IC2005 \$6.1,2,3; PRYB2016 \$4.14b,14b3; PPE&C 4.2,2;
		Defective work	Contractor		UAC-IC2005 \$38.1;
		Unskillfulness	Contractor		UAC-IC2005 \$4.5,9; \$21.2; \$41; PRYB2016 \$4.01; \$20/21; BA 27; PPE&C 4.6,2,1;
	Social Factors	Negligence and malicious acts	Contractor		UAC-IC2005 \$21.2; PRYB2016 \$4.12; \$20/21;
		Labor disputes	Contractor		UAC-IC2005 \$12.1; \$41; PRYB2016 \$4.01; BA \$27;
		Unsuitable materials	Predominantly Contractor	for subcontracts: PRYB2016 \$4b;	UAC-IC2005 \$38.1; \$47; PRYB2016 \$14; \$38; \$47;
		Construction productivity (labor and equipment)	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 \$3.1c,2.5; \$4.1,3.5,9; \$21.2; PRYB2016 \$20/21; PPE&C 4.2,2;
	Public Involvement	Accidents and injuries	Contractor		UAC-IC2005 \$4.1; \$21.2; PRYB2016 \$20/21; A15;
		Critical lead times	Contractor		UAC-IC2005 \$12.1; \$41; PRYB2016 \$4.07;
		Tight project schedule	Contractor		UAC-IC2005 \$7; \$21.2; \$36.1; PRYB2016 \$7.01; \$20/21; BA \$16.2,3;
		Client's quality and performance expectations higher than documented	Client		\$24.1,2;
	Force Majeure Factors	Weak definition and documentation of project objectives (cost, schedule, scope, quality)	Predominantly Client		UAC-IC2005 \$3.3,4; \$21.4; PRYB2016 \$20/21;
		Overlooked or new powerful and influencing stakeholders	Undefined		UAC-IC2005 \$3.3,4; \$21.2; PRYB2016 \$20/21; BA \$3.4;
		Influencing late changes in stakeholders' requirements	Undefined		
		Market changes	Contractor		
	Social Factors	Economic and political instability	Contractor		UAC-IC2005 \$4.4; \$34;
		Changes in regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$4.4; \$34;
		Labor strikes	Contractor		UAC-IC2005 \$11.1,3;
		Adverse weather	Prenominantly Contractor		UAC-IC2005 \$4.4; \$36.1;
	Public Involvement	Natural calamities	Shared		UAC-IC2005 \$36.1; MCHW; A14,2;
		Acts of God	Undefined		UAC-IC2005 \$36.1; A14,2;
		Competing interests between project and local communities	Client		UAC-IC2005 \$36.1; \$41.4;
		Working patterns linked to local cultural and religious factors	Contractor		PPE&C 9.1;
	Environmental Factors	Culture and habits	Undefined		UAC-IC2005 \$36.1;
		Neighboring citizens rejecting the project	Client		
		Nongovernment organisations (NGOs) and environmental organisation opposing the project	Client		PPE&C 9.1;
		Public perception distorted by media	Client		PPE&C 9.1;
	Contractual Factors	Public exposure	Shared		PPE&C 9.1;
		Citizen interest	Client		UAC-IC2005 \$4.6,11; \$12.1; \$18; PRYB2016 \$18; A12.1,1; PPE&C 9.1;
		Unexpected additional environmental regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1,3;
		Environmental impact statement or assessment	Contractor		UAC-IC2005 \$4.6;
	Political Visibility & Regulatory Factors	Historical and artistic patrimony and archeological patrimony protection	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1,3; \$13.7; PPE&C 6.4;
		Anthropological or biological interest (protection of endangered species, flora, and fauna)	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$11.1,3; PPE&C 4.5;
		Hazardous waste, noise, contamination, and emissions	Predominantly Contractor	contractor can be compensated in unforeseeable cases (BA \$9);	UAC-IC2005 \$4.6,11; \$12.1; PRYB2016 \$4.11d; BA \$6; A5; A15; PPE&C 4.4;
		Authorities with jurisdiction and vulnerability of political support	Client		PPE&C 9.1;
	Organisational Risks	Regulatory institutions, government, and administration's statutory requirements or clearances	Client		UAC-IC2005 \$9.1; PRYB2016 \$10; BA \$6.1,2;
		Changes in law, procedures, subsidies, policies and regulations, or project priorities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (\$44.1a)	UAC-IC2005 \$10.1; PRYB2016 \$4.13,14; \$10; BA \$6.3; PPE&C 6.1,2;
		Complex administrative approval procedures	Contractor		UAC-IC2005 \$11.1,3;
		Obstruction of approvals	Undefined		UAC-IC2005 \$9.1,5;
	Project Management Risks	Bureaucracy	Undefined		UAC-IC2005 \$10.1,4;
		Environmental political pressures	Undefined		PRYB2016 \$10.1;
		Political sensitivity and climate	Undefined		
		Culture	Undefined		
	Contractual Factors	Attitudes	Undefined		
		Disagreement about objectives	Predominantly Client		UAC-IC2005 \$38.1; PRYB2016 \$38;
		Insufficient resources	Predominantly Contractor		UAC-IC2005 \$3.3,4; \$14; \$47; PRYB2016 \$47;
		Inexperienced, inadequate, or undertrained staff	Predominantly Contractor		UAC-IC2005 \$38.1,7;
	Performance Factors	Internal approval complexities	Predominantly Client		UAC-IC2005 \$2.1,4,5,7,8; \$4.1,5,9; \$23.9; PRYB2016 \$4.12;
		Inconsistent cost, time, scope, and quality objectives	Predominantly Client		UAC-IC2005 \$22; \$23;
		Changes to prioritization of existing program	Client		UAC-IC2005 \$3.3,4; BA \$3.4;
		Incomplete stakeholder identification	Contractor		UAC-IC2005 \$3.3,4; \$14;
	Public Involvement	Overloaded team project portfolio	Undefined		UAC-IC2005 \$4.6,11;
		Insufficient resources assigned to the management of the project	Contractor		
		Insufficient time to plan	Contractor		UAC-IC2005 \$38.1;
		Unanticipated project manager workload	Undefined		UAC-IC2005 \$7;
	Contractual Factors	Project team stability (lack of project team continuity, high rotation)	Shared		
		Inadequate change request procedure	Predominantly Client		UAC-IC2005 \$2.1,2,7,8;
		Communication breakdown within project team	Shared		UAC-IC2005 \$14; \$15; \$22; \$23; \$44; \$45;
		Project purpose definition, needs, objectives, costs, and deliverables that are poorly defined or understood	Shared		UAC-IC2005 \$47; PRYB2016 \$47; BA \$22,6;
	Performance Factors				UAC-IC2005 \$3.3,4; \$21.2; PRYB2016 \$20/21;

Business Risks	Financial & Economical	Funding and financing	Client		UAC-IC2005 §3.9;
		Inflation rate volatility	Contractor		UAC-IC2005 §4.4;
		Currency exchange rate fluctuations	Contractor		UAC-IC2005 §4.4;
	Planning, Monitoring, & Controlling	National economic growth and recessions	Contractor		UAC-IC2005 §4.4;
		Loan interest rates	Predominantly Contractor		UAC-IC2005 §4.4;
		Number of key sponsors for decision making and management	Client		UAC-IC2005 §4.4; §42.1;
		Contractor selection procedure	Client		UAC-IC2005 §22; §23;
		Designer selection procedure	Client		TRUI2016 §19.3;
		Selection of insurance	Shared		TRUI2016 §19.3;
		Priorities of the project	Contractor		UAC-IC2005 §39.1; BA §14.6b; A10;
Others	Land & Property, Statutory Clearance	Control of key issues of the project	Predominantly Contractor		UAC-IC2005 §7;
		Project management information systems	Contractor		UAC-IC2005 §19; §21.2.4;
		Land acquisition	Client		UAC-IC2005 §19; PRYB2016 §4.13,14b1; BA §3.3; §22.4; PPE&C 7.1; 9.2;
		Clear title to land with appropriate zoning	Client	based on UAC-IC-2005 §3.1b	UAC-IC2005 §3.1b;
		Expropriation	Client	based on UAC-IC-2005 §3.1b	
		Rights of way	Shared		
		Delay in land access agreements	Client		PRYB2016 §3.01;
	Early Use	Damage to neighboring properties	Contractor		UAC-IC2005 §3.1b;
		Clearance from regulatory institutions, governments, and administrations	Client		UAC-IC2005 §4.10,11; §11.4; PRYB2016 §4.02.03; A12.1.1; PPE&C 5.1.1;
			Contractor		UAC-IC2005 §9.1; PRYB2016 §10; BA §6.1,2;

D.4 Nunspeet – Construction of Station Area Underpasses

Risk Category	Risk Subcategory	Risk	Allocation (=Reasonably Assumed)	Notes	Source
Design/ Technical Risks		Inadequate and incomplete design	Contractor		UAC-IC2005 §4.5.9; §19; §21.2; PRYB2016 §20/21; BA §3.3; §25a; PPD&C 3.1.2.1;
		Incomplete knowledge of local site conditions	Predominantly Contractor		UAC-IC2005 §4.5.9; §13.1.4,6; PPD&C 3.1.2.1;
		Inaccurate technical assumptions	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; BA §3.3;
		Insufficient technical background and experience on specific project type and local characteristics	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; PPD&C 3.1.2.1;
		Incorrect selection of equipment, materials, and building techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA §3.3; §25a;
		Incorrect geotechnical and foundation estimations and structural design	Contractor		UAC-IC2005 §4.5.9; §13.1; §19; §21.2; PRYB2016 §20/21; BA §3.3; §25a; PPD&C 3.1.2.1;
		Errors and omissions by consultants	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.5.9; §5; §6.1;
		Lack of specialised technical consultants on critical aspects of the project	Contractor		UAC-IC2005 §4.5.9; BA §3.3; PPD&C 3.1.2.1;
		Over-involvement of the owner in design	Contractor		UAC-IC2005 §23.11,12,13,16; PRYB2016 §20/21; BA §3.3; §30;
		Continuous changes to the project scope	Predominantly Client		UAC-IC2005 §3.3; §14; §15; §16; BA §27;
Construction Risks	Contractual Factors	Delays in obtaining client concurrence	Predominantly Client		UAC-IC2005 §23.5,6,7,16; §45.13; A3;
		Design scope exceeding available budget	Contractor		UAC-IC2005 §4.4;
		Uncertainty in the total cost estimate due to uncertain quantities and unit prices during the planning and initial design phase	Shared	contractor unless a provisional sum has been agreed upfront	UAC-IC2005 §34; BA §3.3; §15a; A7.1;
		Incomplete project cost estimate and inaccurate project schedule	Predominantly Contractor		UAC-IC2005 §4.4; §7; §34; §36.1; PRYB2016 §7.01; BA §3.3; §15a; §16.2,3;
		Contractor and/or subcontractor capability	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.1,3,5; §5; §6.1; §43.2; PRYB2016 §6.01; BA §25a; §25b; PPD&C 7;
		Inefficient coordination of project plans	Contractor		UAC-IC2005 §21.2; §36.1; PRYB2016 §7.01; §20/21; BA §25a; PPD&C 7.1;
		Unavailability of sufficient and skilled human resources	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §4.13; §20/21;
		Unavailability in time of special materials and construction equipment and equipment breakdowns	Predominantly Contractor		UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; PRYB2016 §4.10; §7.01; BA §30; PPD&C 4.2.2;
		Equipment commissioning	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9;
		Unsuitable equipment and materials	Predominantly Contractor	although it depends on the provider, in practice it is often the contractor; some materials are prescribed	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; BA §30; PPD&C 4.2.2;
	Technical Factors	Low level of competency in management (especially subcontractors)	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA §25a; PPD&C 7;
		Incomplete knowledge and training on specific construction techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §4.12; §20/21;
		Construction occupational safety	Contractor		UAC-IC2005 §12.1; PRYB2016 §4.06.08; BA §25a; PPD&C 3.4;
		Lack of environmental training and knowledge of workers on site	Contractor		UAC-IC2005 §12.1; PRYB2016 §4.12; BA §25a;
		Restricted work hours	Undefined		UAC-IC2005 §17.1;
	Site & Layout Conditions	Health and safety regulations and responsibilities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3; §12.1; BA §25a; §30; PPD&C 3.4;
		Changes in work orders	Predominantly Client		UAC-IC2005 §14; §16; §45; PRYB2016 §14; §44/45; BA §30;
		Low level of documented detail design	Contractor		UAC-IC2005 §19; BA §3.3; PPD&C 3.1.3.1;
		Lack of scheduled instructions and drawing documents	Contractor		UAC-IC2005 §12.2,3,5; §19; BA §3.3; PPD&C 3.1.3.1; 7.1;
		Gap between theory and actual quantities of work	Contractor		UAC-IC2005 §3.1a,2; §36.1; §44; PRYB2016 §44; BA §3.3,4;
	Physical Factors	Unexpected costs of tests and samples	Predominantly Contractor	but very nuanced	UAC-IC2005 §4.4; PRYB2016 §4.01a; A15;
		Site access	Predominantly Client		UAC-IC2005 §3.1b; PRYB2016 §3.01; §4.09; A14.1; PPD&C 6.2.1;
		Site security	Contractor		UAC-IC2005 §12.1; PPD&C 5.1.1;
		Availability of resources	Contractor		UAC-IC2005 §6.1; PRYB2016 §4.10;
		Availability and capacity of utility services	Contractor		UAC-IC2005 §17.1.2; PPD&C 5.1.1;
	Security Factors	Resource overloading	Contractor		UAC-IC2005 §12.1;
		Interference between task fronts	Contractor	compensation in case of hindering side-contractor (UAC-IC2005 §44.1a)	UAC-IC2005 §8; BA §9; PPD&C 3.1.3.4;
		Geological and geotechnical conditions	Predominantly Contractor		UAC-IC2005 §3.1a,2; §13.1,4,6; PPD&C 3.1.2.1; 4.10;
		Sufficient and representative geotechnical and geological tests and samples	Contractor		UAC-IC2005 §13.1; A15; PPD&C 4.10;
		Groundwater level	Contractor		UAC-IC2005 §13.1;
	Contractual Factors	Topography	Contractor		UAC-IC2005 §13.1; PPD&C 3.1.2.1; 4.10;
		Unforeseen subsurface conditions	Predominantly Contractor		UAC-IC2005 §13.1,4,6; PPD&C 6.3.1.2;
		Unexpected climate conditions not covered under force majeure	Undefined		
		Corruption	Contractor		PRYB2016 §4.14;
		Assault, vandalism, sabotage, and theft	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §17;
	Performance Factors	Intrusion and illegal occupancy of site	Contractor		PPD&C 5.1.1;
		Inaccurate contract time estimates	Contractor		UAC-IC2005 §7; §36.1; PRYB2016 §7.01; BA §16.2,3; §25a;
		Insolvency of contractor, subcontractor, or supplier	Predominantly Contractor		UAC-IC2005 §4.4; §6.1; §33.9; §43.3;
		Inadequate change orders procedure	Predominantly Client		UAC-IC2005 §14; §15; §16; §22; §23; §44; §45; PRYB2016 §14; §44/45;
		Change orders negotiation	Predominantly Client		UAC-IC2005 §14; §15; §23; §44.7; PRYB2016 §44;
	Performance Factors	Unexpected work and extras	Predominantly Contractor	the question "unexpected for whom" is left aside	UAC-IC2005 §13.4,5; §14; §24.7; §25.1; §36.1; §44; PRYB2016 §14; §44; BA §27;
		Delayed deliveries and disruptions	Predominantly Contractor		UAC-IC2005 §7; §16.7,9,10; §36.1; PRYB2016 §7.01; BA §16.2,3; A14.1;
		Delayed payment on contracts	Client	only considering the main contract, for subcontracts: PRYB2016 §4b;	UAC-IC2005 §3.9; §33.4,7; §38.7; §42.1; BA §14;
		Vendor appraisals	Predominantly Contractor	some vendors are prescribed	UAC-IC2005 §6.1,2,3; PRYB2016 §4.14b2,14b3; PPD&C 4.2.2;
		Reliance on a single source	Contractor	partially related to quartz-free balast (BA §30.)	UAC-IC2005 §38.1;
	Performance Factors	Defective work	Contractor		UAC-IC2005 §4.5.9; §21.2; §41; PRYB2016 §4.01; §20/21; PPD&C 4.7.2.1;
		Unskillfulness	Contractor		UAC-IC2005 §21.2; PRYB2016 §4.12; §20/21; BA §25a;
		Negligence and malicious acts	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §4.01; BA §25a;
		Labor disputes	Predominantly Contractor	for subcontracts: PRYB2016 §4b;	UAC-IC2005 §38.1; §47; PRYB2016 §14; §38; §47;
		Unsuitable materials	Predominantly Contractor	although it depends on the provider, in practice it is often the contractor, some materials are prescribed	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; §21.2; PRYB2016 §20/21; BA §30; PPD&C 4.2.2;
	Performance Factors	Construction productivity (labor and equipment)	Contractor		UAC-IC2005 §4.1; §21.2; PRYB2016 §20/21; BA §25a;
		Accidents and injuries	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §4.07; BA §25a;
		Critical lead times	Contractor		UAC-IC2005 §7; §21.2; §36.1; PRYB2016 §7.01; §20/21; BA §16.2,3;

External Risks	Contractual Factors	Tight project schedule Client's quality and performance expectations higher than documented Weak definition and documentation of project objectives (cost, schedule, scope, quality) Overlooked or new powerful and influencing stakeholders Influencing late changes in stakeholders' requirements	Contractor Client Contractor Predominantly Contractor		UAC-IC2005 §7; §21.2; §36.1; PRYB2016 §7.01; §20/21; BA §16.2.3; UAC-IC2005 §3.3.4; §21.4; PRYB2016 §20/21; UAC-IC2005 §3.3.4; §21.2; PRYB2016 §20/21; BA §3.4; PPD&C 9.3.1; PPD&C 9.3.1;
	Force Majeure Factors	Market changes Economic and political instability Changes in regulations	Contractor Contractor Predominantly Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §4.4; §34; UAC-IC2005 §4.4; §34; UAC-IC2005 §11.1.3;
		Labor strikes Adverse weather Natural calamities Acts of God	Contractor Predominantly Contractor Shared Undefined		UAC-IC2005 §4.4; §36.1; UAC-IC2005 §36.1; MCHW; A14.2; UAC-IC2005 §36.1; A14.2; UAC-IC2005 §36.1; §41.4; PPD&C 9.1; 9.3; UAC-IC2005 §36.1;
	Social Factors	Competing interests between project and local communities Working patterns linked to local cultural and religious factors Culture and habits Neighboring citizens rejecting the project Nongovernment organisations (NGOs) and environmental organisation opposing the project Public perception distorted by media	Client Contractor Undefined Client Client Client		PPD&C 9.1; 9.3; PPD&C 9.1; 9.3; PPD&C 9.1; 9.3; PPD&C 9.1; 9.3; UAC-IC2005 §4.6,11; §12.1; §18; PRYB2016 §18; BA §28; A12.1.1; PPD&C 9.1; 9.3;
	Public Involvement	Public exposure	Predominantly Contractor		BA §28; A16; PPD&C 9.1; 9.3;
		Citizen interest	Predominantly Contractor		UAC-IC2005 §11.1.3;
		Unexpected additional environmental regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §4.6; PPD&C 4.9;
		Environmental impact statement or assessment	Contractor		
	Environmental Factors	Historical and artistic patrimony and archeological patrimony protection	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (UAC-IC2005 §44.1a)	UAC-IC2005 §11.1.3; §13.7; PPD&C 6.6;
		Anthropological or biological interest (protection of endangered species, flora, and fauna)	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1.3; PPD&C 4.6; 4.9;
		Hazardous waste, noise, contamination, and emissions	Predominantly Contractor	contractor can be compensated in unforeseeable cases (BA §8);	UAC-IC2005 §4.6,11; §12.1; PRYB2016 §4.11d; BA §8; A5; A15; PPD&C 4.5;
		Authorities with jurisdiction and vulnerability of political support	Client Client Contractor		PPD&C 9.1; UAC-IC2005 §9.1; PRYB2016 §10; BA §6.1.2; UAC-IC2005 §10.1; PRYB2016 §4.13,14; §10; BA §6.3; §25a; PPD&C 6.1.2;
	Political Visibility & Regulatory Factors	Regulatory institutions, government, and administration's statutory requirements or clearances	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1.3;
		Changes in law, procedures, subsidies, policies and regulations, or project priorities	Contractor		UAC-IC2005 §9.1.5; UAC-IC2005 §10.1.4; PRYB2016 §10.1;
		Complex administrative approval procedures	Client Contractor Undefined Undefined Undefined		
		Obstruction of approvals Bureaucracy Environmental political pressures Political sensitivity and climate	Contractor Undefined Undefined Contractor		A15;
	Organisational Risks	Culture Attitudes Disagreement about objectives Insufficient resources Inexperienced, inadequate, or undertrained staff Internal approval complexities Inconsistent cost, time, scope, and quality objectives Changes to prioritization of existing program	Contractor Undefined Contractor Predominantly Contractor Predominantly Contractor Predominantly Client Contractor Client		UAC-IC2005 §38.1; PRYB2016 §38; UAC-IC2005 §3.3.4; §14; §47; PRYB2016 §47; BA §3.4; UAC-IC2005 §38.1.7; UAC-IC2005 §2.1.4.5,7.8; §4.1.5,9; §23.9; PRYB2016 §4.12; UAC-IC2005 §22; §23; UAC-IC2005 §3.3.4; BA §3.4; UAC-IC2005 §3.3.4; §14; UAC-IC2005 §4.6,11;
	Project Management Risks	Incomplete stakeholder identification Overloaded team project portfolio Insufficient resources assigned to the management of the project Insufficient time to plan Unanticipated project manager workload Project team stability (lack of project team continuity, high rotation) Inadequate change request procedure Communication breakdown within project team Project purpose definition, needs, objectives, costs, and deliverables that are poorly defined or understood	Contractor Undefined Contractor Contractor Undefined Shared Predominantly Client Shared Contractor	also related to ProRail's IAB transformation (BA §29);	UAC-IC2005 §38.1; UAC-IC2005 §7; UAC-IC2005 §2.1.2,7.8; UAC-IC2005 §14; §15; §22; §23; §44; §45; UAC-IC2005 §47; PRYB2016 §47; BA §23(,6); UAC-IC2005 §3.3.4; §21.2; PRYB2016 §20/21; BA §3.4;
	Financial & Economical	Funding and financing Inflation rate volatility Currency exchange rate fluctuations National economic growth and recessions Loan interest rates	Client Contractor Shared Shared Contractor		UAC-IC2005 §3.9; UAC-IC2005 §4.4; UAC-IC2005 §4.4; A7.1; UAC-IC2005 §4.4; A7.1; UAC-IC2005 §4.4; UAC-IC2005 §4.4; §42.1; UAC-IC2005 §22; §23; TRUI2016 §19.3; TRUI2016 §19.3;
	Planning, Monitoring, & Controlling	Number of key sponsors for decision making and management Contractor selection procedure Designer selection procedure Selection of insurance Priorities of the project Control of key issues of the project Project management information systems	Predominantly Contractor Client Client Client Shared Contractor Predominantly Contractor Contractor		UAC-IC2005 §39.1; BA §14.5b; A10; UAC-IC2005 §7; UAC-IC2005 §19; §21.2.4; UAC-IC2005 §19; PRYB2016 §4.13,14b1; BA §3.3; §23.4; PPD&C 7.1; 9.2; UAC-IC2005 §3.1b;
	Land & Property, Statutory Clearance	Land acquisition Clear title to land with appropriate zoning Expropriation Rights of way Delay in land access agreements Damage to neighboring properties Clearance from regulatory institutions, governments, and administrations	Client Client Shared Shared Contractor Client Contractor	based on UAC-IC-2005 §3.1b based on UAC-IC-2005 §3.1b	PRYB2016 §3.01; UAC-IC2005 §3.1b; UAC-IC2005 §4.10.11; §11.4; PRYB2016 §4.02.03; A12.1.1; PPD&C 5.1.1; UAC-IC2005 §9.1; PRYB2016 §10; BA §6.1.2; UAC-IC2005 §10.1; PRYB2016 §10; BA §6.3; UAC-IC2005 §26; PRYB2016 §26; UAC-IC2005 §27.3; §28; PRYB2016 §27.02; §28; BA §13.1; UAC-IC2005 §35; PRYB2016 §4.01; §41; BA §25a; §25b;
	Others	Early Use Early Maintenance & Warranty Sales tax rate change Construction damages Untruthful collaboration	Predominantly Contractor Contractor Contractor Client Contractor	if caught, else client	

D.5 Ede Public Transport Hub – Construction of Station & Rail

Risk Category	Risk Subcategory	Risk	Allocation (=Reasonably Assumed)	Notes	Source
Design/ Technical Risks		Inadequate and incomplete design	Predominantly Contractor	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §4.5.9; §19; §21.2; PRYB2016 §20/21; BA-A §3.3; §25; §27; PPD&C 3.1.2.1;
		Incomplete knowledge of local site conditions	Shared	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §4.5.9; §13.1.4,6; BA-A §25; PPD&C 3.1.2.1;
		Inaccurate technical assumptions	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; BA-A §3.3;
		Insufficient technical background and experience on specific project type and local characteristics	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; PPD&C 3.1.2.1;
		Incorrect selection of equipment, materials, and building techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA-A §3.3;
		Incorrect geotechnical and foundation estimations and structural design	Contractor		UAC-IC2005 §4.5.9; §13.1; §19; §21.2; PRYB2016 §20/21; BA-A §3.3; PPD&C3.1.2.1;
		Errors and omissions by consultants	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.5.9; §5; §6.1;
		Lack of specialised technical consultants on critical aspects of the project	Contractor		UAC-IC2005 §4.5.9; BA-A §3.3; PPD&C 3.1.2.1;
		Over-involvement of the owner in design	Predominantly Contractor		UAC-IC2005 §23.11,12,13,16; PRYB2016 §20/21; BA-A §3.3; RCC; PPD&C 3.1.2.3; 7.3;
		Continuous changes to the project scope	Predominantly Client		UAC-IC2005 §3.3; §14; §15; §16; BA-A §26;
		Delays in obtaining client concurrence	Shared	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §23.5,6,7,16; §45.13; BA-A §25; A3;
		Design scope exceeding available budget	Contractor		UAC-IC2005 §4.4;
		Uncertainty in the total cost estimate due to uncertain quantities and unit prices during the planning and initial design phase	Shared	contractor unless a provisional sum has been agreed upfront	UAC-IC2005 §34; BA-A §3.3; §15a; A7;
		Incomplete project cost estimate and inaccurate project schedule	Predominantly Contractor	significantly higher fees in comparison with Nijmegen and Nunspeet	UAC-IC2005 §4.4; §7; §34; §36.1; PRYB2016 §7.01; BA-A §3.3; §15a; §16.2.3;

Construction Risks	Contractual Factors	Contractor and/or subcontractor capability	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.1,3,5; §5; §6.1; §43.2; PRYB2016 §6.01; PPD&C 7;
		Inefficient coordination of project plans	Contractor		UAC-IC2005 §21.2; §36.1; PRYB2016 §7.01; §20/21; PPD&C 7.1;
		Unavailability of sufficient and skilled human resources	Predominantly Contractor		UAC-IC2005 §4.5,9; §21.2; PRYB2016 §4.13; §20/21; A15;
		Unavailability in time of special materials and construction equipment and equipment breakdowns	Predominantly Contractor		UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; PRYB2016 §4.10; §7.01; PPD&C 4.2,2;
		Equipment commissioning	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9;
		Unsuitable equipment and materials	Predominantly Contractor	although it depends on the provider, in practice it is often the contractor, some materials are prescribed	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; PPD&C 4.2,2;
		Low level of competency in management (especially subcontractors)	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA-A §24.1; PPD&C 7;
	Technical Factors	Incomplete knowledge and training on specific construction techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §4.12; §20/21;
		Construction occupational safety	Contractor		UAC-IC2005 §12.1; PRYB2016 §4.06,08; A15; PPD&C 7.9;
		Lack of environmental training and knowledge of workers on site	Contractor		UAC-IC2005 §12.1; PRYB2016 §4.12;
		Restricted work hours	Contractor		UAC-IC2005 §17.1; BA-A §24.2;
		Health and safety regulations and responsibilities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3; §12.1; A15;
		Changes in work orders	Predominantly Client		UAC-IC2005 §14; §16; §45; PRYB2016 §14; §44/45;
		Low level of documented detail design	Contractor		UAC-IC2005 §19; BA-A §3.3; PPD&C 3.1.3.1;
		Lack of scheduled instructions and drawing documents	Contractor		UAC-IC2005 §12.2,3,5; §19; BA-A §3.3; PPD&C 3.1.3.1; 7.1;
		Gap between theory and actual quantities of work	Contractor		UAC-IC2005 §3.1a,2; §36.1; §44; PRYB2016 §44; BA-A §3.3,4;
		Site & Layout Conditions	Unexpected costs of tests and samples	Predominantly Contractor	but very nuanced
	Site access		Predominantly Client		UAC-IC2005 §3.1b; PRYB2016 §3.01; §4.09; A14.1; PPD&C 4.3,2,3;
	Site security		Contractor		UAC-IC2005 §12.1; PPD&C 5.1.1;
	Availability of resources		Contractor		UAC-IC2005 §6.1; PRYB2016 §4.10;
	Availability and capacity of utility services		Contractor		UAC-IC2005 §17.1,2; PPD&C 5.1.1;
	Resource overloading		Contractor		UAC-IC2005 §12.1;
	Interference between task fronts		Predominantly Contractor	compensation in case of hindering side-contractor (UAC-IC2005 §44.1a)	UAC-IC2005 §8; A6; PPD&C 3.1.3,5; 7.10;
	Physical Factors	Geological and geotechnical conditions	Shared	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §3.1a,2; §13.1,4,6; BA-A §25; PPD&C 3.1.2,1;
		Sufficient and representative geotechnical and geological tests and samples	Shared	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §13.1; BA-A §25; A15; PPD&C 4.4;
		Groundwater level	Contractor		UAC-IC2005 §13.1;
		Topography	Contractor		UAC-IC2005 §13.1; PPD&C 3.1.2,1;
		Unforeseen subsurface conditions	Shared	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §13.1,4,6; BA-A §25; PPD&C 6,2;
		Unexpected climate conditions not covered under force majeure	Undefined		
		Corruption	Undefined		PRYB2016 §4.14;
		Assault, vandalism, sabotage, and theft	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §17;
		Intrusion and illegal occupancy of site	Contractor		PPD&C 5.1.1;
		Security Factors	Inaccurate contract time estimates	Contractor	
	Insolvency of contractor, subcontractor, or supplier		Predominantly Contractor		UAC-IC2005 §4.4; §6.1; §33,9; §43,3;
	Inadequate change orders procedure		Predominantly Client		UAC-IC2005 §14; §15; §16; §22; §23; §44; §45; PRYB2016 §14; §44/45;
	Change orders negotiation		Predominantly Client		UAC-IC2005 §14; §15; §23; §44,7; PRYB2016 §44;
	Unexpected work and extras		Predominantly Contractor	the question "unexpected for whom" is left aside	UAC-IC2005 §13.4,5; §14; §24,7; §25.1; §36.1; §44; PRYB2016 §14; §44; BA-A §26;
	Contractual Factors	Delayed deliveries and disruptions	Predominantly Contractor		UAC-IC2005 §7; §16.7,9,10; §36.1; PRYB2016 §7.01; BA-A §16.2,3; §24.1,2; A14.1; A15; PPD&C 4.2,2;
		Delayed payment on contracts	Predominantly Client	only considering the main contract, for subcontracts: PRYB2016 §4b;	UAC-IC2005 §3.9; §33,4,7; §38,7; §42.1; BA-A §14; A10;
		Vendor appraisals	Predominantly Contractor	some vendors are prescribed	UAC-IC2005 §6.1,2,3; PRYB2016 §4.14b2,14b3; PPD&C 4.2,2;
		Reliance on a single source	Contractor		UAC-IC2005 §38.1;
		Defective work	Contractor		UAC-IC2005 §4.5,9; §21.2; §41; PRYB2016 §4.01; §20/21; BA-A §27; PPD&C 4.6,2.1;
	Performance Factors	Unskillfulness	Contractor		UAC-IC2005 §21.2; PRYB2016 §4.12; §20/21;
		Negligence and malicious acts	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §4.01; BA-A §27;
		Labor disputes	Predominantly Contractor	for subcontracts: PRYB2016 §4b;	UAC-IC2005 §38.1; §47; PRYB2016 §14; §38; §47; BA-A §19;
		Unsuitable materials	Predominantly Contractor	although it depends on the provider, in practice it is often the contractor, some materials are prescribed	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; §21.2; PRYB2016 §20/21; PPD&C 4.2,2;
		Construction productivity (labor and equipment)	Predominantly Contractor		UAC-IC2005 §4.1; §21.2; PRYB2016 §20/21; A15;
	Contractual Factors	Accidents and injuries	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §4.07;
		Critical lead times	Contractor		UAC-IC2005 §7; §21.2; §36.1; PRYB2016 §7.01; §20/21; BA-A §16.2,3;
		Tight project schedule	Contractor		UAC-IC2005 §7; §21.2; §36.1; PRYB2016 §7.01; §20/21; BA-A §16.2,3; §24.1,2;
		Client's quality and performance expectations higher than documented	Predominantly Client		UAC-IC2005 §3.3,4; §21.4; PRYB2016 §20/21; RCC; PPD&C 7,3;
		Weak definition and documentation of project objectives (cost, schedule, scope, quality)	Predominantly Client		UAC-IC2005 §3.3,4; §21.2; PRYB2016 §20/21; BA-A §3,4;
Overlooked or new powerful and influencing stakeholders		Contractor		PPD&C 8.1;	
Influencing late changes in stakeholders' requirements		Predominantly Contractor		PPD&C 8.1;	
Market changes		Contractor		UAC-IC2005 §4.4; §34;	
Economic and political instability		Contractor		UAC-IC2005 §4.4; §34;	
Force Majeure Factors		Changes in regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3;
	Labor strikes	Contractor		UAC-IC2005 §4.4; §36.1;	
	Adverse weather	Predominantly Contractor		UAC-IC2005 §36.1; MCHW; A14,2;	
	Natural calamities	Shared		UAC-IC2005 §36.1; A14,2;	
	Acts of God	Undefined		UAC-IC2005 §36.1; §41,4;	
Social Factors	Competing interests between project and local communities	Predominantly Client		PPD&C 8.1;	
	Working patterns linked to local cultural and religious factors	Contractor		UAC-IC2005 §36.1;	
	Culture and habits	Undefined			
Public Involvement	Neighboring citizens rejecting the project	Predominantly Client		PPD&C 8.1;	
	Nongovernment organisations (NGOs) and environmental organisation opposing the project	Predominantly Client		PPD&C 8.1;	
	Public perception distorted by media	Client		PPD&C 8.1;	
	Public exposure	Predominantly Contractor		UAC-IC2005 §4.6,11; §12.1; §18; PRYB2016 §18; A12.1,1; PPD&C 8.1;	
	Citizen interest	Predominantly Contractor		PPD&C 8.1;	
Environmental Factors	Unexpected additional environmental regulations	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3;	
	Environmental impact statement or assessment	Contractor		UAC-IC2005 §4,6;	
	Historical and artistic patrimony and archeological patrimony protection	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3; §13,7; PPD&C 6,5;	
	Anthropological or biological interest (protection of endangered species, flora, and fauna)	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3; PPD&C 4,5;	
	Hazardous waste, noise, contamination, and emissions	Predominantly Contractor	contractor can be compensated in unforeseeable cases (BA §9);	UAC-IC2005 §4.6,11; §12.1; PRYB2016 §4.11d; BA-A §8; A5; A15; PPD&C 4,4;	
	Authorities with jurisdiction and vulnerability of political support	Undefined			
	Regulatory institutions, government, and administration's statutory requirements or clearances	Client		UAC-IC2005 §9.1; PRYB2016 §10; BA-A §6.1,2;	
	Changes in law, procedures, subsidies, policies and regulations, or project priorities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §10.1; G80 PRYB2016 §4.13,14; §10; BA-A §6,3; PPD&C 6.1,2;	
	Complex administrative approval procedures	Client		UAC-IC2005 §11.1,3;	
	Political Visibility & Regulatory Factors	Obstruction of approvals	Contractor		UAC-IC2005 §9.1,5;
Bureaucracy		Shared	(See also Bid Attachment 4B - List of Agreed Risks to share)	UAC-IC2005 §10.1,4;	
Environmental political pressures		Undefined		PRYB2016 §10.1; BA-A §25;	
Political sensitivity and climate		Undefined			
Culture		Shared			
Attitudes		Shared			
Disagreement about objectives		Predominantly Client		RCC; PPD&C 7,3;	
Insufficient resources		Predominantly Contractor		UAC-IC2005 §38.1; PRYB2016 §38; RCC; PPD&C 7,3;	
Inexperienced, inadequate, or undertrained staff		Predominantly Contractor		UAC-IC2005 §3.3,4; §14; §47; PRYB2016 §47; BA-A §19; RCC; PPD&C 7,3;	
Internal approval complexities		Predominantly Client		UAC-IC2005 §38.1,7;	
Project Management Risks	Inconsistent cost, time, scope, and quality objectives	Predominantly Client		UAC-IC2005 §2.1,4,5,7,8; §4.1,5,9; §23,9; PRYB2016 §4.12;	
	Changes to prioritization of existing program	Predominantly Client		UAC-IC2005 §22; §23;	
	Incomplete stakeholder identification	Client		UAC-IC2005 §3.3,4; BA-A §3,4;	
	Overloaded team project portfolio	Contractor		UAC-IC2005 §3.3,4; §14;	
	Insufficient resources assigned to the management of the project	Undefined		UAC-IC2005 §4,6,11;	
	Insufficient time to plan	Contractor		UAC-IC2005 §38.1;	
	Unanticipated project manager workload	Contractor		UAC-IC2005 §7;	
	Project team stability (lack of project team continuity, high rotation)	Shared			
	Inadequate change request procedure	Predominantly Client		UAC-IC2005 §2.1,2,7,8;	
	Communication breakdown within project team	Shared		UAC-IC2005 §14; §15; §22; §23; §44; §45;	
Project Management Risks	Project purpose definition, needs, objectives, costs, and deliverables that are poorly defined or understood	Shared		UAC-IC2005 §47; PRYB2016 §47; BA-A §22(.6); §47; RCC; PPD&C 7,3;	
				UAC-IC2005 §3.3,4; §21.2; PRYB2016 §20/21; RCC; PPD&C 7,3;	

Business Risks	Financial & Economical	Funding and financing	Client		UAC-IC2005 §3.9;
		Inflation rate volatility	Contractor		UAC-IC2005 §4.4;
	Planning, Monitoring, & Controlling	Currency exchange rate fluctuations	Shared		UAC-IC2005 §4.4; A7;
		National economic growth and recessions	Contractor		UAC-IC2005 §4.4; A7;
		Loan interest rates	Predominantly Contractor		UAC-IC2005 §4.4;
		Number of key sponsors for decision making and management	Client		UAC-IC2005 §4.4; §42.1;
		Contractor selection procedure	Client		UAC-IC2005 §22; §23;
		Designer selection procedure	Client		TRUI2016 §19.3;
		Selection of insurance	Shared		TRUI2016 §19.3;
		Priorities of the project	Contractor		UAC-IC2005 §39.1; BA-A §14.6c; A8; A10;
	Land & Property, Statutory Clearance	Control of key issues of the project	Predominantly Contractor		UAC-IC2005 §7;
		Project management information systems	Contractor		UAC-IC2005 §19; §21.2.4;
		Land acquisition	Client		UAC-IC2005 §19; PRYB2016 §4.13,14b1; BA-A §3.3; 22.4; PPD&C 3.1.2.4; 7.1; 8.2;
		Clear title to land with appropriate zoning	Client	based on UAC-IC-2005 §3.1b	UAC-IC2005 §3.1b;
		Expropriation	Client	based on UAC-IC-2005 §3.1b	
		Rights of way	Shared		
		Delay in land access agreements	Client		PRYB2016 §3.01;
		Damage to neighboring properties	Contractor		UAC-IC2005 §3.1b;
		Clearance from regulatory institutions, governments, and administrations	Client		UAC-IC2005 §4.10,11; §11.4; PRYB2016 §4.02,03; A12.1.1; PPD&C 5.1.1;
		Early Use	Contractor		UAC-IC2005 §9.1; PRYB2016 §10; BA-A §6.1,2;
Others		Early Maintenance & Warranty	Predominantly Contractor		UAC-IC2005 §10.1; PRYB2016 §10; BA-A §6.3;
		Sales tax rate change	Contractor		UAC-IC2005 §26; PRYB2016 §26;
		Construction damages	Contractor		UAC-IC2005 §27.3; §28; PRYB2016 §27.02; §28; BA-A §13.1; PPD&C 4.2.2.4;
		Risk management capabilities	Client		UAC-IC2005 §35;
			Contractor		PRYB2016 §4.01; §41;
			Shared		PPD&C 7.5.2.1;

D.6 ZwolleSpoort IJssel-Herfte

Risk Category	Risk Subcategory	Risk	Allocation (=Reasonably Assumed)	Notes	Source
Design/ Technical Risks		Inadequate and incomplete design	Contractor		UAC-IC2005 §4.5.9; §19; §21.2; PRYB2016 §20/21; BA §3.3;
		Incomplete knowledge of local site conditions	Shared		UAC-IC2005 §4.5.9; §13.1.4.6;
		Inaccurate technical assumptions	Predominantly Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21; BA §3.3; AA-AE;
		Insufficient technical background and experience on specific project type and local characteristics	Contractor		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §20/21;
		Incorrect selection of equipment, materials, and building techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA §3.3;
		Incorrect geotechnical and foundation estimations and structural design	Predominantly Contractor		UAC-IC2005 §4.5.9; §13.1; §19; §21.2; PRYB2016 §20/21; BA §3.3; AA-AE;
		Errors and omissions by consultants	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.5.9; §5; §6.1;
		Lack of specialised technical consultants on critical aspects of the project	Contractor		UAC-IC2005 §4.5.9; BA §3.3;
		Over-involvement of the owner in design	Predominantly Contractor		UAC-IC2005 §23.11,12,13,16; PRYB2016 §20/21; BA §3.3; AA-AE;
		Continuous changes to the project scope	Client		UAC-IC2005 §3.3; §14; §15; §16;
Construction Risks	Contractual Factors	Delays in obtaining client concurrence	Predominantly Client		UAC-IC2005 §23.5,6,7,16; §45.13;
		Design scope exceeding available budget	Shared		UAC-IC2005 §4.4; AA-AE;
		Uncertainty in the total cost estimate due to uncertain quantities and unit prices during the planning and initial design phase	Contractor		UAC-IC2005 §34; BA §3.3;
		Incomplete project cost estimate and inaccurate project schedule	Predominantly Contractor	significantly higher fees in comparison with Nijmegen and Nunspeet and also higher than Ede	UAC-IC2005 §4.4; §7; §34; §36.1; PRYB2016 §7.01; BA §3.3; §16.2,3;
		Contractor and/or subcontractor capability	Contractor	compensation in case of underperforming prescribed independent assistants (UAC-IC2005 §44.1a)	UAC-IC2005 §4.1,3,5; §5; §6.1; §43.2; PRYB2016 §6.01;
		Inefficient coordination of project plans	Contractor		UAC-IC2005 §21.2; §36.1; PRYB2016 §7.01; §20/21;
		Unavailability of sufficient and skilled human resources	Shared		UAC-IC2005 §4.5.9; §21.2; PRYB2016 §4.13; §20/21; AA-AD 9;
		Unavailability in time of special materials and construction equipment and equipment breakdowns	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; PRYB2016 §4.10; §7.01;
		Equipment commissioning	Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9;
		Unsuitable equipment and materials	Predominantly Contractor		UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; AA-AE;
	Technical Factors	Low level of competency in management (especially subcontractors)	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §20/21; BA §24.1;
		Incomplete knowledge and training on specific construction techniques	Contractor		UAC-IC2005 §19; §21.2; PRYB2016 §4.12; §20/21;
		Construction occupational safety	Contractor		UAC-IC2005 §12.1; PRYB2016 §4.06,08;
		Lack of environmental training and knowledge of workers on site	Contractor		UAC-IC2005 §12.1; PRYB2016 §4.12;
		Restricted work hours	Shared		UAC-IC2005 §17.1; BA §24.2; AA-AD 5;
		Health and safety regulations and responsibilities	Contractor	as long as he could have reasonably known and foreseen them, if not, he is eligible for compensation (§44.1a)	UAC-IC2005 §11.1,3; §12.1;
		Changes in work orders	Predominantly Client		UAC-IC2005 §14; §16; §45; PRYB2016 §14; §44/45;
		Low level of documented detail design	Contractor		UAC-IC2005 §19; BA §3.3;
		Lack of scheduled instructions and drawing documents	Contractor		UAC-IC2005 §12.2,3,5; §19; BA §3.3;
		Gap between theory and actual quantities of work	Shared	but very nuanced	UAC-IC2005 §3.1a,2; §36.1; §44; PRYB2016 §44; BA §3.3,4;
	Site & Layout Conditions	Unexpected costs of tests and samples	Shared		UAC-IC2005 §4.4; PRYB2016 §4.01a; AA-AE;
		Site access	Shared		UAC-IC2005 §3.1b; PRYB2016 §3.01; §4.09; AA-AD 5,6,7;
		Site security	Contractor		UAC-IC2005 §12.1;
		Availability of resources	Contractor		UAC-IC2005 §6.1; PRYB2016 §4.10;
		Availability and capacity of utility services	Shared		UAC-IC2005 §17.1,2; AA-AD 6;
		Resource overloading	Contractor		UAC-IC2005 §12.1;
		Interference between task fronts	Predominantly Contractor	compensation in case of hindering side-contractor (UAC-IC2005 §44.1a). In some cases shared (AA-AD 4).	UAC-IC2005 §8; BA §9; AA-AD 4,9;
		Geological and geotechnical conditions	Shared		UAC-IC2005 §3.1a,2; §13.1,4,6; AA-AD 1;
		Sufficient and representative geotechnical and geological tests and samples	Shared		UAC-IC2005 §13.1; AA-AD 1;
		Groundwater level	Contractor		UAC-IC2005 §13.1;
	Physical Factors	Topography	Contractor		UAC-IC2005 §13.1;
		Unforeseen subsurface conditions	Shared		UAC-IC2005 §13.1,4,6; AA-AD 1;
		Unexpected climate conditions not covered under force majeure	Undefined		
		Corruption	Undefined		PRYB2016 §4.14;
	Security Factors	Assault, vandalism, sabotage, and theft	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §17;
		Intrusion and illegal occupancy of site	Contractor		AA-AE;
		Inaccurate contract time estimates	Contractor		UAC-IC2005 §7; §36.1; PRYB2016 §7.01; BA §16.2,3;
		Insolvency of contractor, subcontractor, or supplier	Predominantly Contractor		UAC-IC2005 §4.4; §6.1; §33.9; §43.3;
		Inadequate change orders procedure	Predominantly Client		UAC-IC2005 §14; §15; §16; §22; §23; §44; §45; PRYB2016 §14; §44/45;
		Change orders negotiation	Predominantly Client		UAC-IC2005 §14; §15; §23; §44.7; PRYB2016 §44;
		Unexpected work and extras	Predominantly Contractor	the question "unexpected for whom" is left aside	UAC-IC2005 §13.4,5; §14; §24.7; §25.1; §36.1; §44; PRYB2016 §14; §44;
		Delayed deliveries and disruptions	Predominantly Contractor		UAC-IC2005 §7; §16.7,9,10; §36.1; PRYB2016 §7.01; BA §16.2,3; §24.1,2; AA-AD 2,7;
		Delayed payment on contracts	Client	only considering the main contract, for subcontracts: PRYB2016 §4b;	UAC-IC2005 §3.9; §33.4,7; §38.7; §42.1; BA §14;
		Vendor appraisals	Shared		UAC-IC2005 §6.1,2,3; PRYB2016 §4.14b2,14,13; AA-AE;
Performance Factors		Reliance on a single source	Contractor		UAC-IC2005 §38.1;
		Defective work	Contractor		UAC-IC2005 §4.5.9; §21.2; §41; PRYB2016 §4.01; §20/21;
		Unskillfulness	Contractor		UAC-IC2005 §21.2; PRYB2016 §4.12; §20/21;
		Negligence and malicious acts	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §4.01;
		Labor disputes	Predominantly Contractor	for subcontracts: PRYB2016 §4b;	UAC-IC2005 §38.1; §47; PRYB2016 §14; §38; §47;
		Unsuitable materials	Predominantly Contractor	although it depends on the provider, in practice it is often the contractor	UAC-IC2005 §3.1c,2,5; §4.1,3,5,9; §21.2; PRYB2016 §20/21; AA-AE;
		Construction productivity (labor and equipment)	Contractor		UAC-IC2005 §4.1; §21.2; PRYB2016 §20/21;
		Accidents and injuries	Contractor		UAC-IC2005 §12.1; §41; PRYB2016 §4.07;
		Critical lead times	Contractor		UAC-IC2005 §7; §21.2; §36.1; PRYB2016 §7.01; §20/21; BA §16.2,3;

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Business Risks	Financial & Economical	Funding and financing	Client		UAC-IC2005 §3.9;
		Inflation rate volatility	Contractor		UAC-IC2005 §4.4; PRYB2008 §37;
		Currency exchange rate fluctuations	Predominantly Contractor		UAC-IC2005 §4.4; A7;
		National economic growth and recessions	Contractor		UAC-IC2005 §4.4; A7;
		Loan interest rates	Contractor		UAC-IC2005 §4.4;
	Planning, Monitoring, & Controlling	Number of key sponsors for decision making and management	Predominantly Contractor		UAC-IC2005 §4.4; §42.1;
		Contractor selection procedure	Client		UAC-IC2005 §22; §23;
		Designer selection procedure	Client		TRUI2016 §19.3;
		Selection of insurance	Client		TRUI2016 §19.3;
		Priorities of the project	Predominantly Client		UAC-IC2005 §39.1; BA §17; A10; A12;
		Control of key issues of the project	Contractor		UAC-IC2005 §7;
		Project management information systems	Predominantly Contractor		UAC-IC2005 §19, §21.2.4;
	Land & Property, Statutory Clearance	Land acquisition	Predominantly Contractor		UAC-IC2005 §19; BA §3.3; AA-AE;
		Clear title to land with appropriate zoning	Client		UAC-IC2005 §3.1b;
		Expropriation	Client	based on UAC-IC-2005 §3.1b	
		Rights of way	Client	based on UAC-IC-2005 §3.1b	
		Delay in land access agreements	Shared		PRYB2008 §3.01; AA-AD 5;
		Damage to neighboring properties	Shared		UAC-IC2005 §3.1b; AA-AD 5;
		Clearance from regulatory institutions, governments, and administrations	Predominantly Contractor		UAC-IC2005 §4.10.11; §11.4; PRYB2008 §4.02.03; BA §20; A12.1.1;
Others		Early Use	Shared		UAC-IC2005 §9.1; PRYB2008 §10; BA §6.1,2; AA-AD 3;
		Early Maintenance & Warranty	Predominantly Contractor		UAC-IC2005 §10.1; PRYB2008 §10; BA §6.3; AA-AD 3;
		Sales tax rate change	Contractor	Less cooperative attitude of client in PRYB2008 compared to PRYB2016;	UAC-IC2005 §26; PRYB2016 §26;
		Construction damages	Client		UAC-IC2005 §27.3; §28; PRYB2008 §27.02; §28; BA §13.1;
			Contractor		PRYB2008 §4.01; §41;

Appendix E: Prototype Framework

Contract scan – project perspective									
Objective					Subjective				
The risk allocation approach aligns with the tender method and delivery method.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Disagree		Neutral					Agree	
How extensive are the changes to the contract in comparison to earlier standardised contracts, due to which it should be expected that organisations have not yet fully adapted to them?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Large changes			Small changes					
Are procedures thoroughly explained?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	No explanation			Clear explanation					
Does the client prioritise market conformity (lowest price) or risk transparency (completeness of risk identification) in the tender?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Market conformity			Risk transparency					
To what extent will the current economic context and competition prevent the contractor from including all risks in the risk cost component in the bid price?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Large discount			No discount					
(Estimate) what risk probability confidence is likely used for the client's risk cost calculation?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	P50			>P85					
A market consultation or dialogue phase enables risk allocation discussion with the client before contract awarding.	<input type="checkbox"/> No <input type="checkbox"/> Yes								
To what extent have risks already been researched by the client, and is it allowed to assume the results to be true?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Low certainty			High certainty					
	<input type="checkbox"/> does not apply								
How much time and money is available in the project to research risks?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	No time/money			Abundant time/money					
How significantly does time pressure affect planning from the start?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	High pressure			No pressure					
Are parties engaged at the right moment with the design/project to prevent the redoing of work?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Much redoing			No redoing					
Does the contract/project guarantee that expectations on collaboration, interests, intentions and motivations will be discussed transparently and respectfully to align the organisations?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	No guarantee/no plan			Guarantee/action plan					
For how long of the project's duration are the client and contractor working in close proximity to each other?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	0 %			100 %					
How dependent is the client on external consultants' approval?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Independent			Very dependent					
Does the contract guarantee that opportunistic behaviour like seizing every opportunity to make the other person pay is curtailed?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	No guarantee/no plan			Guarantee/action plan					
Which contextual changes are included in the contract that result in increased financial compensation?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	0 %			100 %					
Contract scan – risk-specific perspective									
Exclusively Objective									
The one responsible for the risk can control the allocated risk's probability and/or consequence.									<input type="checkbox"/> No <input type="checkbox"/> Yes
The one responsible for the risk has the authority to decide about the risk.									<input type="checkbox"/> No <input type="checkbox"/> Yes
The one responsible for the risk has intrinsic motivation to control the risk.									<input type="checkbox"/> No <input type="checkbox"/> Yes
The one responsible for the risk has access to the required information to control the risk.									<input type="checkbox"/> No <input type="checkbox"/> Yes
The one responsible for the risk has the organisational capacity and decisiveness to guarantee effective risk control.									<input type="checkbox"/> No <input type="checkbox"/> Yes
The one responsible for the risk has the knowledge/expertise to be able to control the risk.									<input type="checkbox"/> No <input type="checkbox"/> Yes

Request for Modification / During the project – project perspective					
Objective			Subjective		
How frequent and direct is the (personal) contact between contractor and client to understand the intentions of each other and the project?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Quarterly and in reports	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Daily and in person	To what extent is strategic behaviour masked, and are answers adequate when asking about it?
Communication is candid and free of strategy.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
How adequate is communication? Communication/answers to questions are:	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Standardised and untimely	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Specific and on-time	How frequently is risk management/allocation discussed against changing (project) contexts?
Communication is unambiguous, and responses are not revoked.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
Mistrust and prejudice do not affect communication.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
Respect, sincerity and politeness are reflected in the interactions.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
In daily appointments, the emphasis is on:	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Trust	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Documentation	How can you mutually regain trust despite these experiences?
Risk management, regardless of allocation, is characterised by:	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Responsibility/demarcation	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Proactivity/transparency	Is the feeling of collectiveness in risk management increasing or decreasing?
How far does a risk usually escalate before the responsible party engages the counterparty?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	When only corrective measures are still possible	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	As soon as preventive measures are drawn up	How often is prejudice (in contractor as well as client) observed?
(Keep tally) how often a risk - is noticed by the contractor but negated by the client: - the contractor still took action: - the contractor was right: (less is better)	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
To what extent does disagreement between the client's departments affect the project?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Client's views are quickly changing	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagreements not noticeable	Securing of interests is adequately facilitated and respected in the project.
To what extent do secondary interests needlessly complicate the collaboration?	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	It is harmful to the relationship	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	No influence	The responsibilities of the counterparty for enabling the other to control risk are sufficiently discussed.
(Keep tally) how often does the client order modifications before negotiations are finalised? (less is better)	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
The return on risk control costs is shared with the client.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Disagree	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	Neutral	Agree
Request for Modification / During the project – risk-specific perspective					
Exclusively subjective					
(If a project is not too complex, because otherwise, the focus will be on blaming instead of efficient resolution) is a risk allocated to the person who caused or enabled the risk to materialise?					
<input type="radio"/> No <input type="radio"/> Yes					

Appendix F: Risk Equitability Assessment Framework

Contract scan – project perspective										
Substantiable by documentation					Feeling-based					
The chosen project delivery method fits the client's stance towards risk allocation. (i.e. not emphasising risk-sharing when alliancing is not applied.) [2]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	The tender procedure is unbiased concerning participating contractors. [2]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Disagree		Agree				Disagree		Agree	
A market consultation or dialogue phase enables risk allocation discussion with the client before contract awarding. [2]	<input type="checkbox"/>	No	<input type="checkbox"/>	Yes		Is the contractor's strategy to hold off risks or to optimise allocation (best able to control)? [3]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
							Holding off		Optimising	
How dependent is the client on external consultants' approval? [2]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Is the client expected to be holding off risks or lenient? [3]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Independent		Very dependent				Holding off		Lenient	
Is the client's preparational (design) work of sufficient quality? [2]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	(For core team members) How much experience do you have with this form of collaboration, and does it align with personal convictions? [3]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Much redoing required		No redoing required				No experience/conflicting		Much experience/aligning	
It is clear what processes are used to allocate and manage risks. [2]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		Unclear		Clear	
Are there plans for how to discuss expectations on collaboration, interests, intentions and motivations between organisations? [3]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		No plan		Clear action plan	
To what extent will the economy and competition affect the contractor's bid price risk cost component? [4]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		< 80% included		All risks included	
How conservative is the client usually in his risk budget calculation? [4]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		Conservative		Always enough	
Which contextual changes are included in the contract that can increase financial compensation? [4]										
Does the client prioritise the lowest price or completeness of risk control measures in the tender? [5]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		Lowest price		Risk completeness	
How much time and money is available in the project to research risks? [5]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		No time/money		Abundant time/money	
Is the contractor's financial exposure capped? [6]	<input type="checkbox"/>	No	<input type="checkbox"/>	Yes						
Does the client provide definitive and reliable information on which to base the design? [7]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		Unreliable		Reliable	
	<input type="checkbox"/> does not apply									
Do the client's and contractor's organisations already have experience with the contract(type), or does it differ significantly from previously used contracts? [8]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		Different		Same	
How significantly does time pressure affect planning? [8]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		High pressure		No pressure	
How much of the collaboration between client and contractor will be physically together? [9]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		0 %		100 %	
(For alliance): which share of the risks makes up the alliance domain? [1]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		0 %		100 %	
Contract scan – risk-specific perspective										
Substantiable by documentation										
The one responsible for the risk can control the allocated risk's probability and/or consequence. [7]						<input type="checkbox"/>	No	<input type="checkbox"/>	Yes	
The one responsible for the risk has the authority to decide about the risk. [7]						<input type="checkbox"/>	No	<input type="checkbox"/>	Yes	
The one responsible for the risk has intrinsic motivation to control the risk. [1]						<input type="checkbox"/>	No	<input type="checkbox"/>	Yes	
The one responsible for the risk has access to the required information to control the risk. [7]						<input type="checkbox"/>	No	<input type="checkbox"/>	Yes	
The one responsible for the risk has the organisational capacity and decisiveness to guarantee effective risk control. [7]						<input type="checkbox"/>	No	<input type="checkbox"/>	Yes	
The one responsible for the risk has the knowledge/expertise to be able to control the risk. [7]						<input type="checkbox"/>	No	<input type="checkbox"/>	Yes	

Request for Modification / During the project – project perspective					
Substantiable by documentation			Feeling-based		
(Keep tally) how often are exclusive contractual powers (e.g. ordering modifications before negotiations are finalised) applied by the client? <i>(less is better)</i> [2]			Parties are free, encouraged and supported to mutually secure their interests in the project. [2]		<input type="radio"/> Disagree <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> Agree
How often and explicitly are intentions discussed to enable contractor and client to better understand each other and the project? [2]	<input type="radio"/> Quarterly and in reports <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> Daily and in person		How often are changing (project) contexts discussed to evaluate risk allocation/management? [2]	<input type="radio"/> Never <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> Weekly	
To what extent does internal disagreement with the client affect the project? [2]	<input type="radio"/> Client's views are quickly changing <input type="radio"/> <input type="radio"/> <input type="radio"/> Disagreements not noticeable		How lenient/flexible are parties during the project? [3]	<input type="radio"/> Rigid <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> Flexible	
Risk management, regardless of allocation, is characterised by: [3]	<input type="radio"/> Responsibility/demarcation <input type="radio"/> <input type="radio"/> <input type="radio"/> Proactivity/transparency		To what extent is strategic behaviour masked, and are questions adequately answered when asking about it? [3]	<input type="radio"/> Masked and questioning not allowed <input type="radio"/> <input type="radio"/> <input type="radio"/> Transparent and questioning allowed	
Communication is unambiguous, and responses are not revoked. [3]	<input type="radio"/> Disagree <input type="radio"/> <input type="radio"/> <input type="radio"/> Agree		Is the feeling of collectiveness in risk management increasing or decreasing? [3]	<input type="radio"/> Decreasing <input type="radio"/> <input type="radio"/> <input type="radio"/> Increasing	
To what extent do secondary interests needlessly complicate the collaboration? [3]	<input type="radio"/> It is harmful to the relationship <input type="radio"/> <input type="radio"/> <input type="radio"/> No influence		How often is prejudice (in contractor as well as client) observed? [3]	<input type="radio"/> Daily <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> Never	
In daily appointments, the emphasis is on: [3]	<input type="radio"/> Trust <input type="radio"/> <input type="radio"/> Documentation		Do clients and contractors discuss experiences affecting their attitude toward risk allocation and shared risk control? [3]	<input type="checkbox"/> No <input type="checkbox"/> Yes	
Respect, sincerity and politeness are reflected in the interactions. [3]	<input type="radio"/> Disagree <input type="radio"/> <input type="radio"/> <input type="radio"/> Agree		The responsibilities of the counterparty for enabling the other to control risk are sufficiently discussed. [9]	<input type="radio"/> Disagree <input type="radio"/> <input type="radio"/> <input type="radio"/> Agree	
Communication is candid and free of strategy. [3]	<input type="radio"/> Disagree <input type="radio"/> <input type="radio"/> Agree				
Mistrust and prejudice do not affect communication. [3]	<input type="radio"/> Disagree <input type="radio"/> <input type="radio"/> Agree				
(Keep tally) how often a risk - is noticed by the contractor but negated by the client: - the contractor still took action: - the contractor was right: <i>(less is better)</i> [3]					
The return on risk control costs is shared with the client. [5]					
<input type="checkbox"/> No <input type="checkbox"/> Yes					
How far does a risk usually escalate before the responsible party engages the counterparty? [8]	<input type="radio"/> When only corrective measures are still possible <input type="radio"/> <input type="radio"/> <input type="radio"/> As soon as preventive measures are drawn up				
How adequate is communication? Communication/answers to questions are: [9]	<input type="radio"/> Standardised and untimely <input type="radio"/> <input type="radio"/> Specific and on-time				
Request for Modification / During the project – risk-specific perspective					
Substantiable by documentation					
(If a project is not too complex, because otherwise the focus will be on blaming instead of efficient resolution) is a risk allocated to the person who caused or enabled the risk to materialise? [7]				<input type="checkbox"/> No <input type="checkbox"/> Yes	

