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Ph.D. Thesis

Mega-transport projects and the formal "rules of the game": The role of transaction costs in the planning and appraisal process in Latin America

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Abstract

Mega-transport projects (MTPs) are frequently seen as being critical to the economic, social, environmental and territorial development of the areas they traverse and influence. However, they are understood to represent high risk undertakings, particularly because they are developed under conditions of considerable uncertainty, frequently leading to underperformance in their delivery of planned objectives and benefits.

Given their uncertainty can be driven by the political and social influences they incorporate, all interwoven in complex stakeholder decision-making processes over long periods of time, there is a growing body of literature suggesting MTPs should be planned and appraised with an "open-systems" approach to decision-making. Yet, in Latin America (LatAm), a "closed-systems" approach to decision-making, with a "hard thought system", is formally requested and applied by central governments.

Although there is evidence that decision-makers understand this incongruence, this "closed-systems" approach is kept in place. While there may be different institutional elements that sustain this status quo, this research concentrated on analysing this topic using a New Institutional Economics theoretical perspective. It particularly sought to understand if formal rules can be promoting these decision-making practices in the LatAm context, and identify pathways of change towards open systems planning of MTPs.

Using a mixed methods research design, applied to a multiple-case study including three Latin American MTPs, this thesis examines the relationship between construction risks and contractual hazards, and explores if governmental decision-makers can perceive that the decision-making approach at the planning and appraisal stages can impact on those contractual hazards. The overall conclusion of the thesis is that the current formal rules can be promoting the use of a "closed-systems" approach to decision-making because it may help decision-makers to minimise transaction costs when developing the contracts. Decision-makers can be sustaining the status quo because it can be, at least in part, a rational behaviour.

Impact Statement

This Ph.D. research presents substantial implications for theory and practice in the field of megaproject planning, appraisal and delivery, particularly for LatAm.

Regarding theory, academics have usually explained megaprojects planning and development challenges via arguments generally alluding to issues of "bad" management, or decision-making based on overoptimism and purposefully dishonest practices. This thesis proposes an alternative and innovative theoretical explanation for the very questionable selection of a "closed-systems" approach for planning and appraising MTPs in LatAm. Using a New Institutional Economics perspective, it shows that the selection of the planning and appraisal approach can be related to the institutional environment, particularly the "formal rules" of the game: bureaucracy, legislation and the judiciary, as key contexts impinging on the adoption of more open, deliberative and sustainable project development approaches.

If theory is understood as a set of constructs linked together in relationships that are supported by theoretical arguments, which seek to explain a focal phenomenon, then this thesis undoubtably presents a theoretical contribution to the topic here presented. This thesis confirms that, given these formal rules, decision-makers can perceive that the transaction costs of dealing with the contractual hazards of MTPs would increase if an "open-systems" approach is applied. Firstly, at the planning and appraisal stages, formal rules can elevate political and social risks if an "open-systems" approach is used, increasing the contractual hazard of third-party opportunism. Secondly, at the contracting stage, formal rules can have a negative impact on the effectiveness of using contractual functions, which are needed to deal with the contractual hazards. This innovative explanation suggests that an adjustment of the formal rules, both at the pre-investment and investment phases, could help to promote a fundamental change in the MTP planning and appraisal approach selected by the LatAm countries, as changes may not happen organically without such measures.

From a practical perspective, this research process was the basis for the publication of eleven monographs developed by the author in the context of his work as a consultant at the Inter-American Development Bank, the main source of development financing for LatAm. These eleven publications, cited along this document, already totalise more than 18,000 downloads at the moment of the formal presentation of this thesis. The extent to which the public policy recommendations presented in these documents have been used in the countries and megaprojects of the region is probably relevant, but difficult to measure. However, there is no doubt that this research process has contributed and will continue to contribute to practice. It has enriched the discussion regarding megaproject planning, appraisal and delivery at the IDB, and between this institution and the LatAm countries it serves via loans and technical assistance work.

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I, Juan Antonio Alberti Vázquez, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

London, September 22nd 2025

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This thesis is for my mom, "Raca", who always encouraged me to aim for my best. She left us a long time ago, but she remains strong in my heart, and in those of my loved ones…

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1 Introduction

This introductory chapter sets the scene for the research via 6 brief sections: Section 1.1 provides the research context; Section 1.2 sets out the research problem and focus; Section 1.3 introduces the core theoretical perspective guiding the work; Section 1.4 provides an overview of the worldview paradigm and methodology adopted; Section 1.5 elaborates on the research gaps motivating the research; and lastly, Section 1.6 presents the outline of the thesis.

1.1 The Research Context

The academic literature studies megaprojects separately due to their special characteristics in relation to their size, uncertainty, ambiguity, complexity and integration, and important political and external influences (see for example Dimitriou et al., 2014; Greiman, 2013). In this context, the pre-investment phase of the megaproject cycle, involving project planning and appraisal, is understood as significant to deliver the widest possible range of positive transformational benefits that megaprojects can bring in terms of economic, social, environmental, and territorial outcomes, both in the short run and in the long term. However, there is no consensus regarding the approach to use in the decision-making process at these stages.

The more conventional project management approach to project planning and appraisal states that projects should be treated as closed/hard systems. Under this view, project objectives should be fixed in early stages. Planning and appraisal should intend to impose the scientification and depoliticization of the problem, assuming that there is a sole decision-maker, with abstract aims that can be fulfilled with concrete actions, based on a hierarchical chain of command (see for example Checkland, 1985; Lenfle & Loch, 2010). This approach is usually related to the "iron triangle" view to megaproject success. Based on this perspective, a megaproject is considered successful when it is delivered on budget, on time, and in line with the required specifications (Weaver, 2007).

However, other academics and practitioners working in the field of megaprojects, understand that the conventional project management approach is inconsistent for this specific kind of projects. They claim that it undermines the project's ability to adapt to changing contextual influences (see for example Lee, 1973; Dimitriou 1992; Gladwell, 2000; Vasconcellos, 2003; Snowden, 2008; Batty 2008; OMEGA Centre, 2011; and Ward, 2022). These academics support a more holistic perspective, and state that megaprojects should be faced with an "open-systems" approach to decision-making, with a soft thought system, in order to better frame how the different components that are relevant to their justification are accommodated. This approach favours more comprehensive and integrated ways of planning and appraising infrastructure megaprojects, by

promoting a reduction in data demands, focusing on simplicity and transparency aimed at clarifying the terms of conflict and accepting uncertainty. This approach understands "iron triangle" measures as merely one (albeit very important) indicator of successful delivery of a project and its outputs. However, there are other success factors that can be pursued, considering other criteria, such as efficiency, effectiveness, relevance, among others (Samset, 2013). All in all, it is considered that this "open-systems" approach helps to deliver the widest possible range of positive transformational benefits that MTPs are able to bring (for more information check OMEGA Centre, 2011) and a more holistic and adaptive approach to whole life project risk management.

In Latin America the challenge is that a "closed-systems" approach to decision-making is requested and applied by central governments at the planning and appraisal stages of megaprojects and is probably hindering the regions' potential for socio-economic development (Alberti, 2015). Despite the belief, as stated by several decision-makers (and in line with the holistic perspective), that this approach promotes an inconsistent planning and appraisal process for megaprojects, the governance structures that sustain this way of doing are seemingly being kept in place despite the potential damage they may be causing.

In this context, as stated by Scott (2013), there may be different institutional forces in place that sustain this status quo. There may be cultural-cognitive, normative and regulative elements that could be promoting the "closed-systems" approach to decision-making when planning and appraising megaprojects in LatAm, which is preventing change. This research specifically focuses on the regulative element, on the formal rules.

1.2 The Research Focus

The purpose of this research was to make an in-depth, and innovative analysis of the possible contribution of the regulative element, the formal rules (bureaucracy, legislation and the judiciary), along the project lifecycle, to the selection of the planning and appraisal approach to decision-making used in three MTPs in LatAm.

Understanding the role of formal rules, which are always subject to revision, in this decision-making process was expected to help to determine potential alterations to the formal institutional environment that can promote a more successful development of MTPs and better progress of the region. In this way this thesis sought to expose potential pathways for change to allow more sustainable and inclusive models of MTP decision making, or an "open-systems approach" to decision-making at the planning and appraisal stages to take root within LatAM.

This is absolutely relevant because understanding this may help to develop a roadmap of formal institutional enhancements that may contribute to change the status quo, which is lacking from much of the existing literature on the topic. As correctly explained by Gil (2023), based on the ongoing empirical studies developed by Gil & Pinto (2018), Gil & Fu (2022), and Fu & Gil (2023), there is an opportunity to explain megaproject planning problems by using an institutional perspective, going beyond the "bad" management and dishonesty arguments (see for example Gaddis, 1959; Cleland & King, 1968; Wachs, 1989; Morris, 1994; PMI, 2000; Flyvbjerg et al, 2003; Flyvbjerg & Cowi, 2004; Merrow, 2011; McKinsey 2021). While Gil (2023) proposes a New Stakeholder Theory (NST) to deal with this challenge, this thesis analyses it with a New Institutional Economics (NIE) perspective.

The selection of the NIE perspective was based on the theoretical assumption that formal rules are constraints that structure every political, economic and social interaction (for more information check North, 1991; Williamson 2000). If this can be assumed, by definition, for every interaction, it should be true as well for MTP development. It would follow that meaningful changes to infrastructure planning practice cannot be made without consideration of the formal rules constraining change.

1.3 The Theoretical Perspective: New Institutional Economics (NIE)

This thesis opted to conduct the in-depth study of the formal institutions that reinforce a "closed-systems" approach to planning, using a NIE lens. Using this theoretical perspective, it was assumed that there are specific characteristics of megaprojects that generate transaction costs that are being economised using this planning and appraisal approach, given the formal institutional environment.

Therefore, this research focused on how the formal rules at the MTP pre-investment and investments stages can impact on the transaction costs of developing the project and, subsequently, if they can be contributing to a "closed-systems" approach to planning and appraisal, as a transaction cost economising tool.

According to NIE, the transaction is the basic unit of analysis (see Commons, 1932), and understanding how the formal rules affect the transaction becomes unquestionably relevant. As succinctly defined by Williamson (1996: p.379), a transaction occurs when a good or service is transferred across a technologically separable interface. In this context, a contract, which frames a transaction, is a legally enforceable agreement to which each party gives express approval and to which a particular body of formal rules apply (see Masten, 2000: p.25).

When a MTP is developed, the transaction involves a construction contract (or contracts - sometimes complemented with other activities such as design, finance, operation and maintenance) between the owner (usually the public sector), and a contractor or consortium. The development of the said contract comprises "transaction costs"[1] that can be economised and the possibility of transaction cost economising is linked to the already mentioned formal rules.

1.4 Research Paradigm and Methods

This research used a "pragmatic paradigm worldview", as defined by Creswell & Plano Clark (2011). It has intended to provide multiple perspectives and shed empirical light about a series of theoretical propositions (see Yin, 2014). A mixed method research with a qualitative priority was designed, as both qualitative and quantitative data could inform the problem under study, focused on the "how". The *theoretical propositions* (derived from NIE as the social science framework) which led the multiple-case study proposed, were the following:

- There is a link between typical MTP construction risks and contractual hazards
- There is a link between formal rules and contractual functions, which affect transaction costs
- The "closed-systems" approach to the planning and appraisal of MTPs may help decision-makers to minimize transaction costs, in the context of the formal rules of the game in place

The previous theoretical propositions served as the theoretical orientation that guided the study, which objective was to produce an analytical generalisation (see Yin, 2014). The focus of this research was to understand, in a multiple-case study of Latin American MTPs, how formal rules, at the pre-investment and investment stages, can impact in the decision of using a "closed-systems" approach to decision-making at the planning and appraisals stages. The multiple-case study here presented, in the same way as an experiment, is generalizable to the said theoretical propositions and not to the population or universe of LatAm MTPs.

As opposed to statistical generalisation, where an inference is made about a population, the analytical generalisation is based on advancing the theoretical concepts (*theoretical propositions*) referenced when designing the multiple-case study. Evidently, as a generalisation, it strives for generalisable lessons learned that go beyond the cases, but the logic is different. If the empirical data matches the theoretical propositions, constructed from the social science perspective, this can lead to recommendations for future policy actions (see Yin, 2014:148).

[1] Defined by Furubotn and Richter (1997) "Transaction Costs" are the costs of resources utilised for the creation, maintenance, use, and change of institutions and organisations. They include the costs of defining and measuring resources or claims, the costs of utilizing and enforcing the rights specified, and the costs of information, negotiation, and enforcement.

1.5 Research Gaps and Objectives

1.5.1 Mega-Transport Projects and Risks in Latin America

MTPs, as megaprojects, are categorised as "mega" for several reasons. One of the most frequently argued reasons has to do with their very high construction costs. However, megaprojects are also politized, human-centred, global, complex, open, organic and iconic. All these characteristics imply that MTPs are also very risky projects. At the contracting stage, this characteristic is materialised in a set of construction risks.

Specialised literature has shown that analysing the resulting set of risks is a very complex task. Not all information regarding uncertainty factors is numerical, and the aggregation of different risks becomes a very difficult task. Basically, the imprecision, complexity and vagueness of several of the risks that developers face is the norm. This reality implies an unfailingly subjective assessment of risks.

In this context, the *first research gap* that this thesis intended to close was the nature and relative importance of the different construction risk factors and dimensions in the cases included in the multiple-case study, by using a methodology that could include the said subjectivity. In particular, the objective was to understand it from a decision-maker point of view, considering the following risk dimensions: social, technical, environmental, economic, and political. This was the first knowledge gap to be addressed as it was considered that it could help to understand, with more detail, the decision-makers view of the potential transaction costs behind writing and executing the MTP's construction contract. For this purpose, a quantitative strand based on Fuzzy Set Theory was included as part of the mixed methods research design used.

1.5.2 Link Between Construction Risk Dimensions and Contractual Hazards

The second step was to understand how the previous risk dimensions were related to the said transaction costs. This was the *second research gap* that was considered in the context of applying an institutional analysis, with a NIE perspective, to understand the selection of the "closed-systems" approach to planning and appraisal. For that purpose, the first *theoretical proposition* drawn from the NIE theory (mentioned in the previous section 1.4, and thoroughly explained in Chapter 2 – Literature Review) was considered: 1) there is a link between typical MTP construction risks and contractual hazards.

Therefore, it was here analysed how this theoretically expected link could be working in the selected cases. With a NIE view, the main problem dealt with when developing the contracts,

which generate transaction costs, is the control of contractual hazards induced by the logic of transactions. The emphasis of NIE is therefore placed on understanding the nature of the said contractual hazards. The case of public contracts is special as it is exposed to a larger set of hazards than those held between private transactors.

With this in mind, in this research, following Spiller (2008, 2013), the three contractual hazards considered were: standard opportunistic behaviour, governmental opportunism and third-party opportunism. The first one is related to asset-specific investments, which are linked to bounded rationality and idiosyncratic knowledge. Basically, this is associated to the fact that the contractual parties can use information asymmetries in their favour. Governmental opportunism, in the second place, is linked with the ability of governments to opportunistically change the rules of the game. Governments may use standard governmental powers to extract rents from their contractual counterparts. Finally, third-party opportunism is related to public contract scrutiny, considering that the essence of public contracting is its publicity. This opportunism may be practiced by designated agencies, politicians, or other stakeholders. The problem is that they are biased, and they may be tempted to challenge the probity of the interaction without a solid reason.

Understanding how the link between particular MTPs' construction risk dimensions and contractual hazards could be working, from the decision-makers perspective, was mandatory to understand their concerns when writing a MTP contract.

1.5.3 Link between contractual functions and formal rules

With a NIE view, the contractual hazards previously mentioned are dealt with contractual functions: safeguard or control function, coordination function, and adaptation function. The development of a MTP construction contract usually requires the specification of contractual clauses associated with each one of these functions.

The effectiveness of those functions, at least theoretically, can be related to the characteristics of the formal institutional environment: bureaucracy, legislation and the judiciary. If the previous formal rules make contractual functions ineffective, it is theoretically reasonable to state that transaction costs would be especially elevated.

Therefore, the *third research gap* which was intended to close was to analyse how these contractual functions could be working, from the decision-makers' perspective, in the selected cases, and their relationship with the said rules. This is why the second theoretical proposition was included: there is a link between formal rules and contractual functions, which affect transaction costs.

1.5.4 The use of the planning and appraisal stages to economise transaction costs

The final step, which is the core of the MTP planning challenge presented in this research was to analyse if decision-makers could be acting rationally (at least to some extent) when using a "closed-systems" approach. The third theoretical proposition here studied was that decision-makers could be using this type of approach to planning and appraisal as a strategy to minimize transaction costs. This would be right if they expect that this "closed-systems" approach minimizes construction risks and contractual hazards, in the context of the formal rules in place.

Those academics and practitioners who favour a "closed-systems" approach to decision-making at the planning and appraisal stages believe that projects should be treated as closed/hard systems, and believe that planning and appraisal should intend to impose the scientification and depoliticization of the problem. On the other hand, those who defend an "open-systems" approach to decision-making at the planning and appraisal, with a soft thought system, do so as it promotes a reduction in data demands, focusing on simplicity and transparency aimed at clarifying the terms of conflict and accepting uncertainty, keeping options open.

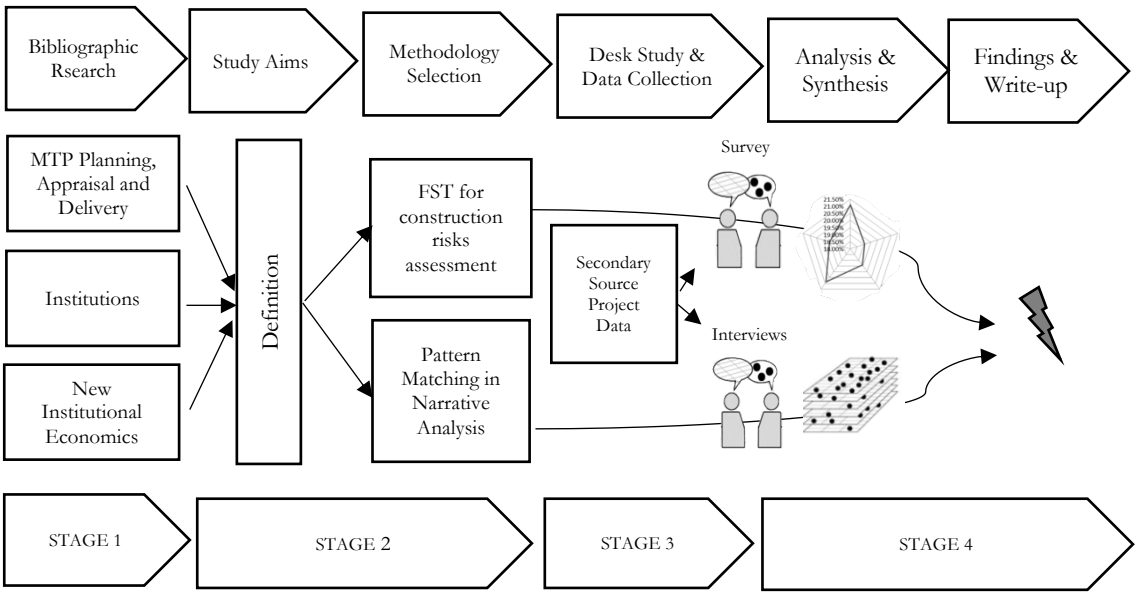
Although there is theoretical merit to use an "open-systems" approach to planning, it is here presented that a "closed-systems" approach to planning and appraisal could be perceived as a good option to reduce transaction costs, given the formal rules of the game (bureaucracy, legislation and the judiciary). If this is true, decision-makers could be rationally encouraged to use this approach at the planning and appraisal stages of MTPs. This is the final research gap that is analysed in this thesis.

This thesis studies if the fact that MTPs are not being planned in Latin America with an "open-systems" approach to decision-making, in order to deliver the widest possible range of positive transformational benefits that megaprojects are able to bring, could be reinforced by the perception that it may be ineffective with a transaction cost minimizing view. If this is the case, the rules of the game that are in place throughout planning, appraisal, and execution could and should be modified in order to change the status quo.

1.6 Thesis Structure

Chapter 1 has set the scene for showing the research developed. The following figure summarises the logic and stages of the research process.

Figure 1 – Logic of Study



This thesis is divided in 8 chapters:

- Chapter 2 describes the literature reviewed, which justifies the chain of thought that led to the research aim and questions. It covers relevant literature on MTP definition and characteristics, construction risks, the role of MTP planning and appraisal, and the challenge behind institutional analysis, focusing at the end of the chapter on the NIE theoretical perspective.

- Chapter 3 includes the aims, objectives and questions of this research.

- Chapter 4 provides an overview of the selected methodology, describing the selected paradigm worldview, the theoretical lens, the methodological approach and the methods for data collection. It finishes explaining in detail the analysis proposed for this thesis.

- Chapter 5 generally describes the context, planning and appraisal processes, and technical background of the three MTPs that were included in the multiple-case study: Ferroanel North Railway Sao Paulo, Brazil; Central Railway Project, Uruguay; and Line 1 Metro of Bogotá, Colombia.

- Chapter 6 presents the results of the application of the methodology. Firstly, it covers the application of the quantitative strand, used to understand how the decision-makers included in the analysis perceived that construction risk factors and dimensions contributed to the general risks of the selected MTPs. Secondly, it presents the results of the application of the qualitative strand, employed to make a detailed analysis of the selected decision-makers view on the role of the planning and appraisal process for transaction cost economising in the cases studied.

- Chapter 7 offers a critical discussion of the results, in the context of the literature reviewed. It discusses cross-case results, elaborating finally on how a "closed-systems" approach to decision-making at the planning and appraisal stages of MTP can be used to deal with transaction costs.

- Chapter 8 contains the final conclusions and reflections of the research. It presents the responses to the research questions, the general contributions of the research, its limitations, and recommendations for further investigation.

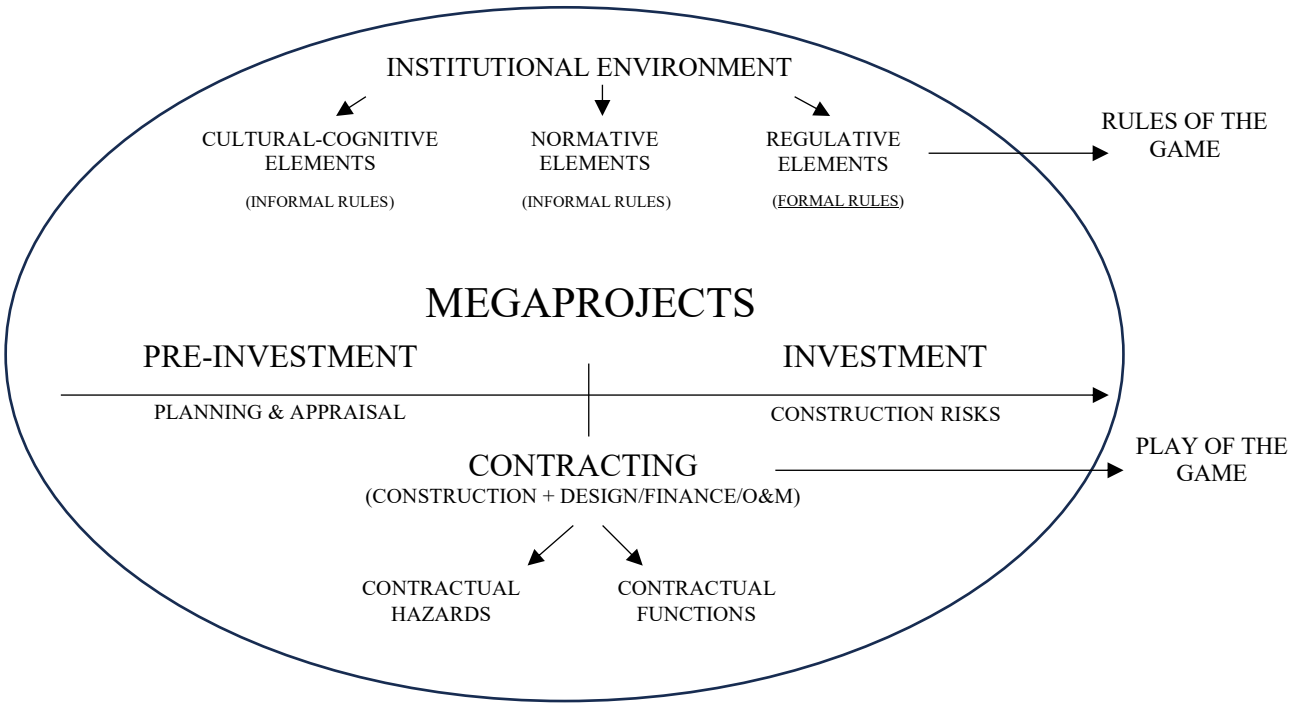
2 Literature Review

2.1 Chapter Overview

The literature review is presented in this chapter so that the reader can follow the chain of theoretical thought that led to the theoretical propositions considered, and the research aim and questions presented in Chapter 3. This is particularly relevant given that the research objective of this thesis was constructed by combining knowledge from different theoretical backgrounds: planning studies, public policy, construction management and economics.

In fact, megaprojects can be, and have been, analysed with different theoretical backgrounds by different authors. The combination presented here is based on two building blocks: 1) Planning studies shed light on the way to go on MTP's planning and appraisal, so that central governments can deliver the fullest range of transformational benefits that megaprojects are able to bring, considering economic, social, environmental and territorial long-term outcomes; 2) Planning studies can and should be informed by other disciplines to expand its scope and achieve a more holistic perspective. In particular, it is the view of the author of this thesis that inputs from New Institutional Economics (NIE), as a social science framework, can promote a better understanding of the challenges behind the planning and appraisal of MTPs. In this context, this chapter is organised as follows. Figure 2 presents a diagram to help illustrate the various topics presented and how they relate to each other. Relevant topics will be highlighted in bold as the literature review unfolds.

Figure 2 – Literature Review Diagram - General



At the beginning of each section, the specific part of the previous diagram which is analysed in that section is highlighted. Firstly, section 2.2 is structured to show the definition and characteristics of megaprojects in general and MTPs in particular, combining background from planning studies and construction management. The peculiarities of megaprojects in general and MTPs in particular are presented, specifically indicating that they are political, human-centred, global, complex, organic and iconic. This is relevant as these characteristics are fundamental to understand the source of the construction risks that these projects involve, which are considered when developing the contract.

Secondly, section 2.3 analyses how the previous MTP characteristics are translated into construction risks, when MTPs are contracted. The section shows the theoretical approaches to risks, how they are usually defined in project management, and particularly construction projects, and how the MTPs unique characteristics mentioned in 2.2 affect construction risks. It ends with a comprehensive list of risk factors and dimensions, usually considered in the construction management literature, which was necessarily developed to understand the link between construction risk factors and contractual hazards initially proposed.

In third place, section 2.4 delves into planning and appraisal of megaprojects, confronting two approaches: the conventional project management approach and a more holistic planning perspective. It is there theoretically advocated that central governments should use a holistic planning and appraisal, by presenting a critical review of the conventional project management recommendations, and defending the use of an "open-systems" approach to decision-making, with a soft thought system. Moreover, this section exhibits that in LatAm, a "closed-systems" approach to decision-making is requested and applied by central governments, from different countries, at the planning and appraisal stages of megaprojects. This is the pressing public policy challenge on which this thesis has focused.

In particular, the emphasis of this thesis was to analyse the institutional forces that sustain this status quo, given that a case can be made to justify a change of strategy. The problem to analyse this deeply is that "institutions" may have very different meanings if studied by sociologists, political scientists, planners or economists. Therefore, section 2.5 shows the different theoretical approaches to institutions. It does so in general, and particularly for the case of MTPs. This is pertinent to illustrate to what extent this thesis analyses the institutional background. It clarifies that it studies the problem at hand only with a NIE perspective. This section helps to acknowledge that this is not more than one part of a very big institutional picture. It also shows that it is much reasonable to use this social science theoretical framework to analyse the contribution of the formal institutional environment (legislation, bureaucracy and the judiciary) to the selection of a "closed-systems" approach to the planning and appraisal of MTPs in LatAm.

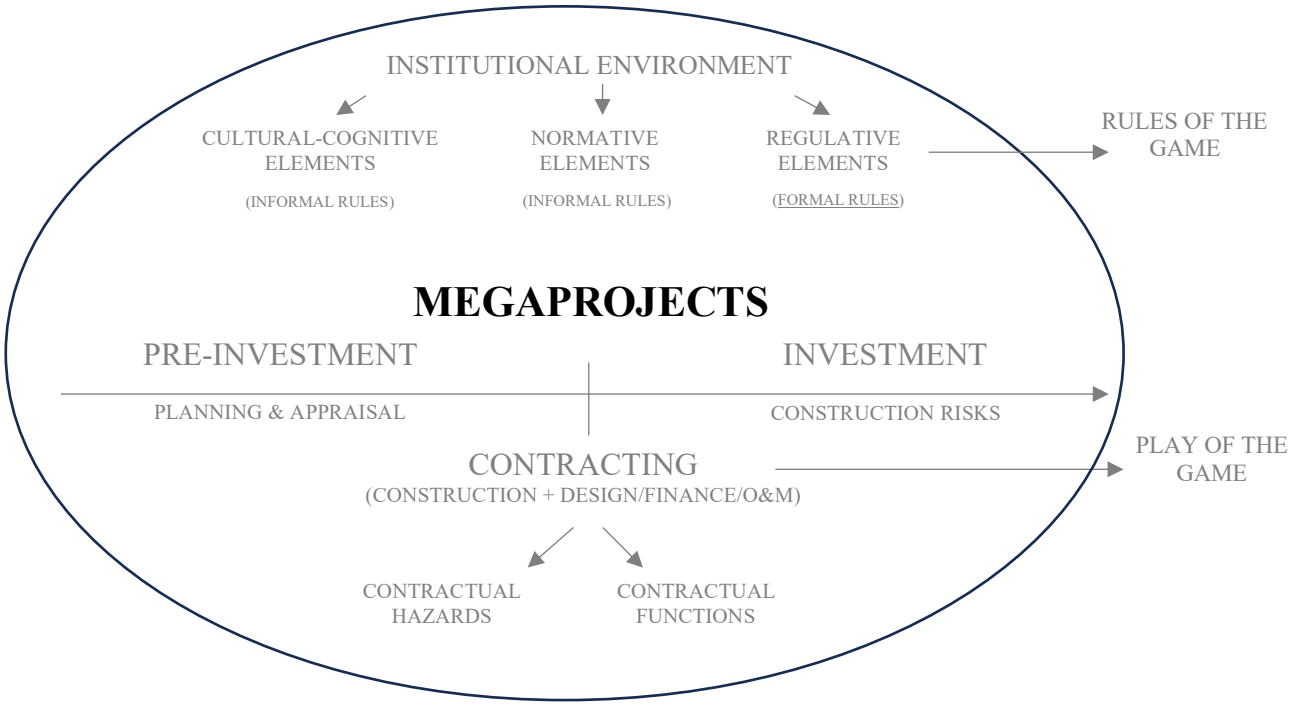
Finally, section 2.6 clarifies the way that NIE can be used to analyse how formal rules are related to the planning and appraisal approach to megaprojects, defining and delving into the knowledge gaps already stated in Chapter 1. It is there theoretically presented that it is reasonable to propose that MTPs' construction risks are linked to contractual hazards. Moreover, it is illustrated that those contractual hazards could generate transaction costs that could be minimised by the formal abovementioned rules of the game and the contract. In order to do so, the chapter combines knowledge from planning, construction management and economics.

The chapter ends with a summary that justifies the research aim, objectives and questions immediately presented in Chapter 3. Moreover, it lays the groundwork for the methodology of this thesis offered in Chapter 4.

2.2 Nature of Mega-Transport Projects[2]

Section 2.2 focuses on the nature of megaprojects in general and MTPs in particular.

Figure 3 – Literature Review Diagram - Megaprojects



2.2.1 Key Definitions

Megaprojects are a particular type of infrastructure projects; they are categorised as "mega" for various motives. One of the most frequently argued reasons has to do with their very high construction costs. There is growing academic agreement that infrastructure megaprojects are large-scale projects, high investment ventures of one billion USD or more (see Flyvbjerg, 2014). This author states that, as a general rule of thumb, megaprojects are measured in billions of dollars, and are sometimes also called major programs.

Notwithstanding this narrative, some authors such as Greiman (2013) believe that this measure should in some way be related to a country's gross national product, and others affirm that this should be related to the development context within which they are developed (Capka, 2004).

[2] Section 2.2 draws on aspects of research undertaken by the author both during his PhD studies at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It is based on the following papers, originally published by the Inter-American Development Bank: Alberti (2019a), Alberti & Pereyra (2018a, 2018b, 2020a, 2020b, 2020c, 2020d, 2020e & 2020f).

These authors emphasise that the cost of a megaproject is relevant but should be contrasted with the size of the location or country where it is developed.

Apart from matters related to the scale of costs, other characteristics are often included to differentiate megaprojects from other projects. For example, they are frequently seen as being critical to the economic, social, environmental and territorial development of the areas they traverse and influence (see for example Dimitriou et al., 2014). In other instances, they are seen to involve a large number of important public and private stakeholders that can influence (or be influenced by) the progress of their development (see Macharis & Nijkamp, 2013). Either way, as explained by Allport (2010), they are frequently understood to represent high risk undertakings particularly because they are developed under conditions of considerable uncertainty.

From the existing literature it arises that projects of this kind have been studied separately not only because of their special features in relation to their size, uncertainty, and the risks they involve, but also because of the ambiguities they frequently pose, the complex interfaces and integration challenges they encounter, and the significant political and external influences (Greiman, 2013) they incorporate—all interwoven frequently in complex stakeholder decision-making processes over long periods of time (Priemus & van Wee, 2013).

This thesis particularly focuses on the analysis of megaprojects in the transport sector that comply with said USD 1 billion price tag plus many of the other features of megaprojects described above. As stated by Dimitriou (2016), MTPs are associated with icons of development and progress, whether in the form of major airports, seaports, fast train links, metros, major highways or even bridges and tunnels. MTPs have been defined by Dimitriou et al. (2012) as "land-based infrastructure investments (…) in the form of bridges, tunnels, road and rail links or combinations of these structures. They are projects that entail a construction cost of over USD 1 billion (at 1990 prices) that are frequently perceived as critical to the "success" of major urban, metropolitan, regional and /or national development".

Although this thesis focuses on the transport sector, it acknowledges that many MTPs are not in fact "stand-alone" projects but a program or programs of projects. Many transport megaprojects are developed or evolve in urban corridors or regional development corridors, and are related to other mega infrastructure projects found in the same corridors.

According to predictions made by the McKinsey Global Institute, in order to keep pace with the projected global economic needs of population growth, the world needs to invest USD 3.3 trillion annually in infrastructure through 2030 (Woetzel et al., 2016). This same source argues that a significant portion of such investment will be developed in the transportation sector, much of it in the form of megaprojects.

With this in mind, understanding the complexity of the issues and challenges that surround such projects becomes crucial to all the stakeholders involved, especially decision-makers. In the following sections, key characteristics of megaprojects in general and MTPs in particular are explained, in order to illustrate the different facets of these endeavours. This is particularly important for this thesis' objectives, given that it is here illustrated that these MTP characteristics are the source of the risks usually encountered when developing a construction contract. Acknowledging these sources theoretically is particularly useful to frame the first knowledge gap (see section 1.5.1), which can help to produce a better discussion when analysing if governmental decision-makers may perceive that the approach to decision-making at the planning and appraisal stages affects transaction costs.

2.2.2 Political Projects

MTPs are usually characterised as "political projects", that is, projects which preeminent function deals with the building of political consensus (see Beria et al., 2018). MTPs may not respond to a transport policy at the service of productivity, welfare or sustainability, but may be a means to achieve political power.

In large and complex projects, between the initial exploratory research and the strategic structuring stage, a coalition between participants must emerge and political support must be organised. As stated by Miller & Hobbs (2005, p.44), this process is often quite fuzzy, and it is much a question of gathering momentum. The challenge that arises is that projects can be selected to optimize the agreement process, limiting attention to other decision criteria, for example technical efficiency, equity, environmental sustainability, among others (for more information on this issue see Siemiatycki, 2013).

Optimizing the decision-making process with a political criterion, in search of the said agreements, includes the development of activities that influence the electoral contest, maintain the capacity of government and direct public policies (McConnell, 2010). Therefore, for greater technical effectiveness to be obtained from the pre-investment process, there must be a balance of power between the political and technical environments of the project. As explained by Allport (2010), it is desirable that there be a balance between the two so that neither too many technical feasibility risks nor too many political risks are taken.

However, it is usual that in megaprojects, normally political projects, there is no balance in said issue, and political pressure causes that, strategically, it is resolved to misinform or incorrectly represent reality by the technical area. Cantarelli et al. (2010) state that political pressures cause strategic misrepresentation because forecasts are adjusted to derive the most attractive outcomes.

Basically, the political importance of such projections and the technical complexities to develop them usually combine to create an important ethical dilemma in the technical environment in charge (see Wachs, 1990).

In short, in MTPs there may be a tension between what is rational technical planning and the process of political agreement, which may be too far removed from the general interest and designed to accumulate power. According to some authors, such as Allport (2010), in political projects, what determines the decision-making process is usually the political leadership, and how it deals with the behaviour of stakeholders. This MTP characteristic is particularly relevant to understand why they are usually considered politically risky.

2.2.3 Human-Centred Projects

MTPs are also understood as systems centred on human activity, and are characterised by involving various interconnected stakeholders in a complex way and with conflicting interests (Erkul et al., 2016; Mok et al., 2015; Yeo, 1995). In this type of projects, effective stakeholder management is crucial for their development and delivery, in order to meet the expected objectives. As stated by Winch (2017), megaprojects should always be understood in the context of the society they serve.

In its beginnings, specialised literature on the strategic management of firms deepened this topic. The term stakeholder was defined in the work of Freeman (1984) as a group that can affect or be affected by a certain organisation. The academy focused on studying three aspects: the descriptive/empirical, the instrumental, and the normative ones (Elias et al., 2002). This resulted in what was called by Donaldson & Preston (1995) as the stakeholder theory of corporations.

This literature later expanded, particularly towards the analysis of the dynamics of these groups, that is, of their changes over time, within the framework of these organisations. Of special impact was the work of Mitchell et al. (1997) in which the authors generated a characterisation of interest groups based on the interrelation between their power, their legitimacy and the urgency of their demands.

All this work was taken up by the literature associated with construction management (Atkin & Skitmore, 2008) and various methods have been used for stakeholder analysis. As in the case of organisations, the literature on projects has also focused on categorizing them and analysing their potential impact, based on their attributes, attitudes, roles, and predictability. However, this posed an additional difficulty in the case of megaprojects, given the confusion involved in establishing

the boundaries of group action in the framework of the complexity imposed by the nature of this particular kind of projects (Mok et al., 2015).

Megaprojects in general, and MTPs in particular, involve multiple interdependent stakeholders. MTPs, as human-centred projects, are therefore particularly risk prone, especially considering the social dimension of risk. The challenge is to understand their simultaneous influence, in order to manage it. Lund Jepsen & Eskerod (2008) suggest that the people in charge often do not have the capacity to capture this. It is necessary, first, to understand the interests and the possibility of influence of the groups –which is not trivial– to then determine what type of management is necessary to carry out and what level of involvement is necessary.

2.2.4 Global Projects

MTPs are also characterised by the special organisational challenge they pose. They are usually examples of what recent literature defines as global infrastructure projects. Very few megaprojects in the present rely exclusively on people and resources from a single country. The strategic environment is usually global, interconnected and dynamic. Although the final assembly of the project occurs locally, it arises from resources that flow through different value chains, which can extend to different regions and countries (Orr et al., 2011).

A global project is defined as "a temporary endeavour where multiple actors seek to optimize outcomes by combining resources from multiple sites, organisations, cultures, and geographies, linking contractual, hierarchical, and network-based modes of organisation" (Orr et al. al., 2011, p. 17). Global infrastructure projects have the following characteristics. First, they are infrequent efforts that include global and local players, which can lead to tensions over who has knowledge and responsibility in the long run. In addition, they tend to be projects with complex interfaces between the public and private sectors, which generates challenges, given the different logics that govern them. Third, they are projects that are strongly integrated at the local level, with various points of contact with the community, and this implies additional social and political complexity. Finally, due to their physical characteristics, they are also usually projects with a certain irreversibility, exacerbating the stress and relational dynamics of the participants (Orr et al., 2011).

Authors who study this phenomenon suggest that the challenges imposed by global projects are due to distance, geographical dispersion and complexity of the network. Distance refers to institutional differences, dispersion to the fact that participants are located in different places, and the complexity of the network, to the interconnection between the parties based on different levels

of formal and informal relationships (Orr et al., 2011). MTPs, as global projects, are usually risky considering their particular social, technical, economic and political context.

2.2.5 Complex Projects

MTPs are also characterised by being especially complex projects. This complexity is associated to a unique decision-making process, different from those of smaller projects. A complex system is one that is made up of several components, and its behaviour cannot be inferred from the behaviour of the said components separately (Bar-Yam, 1997). A given project can be understood as a complex system when there are multiple structural elements interacting and changing as the different phases progress (Whitty & Maylor, 2009).

According to Remington & Pollack (2011), megaprojects are typical examples of complex systems. These authors propose an analysis framework in which they specify four dimensions of complexity: structural, technical, directional and temporal. The first derives from the many interrelated and interdependent activities that generate a form of non-linear feedback between the organisational structures that carry out the project. Technical complexity, on the other hand, alludes to the design challenge, which can generate problems for which there is no solution in the required time. Directional complexity is the result of objectives (or paths to achieve them) that are unclear or not shared by the different project participants. Finally, temporal complexity refers to that which arises due to the project's sensitivity to unpredictable changes in the context, both internal and external, during its development (Remington & Pollack, 2011).

Brockmann & Girmscheid (2007) also make an effort to characterize the complexity of megaprojects, with which they arrive at a solution divided into three layers: task complexity, social complexity and cultural complexity. The first is associated with the density of activities in the spatial and temporal framework. Social complexity refers to the number and diversity of participating actors, who communicate and work with each other. The third type of complexity, the cultural type, is tied to the history, experience and way of reasoning of the interest groups involved in the project.

Likewise, de Bruijn & Leijten (2008) maintain that megaproject management is linked to two characteristics: technical complexity and social complexity. The first refers to the nature of the project, and the second, to its implementation. The strength of the project is related to: the possibilities of generating a robust design and using proven technology; the divisibility of the project itself; the level of association between the different components; the options available to create redundancy; the level of multifunctionality of the project; and how incremental its implementation is. Social complexity, on the other hand, comes from the dependence of

stakeholders' decision-making, from the high variety and dynamism of preferences, from the blocking power of third-parties, from the level of social impact of the project and from its time of implementation.

The typical project management process is associated with the generation of command-and-control structures, with a defined hierarchy, with a reasonable balance between authority and responsibility, and with the project objectives understood by the stakeholders. However, what usually happens in complex projects is that there is a difference between the organisational strategy visualised by decision-makers and the one that is actually achieved, mainly due to the characteristic of the organic system that complexity imposes. There are shifting and divergent goals, with many levels and types of authority involved in the project, and the end product is difficult to visualize (Bourne & Walker, 2005).

Assuming the above complexity, it is difficult to orderly manage the planning and implementation of a megaproject through a structure based on command and control, with a project management approach. Such a structure is not particularly useful for managing the interdependencies and very likely conflicts of interest that arise from the network of organisations involved in megaprojects. At the same time, a project management approach assumes that the problem remains relatively stable, something that does not happen in these cases either (de Bruijn et al., 2002). The key is to focus on process management and redundancy (de Bruijn & Leijten, 2008).

A process approach is reasonable to encourage, in an orderly manner, the necessary involvement of the different interest groups that are relevant. An approach of this nature includes discussion and negotiation processes between the parties. In this way, agreements are generated on the rules that the interest groups must use to make a decision, and thus the role of the "Process Manager" is generated, instead of that of the "Project Manager" (de Bruijn et al., 2002).

The intrinsic complexity of megaprojects in general, and MTPs in particular, is associated with the degree of multiplicity, interrelation and impact on the decision-making process (Brockmann & Girmscheid, 2007). Evidently, this special characteristic of MTPs results in a complex set of risks as well, which need to be managed appropriately at the different stages of their development.

2.2.6 Organic Projects

MTPs are also characterised by being organic phenomena (after OMEGA, 2011) that co-evolve with their context and thus undergo continuous transformation in terms of goals and objectives (Lehtonen, 2014). Megaprojects should not be viewed solely as engineering artifacts. They

change in time and space, to the extent that they affect –from their gestation to execution– the territories, economies and societies they serve (Dimitriou et al., 2014).

Due to this characteristic, it is often difficult to establish its scope from very early stages (Wysocki, 2014). For this reason, some authors suggest that these projects should have an initial gestation period to achieve a certain stability in terms of the expectations of the different stakeholders. This period has two main objectives at the beginning of the project: the new opportunities can be visualised and exploited, and the decisions that have negative effects can be revised (Dimitriou et al., 2013).

At the same time, their organic nature also means it is particularly difficult to assume that the development of megaprojects can be effectively foreseen at all levels at their gestation. At some levels they can be predictable, and there are institutional challenges that can be addressed. However, for the megaproject modules that cannot be foreseen, which contribute to their risky nature, there are relevant decisions that must be made over time.

By adopting this assumption as true, at least for a relevant part of the components of megaprojects, the spectrum of recommendations for their management is broadened, beyond the typical ex-ante strategic planning. In organic projects, the focus should also be on actual practice. A large part of the efforts must be devoted to addressing to the spontaneous processes, and risks, that arise at all times. Although they are two sides of the same coin, governance design is just as important as the mode of government (see for example Sanderson, 2012). The first is decisive for efficiency and the second for flexibility.

2.2.7 Iconic Projects

MTPs are also understood as iconic projects, capable of revitalizing an economy through changes in the image of a city or country, a value that cannot be captured by ex-ante financial or economic analyses (del Cerro Santamaría, 2017).

From an urban perspective, the iconicity of the megaproject's design or its functionality is usually considered capable of transforming or having the potential to transform part or all of the image of a city (del Cerro Santamaría, 2015). Sometimes megaprojects stand as a monument to development, which is capable of giving space meaning (Graham & Marvin, 2001).

Urban elites –which can be political, corporate or cultural– understand this iconicity as crucial to catalyse growth or link the city with its surroundings. That is why the necessary consensus for its development is achieved, even when it may not have a substantially high benefit from the economic or financial point of view (del Cerro Santamaría, 2015).

The iconicity of a project can take a number of forms; that of megaprojects, in particular, is limited to the valorisation of constructions or spaces based on their uniqueness. It responds, then, to a symbolic and aesthetic value, and that it can favour certain stakeholders (Sklair, 2006). Basically, the cultural base of a society can be used to obtain financial and political returns, among others, from megaprojects (Sklair, 2013).

In this regard, Flyvbjerg (2014) goes one step further and explains that there are four main reasons that explain the boom in the increase, in quantity and size, of megaprojects. The reasons are political, technological, economic and aesthetic. Regarding the latter, it includes the pleasure that societies feel for using goods that are iconic. This author explicitly separates economic and political reasons from aesthetic ones. In the same sense, Leijten (2013) shows that, on occasions, societies may not even regret the development of iconic megaprojects, even though they have been irresponsibly planned and substantial cost overruns and delays have appeared. Then, the iconic nature of megaprojects in general, and MTPs in particular, can be theoretically related to the social risks associated to this particular type of projects.

2.2.8 Summary of Key Findings

Megaprojects in general, and MTPs in particular, are special endeavours given their size, but also considering distinctive characteristics; they are political, human-centred, complex, organic and iconic projects. These particularities have promoted a separate study of this kind of projects, specifically considering how they are related to policy-making. Decision-makers are usually presented with dilemmas that confront technical-engineering solutions with more complex and ambiguous policy options, which are related to political and external influences, with formal and informal relationships of the parties involved.

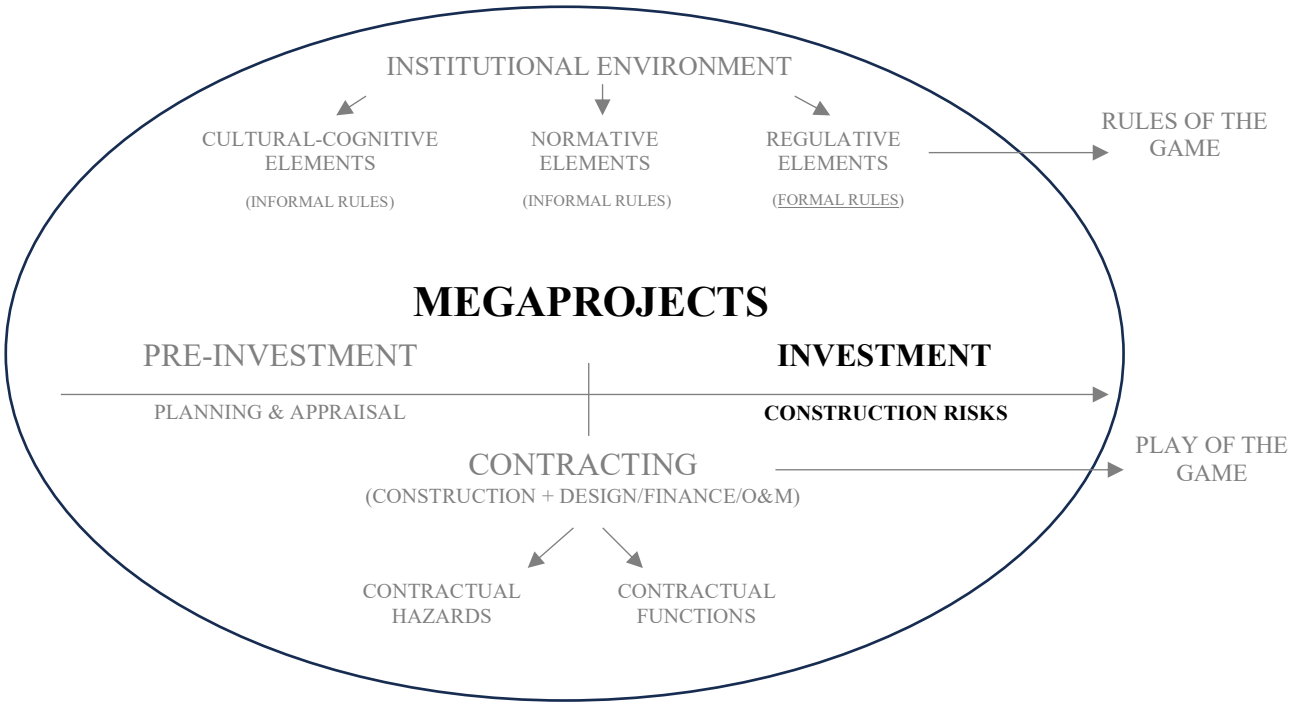
Using a NIE theoretical framework, as mentioned in Chapter 1 and further developed in the following sections of this Chapter, implies analysing the transaction as the basic unit of analysis. The transaction involved when developing a MTP is a construction contract (or group of contracts) that comprises transaction costs.

It is only reasonable to theoretically propose that these transaction costs are very much related to the set of special characteristics of this type of projects mentioned in this section, which imply a thorough set of risks. In order to lay the ground for explaining this theoretical proposition, section 2.3 delves into the concept of construction risks in MTPs.

2.3 Risk in Mega-Transport Projects[3]

This section focuses on how MTP special characteristics are translated in a particular set of project construction risks.

Figure 4 – Literature Review Diagram – Construction Risks



2.3.1 Theoretical Approaches to Risk

Risk, in general terms, can be studied using different theoretical standpoints: a sociocultural perspective and a scientific perspective. The sociocultural perspective analyses the role of risk given social relationships and their subjectivities. Lupton (1999) suggests that there are three approaches to the topic using this perspective: the cultural/symbolic approach; that of the risk society; and the one that deals with governmentality. They share similar concerns, foci and epistemological underpinnings in their work.

This sociocultural perspective of risk emphasises some relevant points, common to the three previous approaches, which are highlighted below. First, the materialisation of a risk can be a consequence of a human error but also a consequence of a purposeful action or bet. Higher risk may have a higher level of potential associated profit. Thus, risk appetite becomes a particularly

[3] Section 2.3 draws on aspects of research undertaken by the author during his PhD studies at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It is based on the following papers, originally published by the Inter-American Development Bank and the Journal of Mega Infrastructure & Sustainable Development: Alberti, J. (2021, 2022).

relevant issue. According to this perspective, propensity to take risks varies according to individuals and circumstances, their idiosyncrasy and culture. Furthermore, the potential return for risk taking may not be monetizable; it can also be associated with power, glory, love, respect and even the feeling of adrenaline. Adams (1995) suggests, therefore, that risk is not always the consequence of a mistake, and it is not evident in all cases that its minimisation is necessary.

At the same time, another issue that adds complexity, with this perspective, is that the measurement of a potential risk can affect the risk that is intended to be measured. That is why, again, an important part of the academic literature considers them as a subjective phenomenon, because it depends on a perception, and not on an unobjectionable reality. This is something that is expected to happen in the future. By definition, in their opinion, it depends on who is waiting for it and it is not a static phenomenon.

Finally, risk comes from uncertainty, a particular state of awareness, which arises from imperfect knowledge, and is by definition a human construction. Therefore, risk, according to the authors who defend this perspective, is also a human construction.

The sociocultural perspective is contrasted with the technical-scientific perspective, used by some currents of engineering and economics, among several other disciplines. In these cases, risk is understood as an objective phenomenon. The study of risk under the assumption of rationality usually has different purposes: identification; cause mapping; generation of predictive models; and response. As noted by Lupton (1999, p.2), this rational approach focuses on generating a scientific measurement and calculation of the phenomenon in question.

The dichotomy, regarding the social-cultural vision, has been resolved differentiating the supposedly objective risks from the subjective risks. With this criterion, the first ones are those that can be modelled with a statistical logic, and the second ones refer to the different perceptions in the population based on how individuals anticipate future events. Objective and measurable risk is usually defined as a measure composed of the probability of occurrence and the magnitude of an adverse effect.

This rational vision is usually criticised by the social-cultural vision, seen previously, alleging that probability and potential impact are inherently subjective variables. Slipping on ice can be a game for a child and a fatal accident for an older person, and therefore, the perception of impact is not independent of the individual who analyses it. The probability of occurrence, in parallel, can be influenced by how individuals perceive this probability (Adams, 1995, p.9).

However, the answer that a defender of the scientific perspective could give is that the example of slip-on ice presents two different phenomena. One refers to the risk in children and the other in older people. Yet, the counter argument is that if only children are grouped together, children

with different characteristics will also be found. So: what is the acceptable level of similarity of children's characteristics which makes the slip-on ice the same phenomenon? Evidently, this is a very difficult question.

2.3.2 Risk in Project Management and Construction

The most orthodox perspective on risk in project management is to adopt the following definition: a risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on projects' objectives (Project Management Institute, 2009). Uncertainty is described based on the probability of occurrence, and the effect considering the expected potential impact.

This vision differentiates specific risks from the global risk of a project. The former refers to those specific events or conditions that may affect one or more objectives. The second represents more than the sum of the different individual risks, and refers to the exposure of the different stakeholders to variations in the impact of the project.

So far, the logic presented by orthodoxy in project management can be analysed within the social-cultural theoretical framework and the scientific method. In this regard, Project Management Institute (2009) specifies that it is necessary to contemplate the attitude towards risk of the different stakeholders, because it defines the relevance of individual risks and global risk. This attitude can be linked to how much the project impacts the activities of the different groups, to the commitment assumed by the developer regarding the objectives, and to their sensitivity to specific factors such as environmental impact and relationships, among others, especially linked to idiosyncratic factors. The prioritisation of some objectives over others is usually the result of the attitude towards the different risks (Project Management Institute, 2009)

In this general project management framework, construction project management has focused on the study of risk under the same probability-impact model aforementioned. Furthermore, risk is usually analysed based on the potential variation in the initially estimated cost or time, as objectives of the construction project itself. These are usually useful for adopting a single scale for measuring risks of different nature (Taroun, 2014).

In this regard, there have been different methodologies to measure risk in construction projects, generally adopting a negative view of the phenomenon. As noted by Latham (1994), under this view, project risks can be managed, minimised, shared, transferred or accepted. In construction projects, risks are usually associated with those events or environmental conditions that can generate cost overruns, delays or changes in scope and quality, with respect to the planning carried out.

Thus, the first methodologies for estimating risk in construction projects, which were developed in the 60s, 70s and 80s, were based on the probability theory, and can be referred as the "probabilistic approach". This allows combining events or risk conditions using their probability distributions to estimate how risky the project as a whole is, in terms of cost overruns and delays. The process for developing such an analysis involves: estimating probabilities of occurrence of adverse events, establishing assumed limits and associated uncertainty, and measuring the potential impact. First analyses in this direction started using statistical methods for their development, from which the literature concentrated on Monte Carlo simulations. Explicitly, as noted by Edwards & Bowen (1998), it involves understanding risk as an estimated variance of project cost or duration. This methodology is especially associated with the scientific perspective presented in section 2.3.1.

However, since the late 1980s, specialised literature has revealed the significant disadvantages of the previous methodology. For example, Kangari & Riggs (1989) note that not all information regarding uncertainty factors in construction projects is numerical, and the aggregation of different risks becomes impossible. Furthermore, construction projects are usually one-time projects, and it is not always reasonable to draw conclusions regarding some risks considering what happened in other projects, as explained by Flanagan & Norman (1993). In parallel, in construction projects, the imprecision, complexity and vagueness of several of the problems that developers face is the norm. This reality implies an unfailingly subjective assessment of risks. Thus, specialised literature has changed the perspective when analysing construction risks. Although it has maintained the previous definition of risks, and used the definition of probability and impact, it has been inclined to try to capture the subjectivity behind this phenomenon, adapting to its inherent complexity.

Thus, other methodologies have emerged, such as the application of Fuzzy Set Theory (FST), and Analytic Hierarchy Process (AHP), for the assessment and management of risks in construction projects. The conceptualisation of FST was first developed by Zadeh (1975), and was proposed for the analysis of risks in construction projects by Kangari & Riggs (1989). It considers the imprecision and vagueness of construction risk factors when numerically representing the subjectivity of the words used by those who assess risk based on linguistic variables and membership functions. In simple terms, fuzzy sets (uncertain sets) are sets which elements have degrees of membership. Besides, the conceptualisation of the second (AHP), was developed by Saaty (1980) and applied to project risk management for the first time by Mustafa & Al-Bahar (1991).

It is used to structure a complex decision-making process, systematizing relative priorities among criteria. Since the 2000s these two developments have been the main approaches in academic

settings to study risks in construction projects. Most publications adopt risk as an attribute of projects, and not as an estimated variance. Gradually, the academy has converged on the idea that human factors, intuition, personal experience and individual judgments are essential in risk assessment (for a detailed analysis of this subject see Taroun, 2014). Laryea & Hughes (2008) suggests that, regarding the vision of construction risks, academic literature has shown a paradigm shift, going from "classicism", focused on probability theory and simulation tools, to "conceptualism", using analytical techniques.

Obviously, neither of them is an infallible methodology. As suggested by Taroun (2014), when using a probability-impact model, based on individual assessments, interdependencies between risks, changes due to the complexity of the context, and the experience of the risk analyst, among others, are not always taken into account. This is particularly relevant in the case of megaprojects. Specifically, in this regard, construction management literature shows that, from its beginning to its conclusion, the construction process in these cases is complex, characterised by much uncertainty and different interactions. This results in unbalanced subjective beliefs regarding risk and uncertainty, and strong difficulties in controlling and managing risks at different moments in time. FST, if applied periodically, may be particularly useful to deal with these issues. The following section delves into this topic in order to understand the complexity of risk in megaprojects. At the end, a list of construction risks is proposed, in the context of MTPs special characteristics.

2.3.3 Megaprojects Unique Characteristics and Risk in the Project Lifecycle

Megaprojects are exceptionally complex projects; as described in section 2.2.5., this complexity is associated with a particular decision-making process which is different from that of smaller projects (see Bar-Yam, 1997; Brockham and Girmscheid, 2007, De Bruijn and Leijten,2008; Whitty and Maylor, 2009; and Remington and Pollack, 2011). Given the mentioned complexity, megaprojects are also characterised as organic phenomena that evolve together with their context and are thus undergoing a process of continuous transformation in terms of their goals and aims, as thoroughly illustrated in section 2.2.6 (Dimitriou et al., 2014; Wysocki, 2014). This is why some authors suggest that it is particularly difficult to effectively foresee every single aspect of the development of a megaproject in its gestation period.

In this context, megaprojects can be understood as successful when they meet the proposed objectives in terms of outputs and outcomes (Samset, 2008). In terms of outputs, when analysing the construction project itself, the success of the project is obtained when the project is carried out without cost overruns and delays, and with the expected scope. In terms of intermediate

outcomes, it depends on the particular sector. It may be related to reducing travel times for users, reducing travel costs and lowering emissions or accidents, among others. Regarding the final outcomes, the megaproject may affect the level of efficiency of the transport system as a whole, or that of equity, or have a focus on specific regional or urban development due to its iconic value, in addition to having clear consequences from the electoral-political point of view. When analysing these differences, Samset (2013) refers to operational success, tactical success and strategic success. The complexity in the decision-making process and the organic nature of the megaprojects imply that the achievement of the proposed objectives, in terms outputs and outcomes, is absolutely uncertain given the social, technical, environmental, economic and political contexts.

Moreover, considering risks can be understood as uncertain events or conditions that have effects on project objectives, megaprojects are usually especially risky. This occurs for many reasons, which are usually related to the fact that they are complex and organic, trying to meet objectives at different levels and in all of them there is uncertainty. In this section, four aspects that emerge from the previous statement are especially considered.

These are related to the fact that megaprojects present a special complexity due to the trade-off that may appear between the different objective levels in terms of outputs and outcomes/impacts, and that said trade-off depends on uncertain events or conditions.

Regarding outputs, megaprojects usually have a high risk of presenting cost overruns, delays or differences in scope in relation to what was originally planned, when the actual decision to go ahead with the project was made. Regarding risk in terms of outcomes and impact, megaprojects have a higher risk of lower economic viability than usual. Furthermore, they present a particularly high risk of negative environmental and social impact. Due to their complexity and size, both the probability and potential magnitude of an environmental impact are usually high. To the previous risks, furthermore, these projects usually add a high political risk, which changes the possibilities of obtaining financing and being carried out. In this context, megaprojects require pre-investment, investment and start-up periods that are, many times, greater than those of government cycles. This fact alone introduces a greater political risk, understood as the risk that the project will not finally be executed because the incoming administration no longer has an interest (Alberti, 2021).

The first noteworthy consideration then, regarding risk in megaprojects, is that risk management at one level (i.e. the aforementioned political risk – associated with outcomes), may require to accept greater risks in terms of outputs. For example, incomplete pre-investment studies can be carried out, resulting in greater subsequent cost overruns. The same happens in the opposite direction: to reduce the risk of delays, a greater risk of environmental or social impact can be accepted. For example, necessary precautions to diminish negative impacts on the affected

communities may not be taken. Countless scenarios can be imagined using this logic (for a detailed analysis see Alberti, 2021).

The second consideration is that some variables that impact one level also impact another. An unexpected increase in costs has obvious impacts in terms of cost overruns, but also in terms of the economic efficiency of the project and the efficiency of the public transport policy itself. For example, incomplete or incorrect site/soil studies have a double risk. First, at the output level, it is likely that cost overruns will be generated, understood as the difference between what was initially projected and what was actually spent. At the same time, a larger investment may also imply that the difference between the social benefits and costs is smaller. It is possible to imagine a scenario where this could imply that the project is not the best alternative to develop anymore.

The third consideration is that the objectives themselves, of different nature, are developed under conditions of uncertainty. As an example, in terms of outputs, cost overruns can be associated with the risks inherent in any complex construction process. They may arise due to bets on the conditions on the site, or to macroeconomic variables beyond the control of the developers, or to the lack of capacities to technically estimate the costs of a project of this nature. In terms of outcomes, they can arise from changes in the concerns of stakeholders, and must respond to changes in priorities, which is also not a priori controllable (see Alberti, 2021).

The fourth and last of the considerations here highlighted, but not least, is that risks are dynamic and interdependent. For example, the risk of unexpected changes in economic variables (i.e. a recession) may be associated with the risk of political instability and more opposition from the affected community. The management of these risks is usually made separately, but that does not mean there is no feedback between them (Alberti, 2021).

2.3.4 Mega-Transport Projects' Construction Risks

Given the previous characteristics of megaprojects, there is no consensus in specialised literature on construction management, when it comes to risk identification, specifically in the case of large-scale projects. Different concepts and approaches appear that generate a range of terminology, definitions and explanations about risk factors and dimensions. In addition, it is common to find theoretical analyses much more than statistical studies that test hypotheses. There is no consolidated risk identification model for megaprojects. On the contrary, as demonstrated by Sanchez-Cazorla & Alfalla-Luque (2016), there is a large number of variables and tools analysed and used.

Considering that success in megaprojects can be evaluated in terms of outputs and intermediate/final outcomes, the first question that must be answered is what is the potential result that would be affected by the materialisation of a particular risk, in order to develop a list of risk factors. At the time of implementation, once the project to be developed has been defined, and the construction contract (or contracts) is being developed, the objectives of decision-makers are focused on outputs.

Thus, although recognising that outputs may be contingent on and influenced by objectives in terms of outcomes, the focus at this stage is the study of the risks associated with achieving output (construction) objectives. Considering the construction contract, to be developed or already signed, it is expected that the project will be executed with the desired scope, at the scheduled time and within the projected cost. It is especially important, using this framework, to study the perception of decision-makers, because it is there where all the previous complexity is synthesised.

Even if the previous restriction is used, the consolidation of a comprehensive group of construction risks is difficult because the literature shows differences regarding the dimensions that may be used to classify the different risk factors. This thesis uses the social, technical, environmental, economic and political dimensions (STEEP), proposed by Boateng et al. (2017), because it is presented, in the opinion of the author, as a more intuitive division than other alternatives presented in the academic literature.

Obviously, as Boateng et al. (2017) explain, there are interdependencies in these risk factors, and it is part of the complexity of working on this issue with this division. Thus, gathering the construction risks in megaprojects proposed by the literature, a list is proposed based on STEEP axes, but including a comprehensive group of risk factors found in the literature. Table 1 illustrates which of the risk factors are ill-defined in nature, and which of them are quantifiable using traditional statistical methods.

Table 1 – Construction Risk Factors and Dimensions

Risk Factor	Risk Dimension	Source	Ill-defined in Nature	Quantifiable by traditional statistical methods
Impossibility of obtaining land and access rights	Social	Boateng et al. (2017); Hilber and Robert-Nicoud (2013); Turner, Henryks, and Pearson (2011); Funderburg et al. (2010)	No	No

Compensations higher than expected	Social	Boateng et al. (2017); Hilber and Robert-Nicoud (2013); Turner, Henryks, and Pearson (2011); Funderburg, Nixon, Boarnet, and Ferguson (2010)	No	No
Protests and interference by residents	Social	Samantra et al. (2017); Kou and Lu (2013); Dey (2001); Baloi and Price (2003)	Yes	No
Legal actions of the affected community	Social	Boateng et al. (2017); Funderburg, Nixon, Boarnet, and Ferguson (2010)	No	No
Claims by third-parties	Social	Boateng et al. (2017); Galloway (2009)	Yes	No
Costs of contractual disputes with contractor	Social	Boateng et al. (2017)	No	No
Threats to the safety of personnel or assets	Social	Boateng et al. (2017); Jones and Brinkert (2008); Alinaitwe et al. (2007)	No	No
Vandalism	Social	Boateng et al. (2017); Bourne and Walker (2006); Olander and Landin (2005); Winch (2000); Miller and Lessard (2001)	No	No
Involvement of many decision-making bodies	Social	Boateng et al. (2017); Jones and Brinkert (2008); Alinaitwe et al. (2007); Al-Momani (2000)	Yes	No
Inappropriate design due to lack of technical capabilities	Technical	Samantra et al. (2017); Renuka et al (2014); Kou and Lu (2013); Tah and Carr (2000); Dey (2001)	Yes	No
Measurement errors on the site	Technical	Samantra et al. (2017); Bunni (2003); Shen et al. (2001); Zeng et al. (2007)	No	Yes
Conflicting interfaces between work items	Technical	Samantra et al. (2017); Kou and Lu (2013); Iyer and Jha (2005)	No	No
Special conditions on the site	Technical	Renuka et al (2014); Shahbodaghlou and Samani (2013)	No	Yes
Insufficient site inspections	Technical	Samantra et al. (2017); Bunni (2003); Shen et al. (2001); Zeng et al. (2007)	Yes	No
Changes in project scope requirements	Technical	Renuka et al (2014); Tamhain (2013)	No	No
Changes in technology or in industry use standards	Technical	Youjie (2004)	No	No
Other changes in the engineering design of the project	Technical	Boateng et al. (2017); Choo, Hammond, Tommelein, Austin, and Ballard (2004); Ghosh and Jintanapakanont (2004)	Yes	No
Inaccurate estimates of project cost	Technical	Boateng et al. (2017); Nielsen and Randall (2013)	No	No
Poor quality construction plan / poor allocation of time and resources	Technical	Samantra et al. (2017); Kou and Lu (2013); Dikmen et al. (2007); Youjie (2004); Shen et al. (2001)	Yes	No
Insufficient capacities in construction work	Technical	Samantra et al. (2017); Wang and Yuan (2011); Zayed et al. (2008); Zou et al. (2007)	Yes	No

Fall in the supply chain / unstable supply of construction materials	Technical	Boateng et al. (2017)	No	No
Poor quality of local materials	Technical	Shahbodaghlou and Samani (2013)	No	Yes
Bad suppliers	Technical	Shahbodaghlou and Samani (2013)	Yes	No
Obstacles to import	Technical	Shahbodaghlou and Samani (2013)	No	No
Distance between site and materials / suppliers	Technical	Shahbodaghlou and Samani (2013)	No	No
Bad contract enforcement	Technical	Youjie (2004)	Yes	No
Budgetary and cash flow inconsistencies	Technical	Shahbodaghlou and Samani (2013)	No	No
Lack of human resources for the development of the works	Technical	Shahbodaghlou and Samani (2013)	No	No
Technical difficulties and delays in making changes in affected utilities	Technical	Samantra et al. (2017); Kou and Lu (2013); Zayed et al. (2008)	No	No
Insufficient protection of adjacent buildings and facilities	Technical	Samantra et al. (2017); Kou and Lu (2013); Carr and Tah (2001)	No	No
Insufficient worker safety	Technical	Samantra et al. (2017); Kou and Lu (2013); Zayed et al. (2008); Carr and Tah (2001)	No	No
Inefficient protection regarding the surrounding environment	Technical	Samantra et al. (2017); Kou and Lu (2013); Bunni (2003)	Yes	No
Inefficient traffic control and management	Technical	Samantra et al. (2017); Kou and Lu (2013); Carr and Tah (2001)	Yes	No
Changes in funding vehicles	Economic	Boateng et al. (2017); Frick (2009); Sturup (2009); Hodge (2004); Haynes (2002)	No	No
Changes in taxes	Economic	Boateng et al. (2017); Hodge (2004); Frimpong et al. (2003)	No	No
Multinational sanctions	Economic	Shahbodaghlou and Samani (2013)	No	No
General inflation	Economic	Boateng et al. (2017); Renuka et al (2014); Frimpong et al. (2003);	No	Yes
Wage inflation	Economic	Boateng et al. (2017); Frimpong et al. (2003);	No	Yes
Changes in prices of construction materials	Economic	Samantra et al. (2017); Zou et al. (2007); Dey (2001); Tah and Carr (2000);	No	Yes
Changes in the cost of energy	Economic	Boateng et al. (2017); Smith (2010)	No	Yes
Exchange rate	Economic	Boateng et al. (2017); Ghosh and Jintanapakanont (2004)	No	Yes
Economic recession	Economic	Boateng et al. (2017); Frick (2009) Sturup (2009); Haynes (2002)	No	Yes
Economic effects of an environmental catastrophe	Economic	Boateng et al. (2017); Flyvbjerg et al. (2003)	No	Yes
Legislative or regulatory changes in financing	Economic	Youjie (2004)	No	No
Underground water filtrations	Environmental	Samantra et al. (2017); Kou and Lu (2013); Zayed et al. (2008); Ghosh and Jintanapakanont (2004)	No	No
Affectation of flora and fauna	Environmental	Boateng et al. (2017)	No	Yes

Heavy rain	Environmental	Samantra et al. (2017); Carr and Tah (2001); Kou and Lu (2013); Dey (2001) Kou	No	Yes
Windstorms	Environmental	Samantra et al. (2017); Kou and Lu (2013); Dey (2001); Carr and Tah (2001)	No	Yes
Earthquake	Environmental	Samantra et al. (2017); Kou and Lu (2013);Carr and Tah (2001); Dey (2001)	No	Yes
Political instability	Political	Shahbodaghlou and Samani (2013)	Yes	No
Lack of political support / Political indecision	Political	Boateng et al. (2017); Wu and Pojani (2016); Sturup (2009); Frick (2009); Flyvbjerg et al. (2003)	Yes	No
War or regional conflicts	Political	Shahbodaghlou and Samani (2013)	No	No
Opposition or political interference	Political	Boateng et al. (2017); Wu and Pojani (2016); Plotch (2015);	Yes	No
Government discontinuity	Political	Boateng et al. (2017); Hertogh and Westerveld (2011); Flyvbjerg et al. (2003)	No	No
Changes in the funding policy	Political	Boateng et al. (2017); Renuka et al (2014); Sturup (2009); Frick (2009); Kain (2004); Hodge (2004); Haynes (2002)	No	No
Delays in obtaining approvals and permits	Political	Boateng et al. (2017);	No	No
Lack of transparency and corruption	Political	Shahbodaghlou and Samani (2013)	Yes	No
Protectionism	Political	Boateng et al. (2017)	Yes	No
Lack of regulatory adaptation	Political	Boateng et al. (2017); Greiman (2013); Youjie (2004)	Yes	No
Other unexpected legislative or regulatory changes	Political	Youjie (2004)	Yes	No

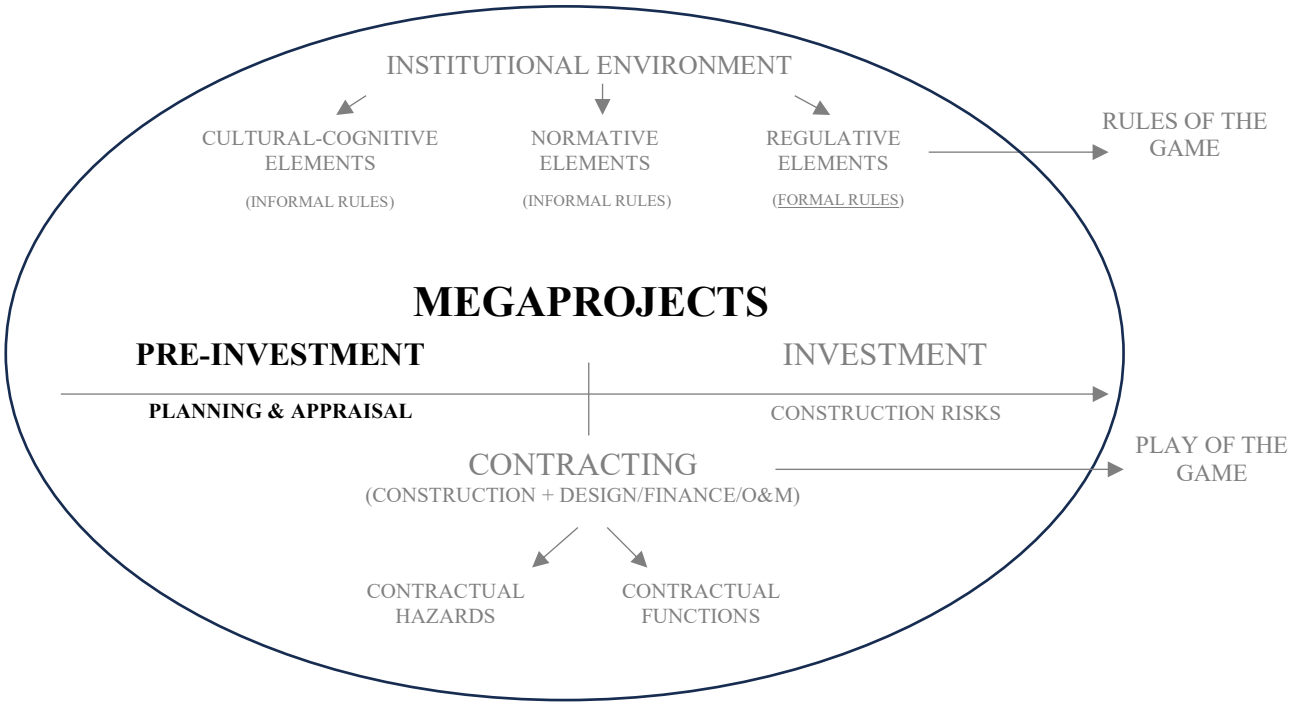
MTPs' special characteristics are intimately related to their overall risky nature. The fact that MTPs are political, human-centred, global, complex, organic and iconic projects, is consistent with an interdependent set of risks in the project lifecycle, which are very difficult to manage at the different stages. In particular, at the planning and appraisal stages there is an unquestionable challenge to consider the "future" construction risk factors and dimensions listed above.

Decision-makers need to consider, since the initial phases, risks related to outputs and outcomes, which may or may not impact on each other, under absolute uncertainty. In this context, the planning and appraisal approach used by decision makers will have a strong impact on risk management. This is thoroughly analysed in the following section.

2.4 The Challenge of Mega-Transport Project Planning and Appraisal[4]

This section addresses the challenges behind MTP planning and appraisal.

Figure 5 – Literature Review Diagram



2.4.1 Introduction

The infrastructure development process is normally divided into four phases: pre-investment, investment, operation, and ex-post evaluation (Cohen and Martinez, 2004). Megaproject planning and appraisal is developed on the pre-investment phase of the project life-cycle. In this stage, authorities need to come up with a solution to deal with a public policy problem, and decide if an alternative should be implemented. It begins with the general identification of the project and ends when project execution starts.

Williams et al. (2019) explain that the beginning of the pre-investment phase is when the initial idea emerges, the first estimates of costs and benefits are made, and stakeholders' preferences and incentives become visible. Moreover, stakeholders are recognised and the project is situated within a wider strategy. It should include preliminary analyses, concept analyses, alternatives analyses, and business case studies. Subsequently, other stages of project assessment should be

[4] Section 2.4 draws on aspects of research undertaken by the author during both his PhD studies at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It is based on the following papers, originally published by the Inter-American Development Bank: Alberti, J. (2019a) & Alberti, J. & Pereyra, A. (2020c).

considered, including stakeholder management, feasibility studies, engineering designs and, finally, project selection.

This stage is usually understood as significant to deliver the widest possible range of positive transformational benefits that megaprojects can bring in terms of economic, social, environmental, and territorial outcomes, both in the short run and in the long term. However, there is no consensus regarding how the decision-making process should be developed at this stage.

The more conventional project management approach to project planning and appraisal states that projects should be treated as closed/hard systems. Under this view, project objectives should be fixed in early stages. Consequently, planning and appraisal should intend to impose the scientification and depoliticization of the problem, assuming that there is a sole decision-maker, with abstract aims that can be fulfilled with concrete actions, based on a hierarchical chain of command.

This approach is usually related to the "iron-triangle" view to megaproject success, focused on outputs. Under this view, a megaproject is considered successful when it is delivered on budget, on time, and in line with the required specifications. The term "iron triangle" was coined in 1969 by Martin Barnes, former Executive Director of the Major Projects Association, mostly referring to the deliverability of the outputs of projects (Weaver, 2007).

Often referred to as the "traditional view" on project management, according to Lenfle & Loch (2010, p.1), it is confined to a model of project life cycle or phased stage-gate approach to executing. It is a control-oriented phased approach that infers the management of structured phases of a project life cycle one after another (Lenfle & Loch, 2010).

However, given the definition(s) and characteristics detailed in the previous sections, megaprojects are typically related to complex public policy problems; they involve several actors, multiple stakeholder perspectives, and conflicting interests (see Rosenhead & Mingers, 2001). The problems they address are often ill-structured (and interdisciplinary), complex (several variables are involved) and dynamic (environment and factors change over time) (for more information check Jonassen, 2004).

Therefore, other academics and practitioners working in the field of megaprojects, understand the conventional project management approach as inconsistent for this specific kind of projects (see for example Lee, 1973; Dimitriou 1992; Gladwell, 2000; Vasconcellos, 2003; Snowden, 2008; Batty 2008, and Ward, 2022). They claim that it undermines the project's ability to adapt to changing contextual influences (see OMEGA Centre, 2011). Common pitfalls in the application of the traditional approach in megaprojects are a consequence of its failure to address the changing

context and the usual impossibility to fix and maintain a desired set of objectives from the earliest stages.

These academics support a more holistic perspective, and state that megaprojects should be faced with an "open-systems" approach to decision-making, with a soft thought system, in order to better frame how the different components that are relevant to their justification are accommodated. This approach favours more comprehensive and integrated ways of planning and appraising megaprojects by promoting a reduction in data demands, focusing on simplicity and transparency aimed at clarifying the terms of conflict and accepting uncertainty. It is focused on both the outcomes and the outputs of the project.

Once the pre-investment stage ends, the investment begins, which includes all those actions aimed at putting the formulated and evaluated solution into place (outputs). Subsequently, during the operation phase, the project is realised and the installed asset commences the generation of the service in order to achieve public policy goals (outcomes). In this context, the pre-investment phase has an impact on how detailed engineering, construction and operations of the MTPs will be developed, and therefore on the outputs and the outcomes of the project.

Samset (2013) claims that the pre-investment phase sets the ground for a correct investment and operations phase, as the different decisions will impact on the "quality-at-entrance" of the project, which will have effects on megaproject success. In particular, regarding the setting up for a successful project execution, Williams et al. (2019) explain that pre-investment includes decisions regarding project governance, and contract and procurement, which are relevant to achieve its objectives, and are especially related to the interests of this thesis.

2.4.2 A Critical Review of the Conventional Approach to Planning and Appraisal

By assuming the stability of the context and a fixed desired output and impact of the megaproject, the conventional project management approach to planning and appraisal is premised on the formulation of the problem in terms of the optimisation of a decision-maker. It is centred on the capability to address and abolish uncertainty often by assuming consensus among key stakeholders and interested parties. It is a data-hungry approach, which looks to present the public policy problem(s) addressed by the megaproject as scientifically as possible in as quantitative a manner as is feasible. In this respect, the approach is very much focused on generating and finding credible data that helps to optimize product delivery (Rosenhead & Mingers, 2001).

The first phase of such approach is usually called the front-end of the project decision-making phase. It commences when the project 'idea' is first conceived and ends with the final (political)

approval, after project appraisal, on whether or not to finance and implement the project. Within the scope of this project management-oriented view, promoters generate information that looks to enable optimal decision-making by key stakeholders in line with decision-makers' interest or that of those whom they represent (Samset & Williams, 2010).

Under this approach, much of this phase is associated with the forecasting of the costs and consequences of different alternatives, involving knowledge and evidence provided by planners, engineers, economists, lawyers and other professionals. Ideally, employing this approach, these studies are supposed to offer unbiased findings based on what are generally considered to be scientific procedures (Wachs, 1990).

Among the challenges that arise in this phase is the fact that, all too often, no proper "problem analysis" is conducted and no impartial appraisal of alternatives is generated (Priemus et al., 2008). Moreover, frequently noted is the lack of alternatives, and an abundance of ambiguities regarding the scope of the project, thereby generating shortcomings in the ex-ante appraisal phase (Priemus, 2010).

With the above circumstances as a backcloth to much megaproject investment planning and appraisal, one particular topical challenge that is under constant consideration is the escalating commitment of decision-makers to an ineffective course of action. This means that, before the formal decision is made to "go ahead" and build a megaproject, decision-makers have frequently already given their earlier implicit commitment to proceed with the project.

This is referred to as "lock-in" by Cantarelli et al. (2010). The process by which some project stakeholders actually make a decision to build the project before fully completing the planning and appraisal steps suggests the pursuit of less flexible analyses that closes the pre-investment analysis to considering other alternatives (Cantarelli et al., 2010). Under this project management conventional approach, it is particularly relevant to conduct a proper problem analysis and an impartial appraisal of alternatives at the front-end, discouraging lock-in. However, the literature shows that this is not usually the case.

Therefore, it is allegedly at this stage that cost overruns and delays start to take form. They do so because "cost overrun" is defined as the difference between actual and forecasted construction costs, as a percentage of forecasted construction costs (Flyvbjerg et al., 2004). In this sense, cost forecasts are, by definition, an intrinsic part of cost overruns. Such is the case with project delays, as well as their scope (outputs). When lock-in occurs, the forecasted cost, time, and scope at the moment of commitment to the project may be very inaccurate.

If the "success" of the megaproject is to be evaluated by employing "iron triangle" criteria, the advice is that a great deal of time and thought should be put into strengthening the forecasting

processes. This is an important recommendation of those who defend this paradigm. Evidently, this explains the insistence to work with reliable information and with state-of-the-art techniques, in a context of institutional incentives to promote ethical and transparent practices (Wachs, 1990).

The forecasted costs and benefits of projects are embedded in the supporting cost-benefit analyses, and in the social and environmental impact assessments used for business cases, and they are allegedly so important that they are supposed to be used to decide whether or not the project is to be implemented. There is ample narrative and academic work focused on explaining why forecasts developed by project promoters tend to be so inaccurate.

A good categorisation of such errors is the one provided by Flybvjerg et al. (2003), who differentiate between technical, economic, psychological and political errors. According to this same source, technical errors include: forecasting errors, poor project design and incompleteness of estimations, changes of scope, general uncertainty, inappropriate organisational structure, inadequate decision-making processes, and inadequate planning processes. Economic concerns include a rational underestimation attributed to: lack of resources, inefficient use of resources, dedicated funding process, poor financing and contract management, and strategic behaviour. Psychological errors are related to: optimism bias among local officials, cognitive bias, and cautious attitudes towards risk. Finally, political concerns are associated to deliberate cost underestimation and manipulation of forecasts (Cantarelli et al., 2010).

Flyvbjerg et al. (2009) summarize the above as either "delusions" (or honest mistakes) or "deceptions" (i.e. strategic manipulations of information or processes). These authors go on to argue that, for each case, there are different potential policy responses (options) to address these problems, as is suggested in the discussion that follows immediately below.

Their recommendation is to take an "outside view" of these issues using "reference class forecasting", which is a statistical procedure that entails: selecting a reference class, assessing the distribution of outcomes, assessing the reliability of predictions, making an intuitive prediction of the project's position in the distribution, and then correcting the intuitive estimates (Flyvbjerg et al., 2009). To particularly address concerns of deception, the same source advocates that active steps should be taken to enforce accountability and transparency in decision-making. These steps, it is further recommended, should be accompanied by the introduction of incentives in the event there be a need to discourage strategic misrepresentations of different stakeholders that participate in principal-agent relationships (Flyvbjerg et al., 2009).

By definition, therefore, the "iron triangle" approach to megaproject success is basically related to success measures regarding the outputs of the project. It considers the changing values and objectives surrounding the megaproject as a driver of distress. Consequently, it leads to an

appraisal stage that consists of analysing a discrete desired state in a static context. Under this view, information should be gathered in order to reliably use state of the art techniques to rationally assess the different options. In this sense, to put it in "iron triangle" terms, technocrats should estimate outcomes of different structured alternatives, and politicians should select the alternative considering the trade-offs proposed by the selected alternatives.

In summary, this approach proposes megaproject planning and appraisal as a technocratic optimisation process for diminishing uncertainty in order to evaluate alternatives. However, MTPs are, as stated in section 3.2, particular endeavours characterised by size, uncertainty, ambiguity, complex interfaces and integration, and significant political and external influences. They are organic, contexts inevitably change in these projects, and stakeholders' agendas change as a result. Moreover, projected outputs and outcomes expected to be achieved by means of the MTP are dynamic and stakeholder dependent.

Therefore, it is here alleged that MTPs should not be faced with this "traditional view" of project management. They cannot be confined to a model of project life cycle or phased stage-gate approach to executing. This control-oriented phased approach that infers the management of structured phases of a project life cycle one after another is not consistent with the nature of MTPs. Problems that arise when using this approach are not related to the lack of an outside view, or the lack of incentives. The more basic problem is that this approach is not suited to plan and appraise MTPs.

2.4.3 A Defence of a More Holistic Approach to Megaproject Planning and Appraisal

The work of Friend & Jessop (1969), developed later in the context of megaprojects by Peter Hall (see Hall, 1982), and further elaborated by Friend & Hickling (1987) highlights the importance of the strategic view of holistic thinking as a dynamic phenomenon which, among other things, has judgements about the success of projects reflected and acknowledged by changes in the values of societies over time.

In these terms, it is not unreasonable to have megaproject objectives set at the outset of the planning stage change over time to what Dimitriou et al. (2012) refer to as "emergent objectives" in response to changing policy or development contexts in different dimensions that reflect alterations in cultural and societal values, economic and fiscal circumstances, administrative frameworks, and spatial conditions, among others (Dimitriou et al., 2013).

To accommodate these circumstances when dealing with the selection (among options) of the project and when deciding objectives and goals to be adopted for a project, these sources advocate

the adoption of an "open-systems" approach to decision-making, such as the one proposed by Sussman et al. (2007). This approach encourages an examination of the political, economic, social, environmental and institutional aspects that lie beyond the more technical and engineering boundaries of decision-making (Dimitriou et al., 2013). These aspects are very much related to the typical MTPs constructions risks mentioned in the Section 2.3, derived from MTPs special characteristics referred in Section 2.2. Sussman et al. (2007) propose a process that consists of three stages: representation of the system; design, evaluation and selection of strategic alternatives; and implementation. It is a process suited for complex, large-scale, interconnected, open, sociotechnical (known as "CLIOS") systems.

As already implied, the complexity referred is primarily associated with the inevitably complex decision-making process involved in megaproject developments, particularly concerning relations between the multiple stakeholders involved in the decision-making process and the states of markets and politics surrounding these endeavours. The complexity of the projects themselves, which obviously affects overall decision-making, may be divided into three categories: technical, organisational and external (Priemus et al., 2013).

In this context, the term "technical complexity" refers to (among other things): the presence of a high number of project goals, a non-alignment of project goals, uncertainties of project goals, a multiplicity of locations, difficulties arising from a lack of experience with (new) technology, uncertainties in methods, and involvement of different technical disciplines (Priemus et al., 2013). "Organisational complexity" arises from (among other things): a lack of resource and skill availability, a lack of experience with the stakeholders involved, the challenges posed by the multiplicity of stakeholders and contracts, the difficulties presented by the involvement of different nationalities (and cultures), the multiplicity of financial sources, and a lack of trust among involved parties (such as developer contractors). To add to organisational complexity, the implications of the "external complexity" of the project's decision-making (among other things) are impacted by the number of external stakeholders affecting the project's progress and outcomes, the level of dependence on external stakeholders, the degree of external political influences bearing on decision-making, and the lack of experience in working in the country where the project is to be built (Priemus et al., 2013).

According to Landau (1969), the best way to deal with complexity in these circumstances is to adopt a redundancy and resilience approach to the decision-making strategy, whereby alternatives and multiple options are considered from the early project phases. Redundancy here implies a pragmatic and experimental decision-making process, permitting several and competing strategies to be followed both simultaneously and separately (Landau, 1969). Resilience, on the other hand, advocates a preparedness to cope with uncertainties and unanticipated situations. It

may be reactive, protecting a particular position from external shocks, or proactive, in managing a range of possible directions (Dovers & Handmer, 1992).

Academics and practitioners working in the field of megaprojects that support this more holistic perspective explain that the more conventional project management approaches to analysing megaproject success prevents the adoption of Landau's advocated approach by virtue of such projects being usually framed as "closed-systems", fixing project objectives in early stages (as the phenomenon of "lock-in" was suggested in the previous section), thereby undermining the project's ability to adapt to changing contextual influences. In response, they advocate the use of both an "open-systems" and a "closed-systems" approach, each one for different stages in the project lifecycle (Dimitriou et al., 2013).

Under this view, at the planning stage, megaprojects should be treated as "open-systems", to better frame how the different components that are relevant to their justification are accommodated. However, at the construction stage, decision-making for megaproject delivery by necessity should be treated as "closed-systems", keeping to the latest project objectives (revised or otherwise from project outset) and the way they intend to achieve them on time, within budget and to specification (Dimitriou et al., 2013).

While the above approach to holistic infrastructure megaproject planning and appraisal is but one approach, it shares with other more "holistic" approaches (see for example Allport 2010) the perspective that such projects involve dynamic complex project decision-making systems that interact with changing policy and development environments that, all too often, lead to emergent rather than directed outcomes. An appreciation of this complexity is reflective of the fact that project components interact in non-linear and stochastic ways that are usually impossible to predict.

Megaproject decision-making also depends on other variables that can divert the megaproject from adopting an initial, "rationally" proposed path. There are behavioural and cognitive deviations associated with the mindset of decision-makers that need to be understood in order to explain this. The way in which information, both objective and subjective, is brought to the planning and appraisal process is important. This frequently very much depends on the stakeholder that receives and acts on the decisions made.

This is strongly related to the fact that politics and political personalities associated with megaprojects usually play a major influential role in the decision-making process. Planning, if understood as a technocratic and systematic way to appraise alternatives, particularly at the pre-investment phase, may be less important than politically motivated directives (Allport, 2010).

There are, furthermore, political and strategic issues that can undermine the technical rationality of the decision-making process. According to Leijten (2013), these issues include: the use of key information and the shift of problem ownership, both susceptible to political opportunism. Sub-optimum outcomes are more likely in this context, especially if they imply satisfying the interests of more stakeholders. It is important to differentiate between the success of a project and the success of its management (Leijten, 2013). While the success of its management is related to "iron triangle" concerns, the success of a project is related to outputs, outcomes and impact as a whole.

Academics that propose a more holistic approach understand "iron triangle" measures as merely one (albeit very important) indicator of successful delivery of a project and its outputs. However, they also consider other variables which may be as or more important than the previous ones. This is related to the following definition provided by Samset (2013, p. 13): "a successful megaproject is one that delivers its outputs and significantly contributes to the fulfilment of agreed objectives". He mentions that there is a set of "success factors" that can be pursued, including efficiency, effectiveness, relevance, and impact, among others. Holistically responding to these aspects requires an important tie-up of tactical performance concepts in project management efficiency and strategic performance to the other criteria cited. This approach to planning and appraisal generates its recommendations based on what happens in fact, including project management variables as only one part of the criteria actually used when planning megaprojects.

Under this view, with an "open-systems" approach to decision-making, the aim is to reach a reasonable definition for the problem itself. In the literature, there is a large number of methodologies, usually called "problem structuring methods" (PSM) (Rosenhead & Mingers, 2001), which are used with this objective.

The logic behind PSMs is different than the traditional approach. They impose a soft approach that does not seek optimisation but to analyse alternative solutions acceptable in different dimensions. This alternative paradigm is based on the simplicity and transparency of the terms of conflict, and on their adaptability to the context (for more information see Rosenhead & Mingers, 2001).

Based on this paradigm, the proposal is to use an iterative decision-making process rather than a sequential one. The procedure must include alternative perspectives, be participative, and seek to find partial commitments. Instead of striving for optimisation, it is about analysing different scenarios and designing strategic options aimed at a wide range of potential solutions (Rosenhead & Mingers, 2001).

It is here alleged that, given their nature, megaprojects should be faced with an open-systems approach to decision-making, with a soft thought system. Project management variables should

be considered as measures of success, but also accepting complexity and non-linearity, addressing the power of context and the influence of the participating stakeholders, understanding there are other success criteria used in the decision-making process. This is crucial to plan and appraise "successful" projects, from the perspective of a central government which intends to deliver the fullest range of transformational benefits that megaprojects are able to bring, considering economic, social, environmental and territorial long-term outcomes.

When dealing with the selection (among options) of the project and when deciding objectives and goals to be adopted for a project, an "open-systems" approach to decision-making, such as those proposed by PSMs, is more consistent. Reflecting the findings of the OMEGA 2 Study alluded to earlier, this approach promotes an examination of the political, economic, social, environmental and institutional aspects that lie beyond the more technical and engineering boundaries of decision-making (Dimitriou et al., 2013).

2.4.4 A Review of Problem Structuring Methods

The academy associated with operational analysis has proposed a dichotomy in the definition of the problems faced by any actor, related to its context, which is applicable to the planning, evaluation and execution of megaprojects.

Ackoff (1979), for example, made a difference between "messes" and problems. The former are dynamic situations in complex systems with changing obstacles that interact with each other. Problems are abstractions of messes, obtained from a specific analysis. Rittel & Webber (1973) suggested, on the other hand, that there are "wicked" problems and there are simple problems. The former, unlike the simple ones, refer to those where there are opposed, different types and levels of explanations of the subject under study. Schon (1987) explained that the problems encountered in practice are confusing and defy technical solutions that can be seen from a higher and theoretical position.

Similarly, Ravetz (1971) suggested that technical problems imply specific functions to be carried out, which can be visualised by experts. Practical problems, on the other hand, in his opinion, are those in which one cannot find an optimal means to reach a certain solution, but rather a stronger argument than others in favour of accepting a particular definition of the problem in question. Finally, Checkland (1985) distinguishes two thought systems, one hard and the other soft. The first assumes that the problem can be modelled objectively and the second assumes it cannot. He states that mathematical optimisation is impracticable in soft systems. Again, the analysis of the latter, in depth, implies the study of the nature of the problem and not its theoretical solution.

Traditional problem modelling, considering a solution rather than a structuring approach, involves defining a desirable state “S1” and a current state “S0”, and selecting an optimal means of bridging that gap in an unchanging context. There are types of problems, such as those mentioned in the previous paragraphs, that are simple, technical, theoretical, that can be tackled with this closed-systems approach and with a hard system thinking (Checkland, 1981). For the more complex problems, or messes, heavily influenced by a changing context, there is a need for an open-systems approach to decision-making, with a soft thought system. The objective in this second case is to reach a reasonable definition of the problem itself, and a significant number of PSMs are available (Rosenhead & Mingers, 2001).

With the hard thought systems approach, planning and appraisal seeks to impose the scientification and depoliticization of the problem, assuming that there is a single decision-maker, with abstract objectives that can be achieved with concrete actions, based on the implementation of a hierarchical chain of command. The logic behind the PSM is different. It imposes a soft approach that does not seek optimisation, but instead analyses alternative solutions, which are acceptable in different dimensions. This paradigm is based on the simplicity and transparency of the conflict terms, and on the adaptability to the context (Rosenhead & Mingers, 2001).

With this paradigm, the use of an iterative, not sequential, decision-making process is proposed. The procedure must incorporate alternative perspectives, must be participatory and try to find partial compromises. Instead of seeking optimisation, it is about analysing different scenarios and mapping out strategic options that point to a wide range of potential solutions (Rosenhead & Mingers, 2001).

In the case of megaprojects, because they are open systems, influenced by many stakeholders and deeply related to a context that changes regularly, PSMs are presented as a reasonable alternative for the development of strategies that aim to better planning and appraisal. In general terms, there are numerous methodologies that can be considered as PSMs. These include: strategic option development analysis (SODA), soft systems methodology (SSM), strategic selection approach (SCA), robustness analysis, and drama theory (Rosenhead, 2013).

For example, the SODA method uses cognitive mapping as a tool to identify and model the underlying problem. Concepts and causal links are mapped with inputs from individual interviews with stakeholders until reaching a strategic mapping with which it is possible to develop and agree on a possible portfolio of actions (Eden & Ackerman, 1998; Rosenhead, 2013).

The SSM method, on the other hand, is based on a systems approach to study the nature of the problem, and tries to organize the debate on potential modifications to the system itself. By ordering the knowledge of the different stakeholders about the roots of the problem, it is possible

to see how different alternatives for change are culturally acceptable and at the same time desirable, from a systemic point of view (Checkland & Poulter, 2006; Rosenhead, 2013).

The SCA method, in parallel, is based on reaching a commitment, among the stakeholders, to pursue certain strategies, based on group discussions. Different modes of analysis are used: model, design, compare and choose. In the first, decision areas selected by different interest groups are analysed based on their urgency, importance and interdependence. In the second, potential actions on the decision areas are identified and their feasibility is analysed based on the possible incompatibility of visions. In the comparison, the different decision criteria proposed by the groups are studied and action schemes are analysed based on their relative advantages over these criteria. Finally, in the last step, a progress package based on partial commitments is agreed and contingency plans and a decision calendar are projected (Friend & Hickling, 1987; Rosenhead, 2013).

The robustness analysis strategy, on the other hand, is usually proposed to maintain flexibility without losing utility. It focuses on determining the flexibility of initial commitments based on their compatibility with the utility they generate in future states of the system. Basically, the flexibility of the commitments is determined based on how robust they are, that is, in how many possible future scenarios of the context, associated with said commitments, desirable results would be obtained. Within this information framework, the flexibility of the commitments is agreed upon by participants (Rosenhead & Mingers, 2001).

Finally, drama theory is based on the metagame and hypergame approaches. Its objective is to assemble a model that serves to study the options of cooperation and conflict between agents. It seeks to study the dilemmas that arise and how these can be points of change in the modelled game itself, based on the emotions that the game generates in the actors. When all dilemmas are resolved, problem resolution is achieved (Howard, 1999; Rosenhead, 2013).

2.4.5 The Pre-Investment Process in Latin America

When dealing with the selection (among options) of the megaproject and when deciding objectives and goals to be adopted for it, an “open-systems” approach to decision-making, with a soft-thought system, such as those proposed by PSMs, is more consistent. Reflecting the findings of the OMEGA 2 Study alluded to earlier, this approach promotes an examination of the political, economic, social, environmental and institutional aspects that lie beyond the more technical and engineering boundaries of decision-making (Dimitriou et al., 2013).

However, in Latin America, the challenge is that a "closed-systems" approach to decision-making is requested and applied by central governments at the planning and appraisal stages of megaprojects. The governmental bodies in charge of supervising the methodological approach used by public sponsors at the pre-investment phase of every infrastructure project are usually called National Investment Planning Systems (SNIPs).

SNIPs are made up of the set of state institutions that participate in the public investment process in the countries, which develop methodologies, standards and procedures to guide the formulation, execution and evaluation of investment projects. The first experience of developing a Project Bank (from which the idea of SNIPs evolved) dates back to 1982, when the Government of Chile, through the National Planning Office (ODEPLAN), with the United Nations' technical cooperation, through the United Nations Development Program (UNDP) and the Department of Technical Cooperation for Development (DTCD), began the implementation of a standardisation and information system on public investment projects. This system was extended to all regions of the country and to the different ministries. This gave rise to the creation of the Integrated Bank of Public Sector Projects, better known as BIP.

Similar experiences began in the 1980s in other countries of the region, such as Guatemala, the Dominican Republic and Venezuela. However, for various reasons, these experiences did not give the expected results and were not consolidated. The next effective experience was the creation of the Bank of National Investment Projects (BPIN) in Colombia. Its origins date back to 1986, when the National Planning Department, with the support of the Organisation of American States (OAS) and the IDB, began a project to support pre-investment and investment activities at the territorial level. In the 1990s, several other countries of the region developed National Public Investment Systems based on the concept of Project Banks. The experiences of Bolivia and Peru stand out, and other countries followed.

Currently, there is a Network of National Public Investment Systems of Latin America and the Caribbean (RedSNIP), which was created in 2010 to strengthen the functioning of these state systems. It is currently made up of the directors of the SNIPs of the region and is supported by the Economic Commission for Latin America and the Caribbean (ECLAC), the IDB and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The following Latin American countries participate and contribute to this network: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru and Uruguay.

In most SNIPs, there are legal, institutional and procedural, methodological, training and information systems components. These share some general characteristics, but are adapted to the political and institutional structure of each country. Regarding the methodological component,

the structure of the methodologies is similar in all SNIPs, incorporating chapters on project identification, diagnosis of the current situation, analysis of alternatives, and private and social evaluation. It only changes the depth with each topic. In general, there is a tendency to develop increasingly detailed and self-explanatory methodologies and to present the results in standardised formats (see Aldunate et al., 2002).

In this context, SNIPs have an economic efficiency view of megaproject "success", and request the use of project life cycle or phased stage-gate approaches to planning and appraisal. Project sponsors are usually forced to present project profiles, pre-feasibility and feasibility studies in sequence over long periods of time to the SNIPs, which have the power to accept or reject the project (see Cortés Mora, 2013 & Alberti, 2015).

However, among the typical problems at the planning appraisal stage that these SNIPs show, particularly for megaprojects, it is possible to find that: sectoral plans are dispersed and megaprojects are not included; the rejection rate of the evaluations is usually low; there are low capacities for project formulation and evaluation of complex projects; projects are included in the budget without an ex-ante evaluation; and decision-makers are incentivised to use extra-budgetary channels to finance the projects (see Ardanaz, Briceño y García, 2019).

Evidence suggests that these challenges, at least to some extent, have to do with the "closed-systems" approach promoted by this type of institutions. Previous work shows that there is a need for: the institutionalisation of participation of key stakeholders, including the private sector, when generating a vision and goals for the future in terms of infrastructure planning; and the institutionalisation of the participation of self-described stakeholders when accepting a project, and before project implementation starts (see Alberti, 2015). Ergo, a more "open-systems" approach to planning is called for in the region.

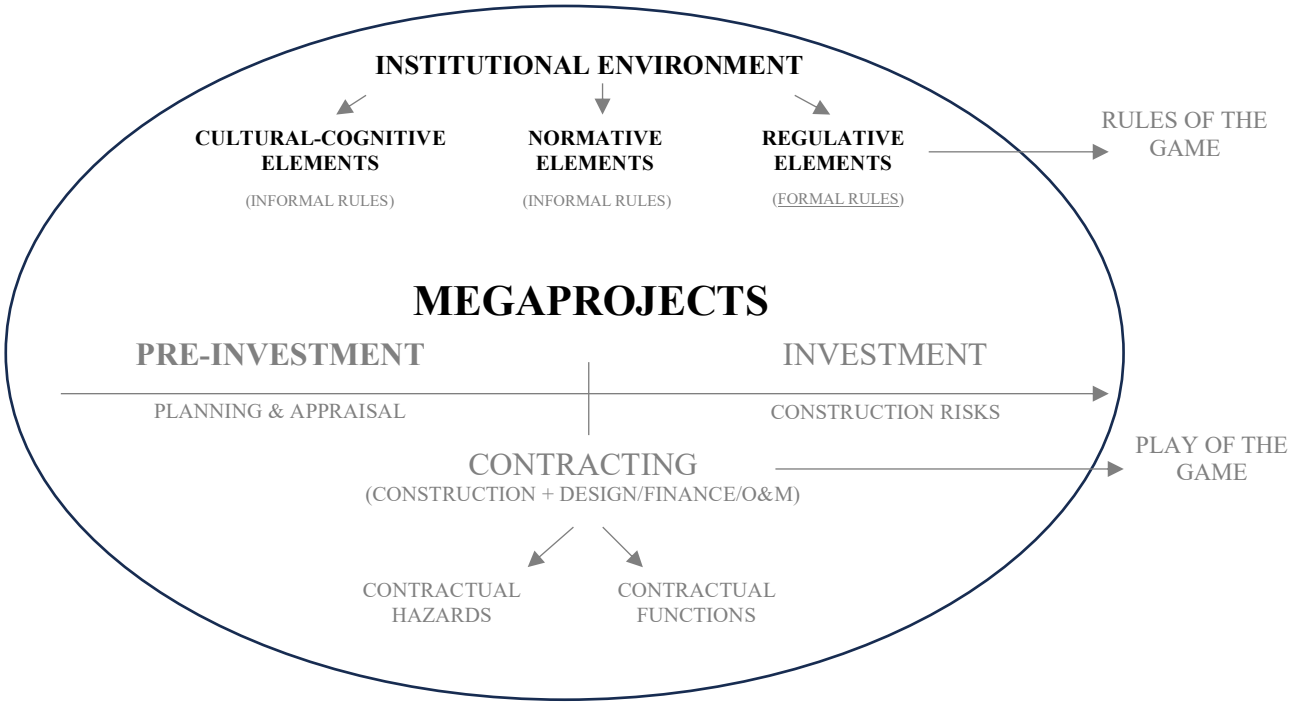
Given the above, two critical questions arose that warranted further scrutiny: Why are these governance structures kept in place and unchanged when it is alleged that they promote a closed-systems approach for megaprojects and, therefore, hinder the delivery of the fullest range of transformational benefits that megaprojects are able to bring? Which are the institutional forces that reinforce the existence of the SNIPs and keep this governmental structure unchanged?

The following section deals with this issue from a theoretical point of view. It shows that professionals from different backgrounds, such as sociologists, political scientists, planners and economists, define institutions in distinct ways and that the institutional environment is composed by elements of different nature. The following section theoretically exhibits that NIE is particularly helpful to analyse the regulative element, which is only one part, but very relevant, of the whole institutional picture.

2.5 The Institutional Environment of MTP Planning and Appraisal[5]

This section explores the different elements of the institutional environment of MTP planning and appraisal.

Figure 6 – Literature Review Diagram – Institutional Environment



2.5.1 Section Overview

Broadly speaking, institutions can be defined as elements that give meaning and organisation to whatever social interaction, political process, or economic activity is being developed. According to Scott (2013), institutions can be understood as a constitutive part of reality with structures and changing patterns that affect every sector in society. This author states that institutions comprise cultural-cognitive, normative and regulative elements.

Using the previous definition, this thesis assumes institutions are related to -and impact on- the way in which megaprojects are planned and appraised. Furthermore, it is here accepted that the three institutional elements may not be aligned to promote an "open-systems" approach to decision-making, with a soft-thought system, in LatAm.

[5] Section 2.5 draws on aspects of research undertaken by the author during his PhD studies at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It is based on the following papers, originally published by the Inter-American Development Bank: Alberti, J. (2019b) & Alberti, J. & Pereyra, A. (2020b)

In order to correctly frame the theoretical focus of this thesis, to limit its scope, and to understand its limitations, this chapter contextualises NIE, which is only one possible approach to study the institutions related to MTP planning and appraisal.

Firstly, section 2.5.2 scans the general definition and scope of two alternative theoretical perspectives: the sociological approach focused on the cultural element of the institutional environment and the political approach concentrated on the normative element. Subsequently, section 2.5.3 introduces NIE and its reasonability to study the regulative element, particularly formal rules. Finally, section 2.5.4 recaps and explains that neither of the previous approaches is capable of analysing every possible angle regarding the institutional environment of megaproject planning and appraisal. However, it concludes that NIE can be particularly helpful to theoretically isolate the topic proposed by this thesis, which is not expected to be comprehensive, as the other approaches are needed to analyse the entire institutional picture.

2.5.2 Two Alternative Approaches to Institutional Analysis

The Sociological Approach – Institutions as a Form of Culture

A good starting point to understanding institutions with a sociological approach is the work of Durkheim, Weber and Parsons. Durkheim treated social institutions as symbolic systems, related to systems of knowledge, belief and moral authority, which impact situations (Durkheim, 1895, p. 45). Weber suggested that rational behaviour cannot be assumed because there are different ways of being rational, affected by culture and ethics (Weber, 1947). Parsons proposed a frame of reference and a general theory of action systems. He alleged that there is an institutionalisation of cultural patterns (Parsons, 1951).

Under this body of knowledge, sociologists started working on the relationship between institutions and organisations (Scott, 2013). Selznick (1948) for example, supported that formal structures never succeed in conquering the non-rational dimensions of organisational behaviour. Merton (1940), related this to the potential inconsistencies between rules (given by regulation) and purpose, attached to sentiment formation and emotional dependence. Furthermore, Simon (1945) alleged individuals follow particular values linked to beliefs about means-ends connection in the context of bounded rationality. This author, among others, was particularly concerned about informal structures and how they affected organisations. They criticised utilitarianism because interests were aggregated and outcomes were unpredictable.

Additionally, Silverman (1970) was one of the first authors to shift his focus from interest aggregation to social action in the context of organisations. This sociological view of institutions

understands that institutional forms are not adopted as a response to a rational act to encourage efficiency. On the contrary, the procedures named as institutions are actually a response to myths and ceremonies that organisations adopt in a natural way.

Under this theoretical approach, bureaucracy is not impacted by culture; it is a form of culture (Hall & Taylor, 1996). Institutions are not a product of human conscious design and therefore are not always instrumentally oriented. Institutionalisation is a cognitive process that arises as a consequence of routines, schemes and scripts (Dimaggio & Powell, 1991). There is a "logic of social appropriateness", in contrast to a "logic of instrumentality" (Campbell, 1998).

Several authors have used this approach as a conceptual framework to analyse transport policy and infrastructure planning (Marshall, 2014; Rozema, 2015; Verma, 2007; Vigar, 2013; Witte et al., 2013). Alexander (2005) explains that all planning, thus including megaproject planning, takes place within an institutional context or in sets of nested institutional contexts. Furthermore, according to González & Healey (2005), the sociological and social constructivist approaches have been useful to understand the nature of "implementation processes" and the relation between strategy and action in this sector.

This sociological institutionalist approach is intimately related to the constructivist view in political science. Constructivists understand actors as both strategic and institutionalised, and institutions are codified systems of ideas and practices (Hay, 2008). Under this view, a great deal of effort is made to understand ideas and discourse. Hajer & Versteeg (2005) defined discourse as a linguistic regularity that can be found in conversations. According to the view of Hajer & Wagenaar (2003), what has a standing in societal discourse defines what is considered a legitimate political discourse and, ultimately, the kind of society that is expected.

In turn, (Schmidt, 2008) alleges that ideas can promote action, persuade and reconstruct interests and values and, ultimately, change. Ideas exist in policies, programs and philosophies, and are cognitive or normative. Based on her view, discourse comes in two forms: the coordinative discourse among policy actors and the communicative discourse between political actors and the public. Moreover, Schmidt (2010) explains that, under this perspective, institutions are defined dynamically as structures and constructs of meaning that are internal to agents whose ideational abilities enable them to create or maintain institutions, and their discursive abilities enable to communicate about them and eventually generate change. Institutional change is theorised as "the product of sentient agents engaged in thinking up new ideas about what to do and how to do it and then engaging in discussions in efforts to persuade others that this is indeed what one needs to do and ought to do" (Schmidt, 2009, p. 533).

Specifically, a good example of the application of this approach in megaprojects in the transport sector is the work of Peters (2003). He analysed the key storylines regarding the development objectives of Pan-European transport investments. The key storylines he included were: cohesion, polycentricity, missing links and bottlenecks. In another good example, Heeres et al. (2012) explain how Dutch planning and realisation of road infrastructure has changed, specifically from "line" towards "area-oriented approaches" and discourse. In the same line, Witte et al. (2013) show that the academic discourse regarding European transport corridors lacks a sector transcendent and comprehensive spatial approach. Marshall (2014) analyses, among others, the relationship between the Trans-European Networks reforms and the possible impact on spatial planning in the long-term, studying ideas and imaginaries.

Rozema (2015, p. 484) specifically uses the following statement to show how this sociological institutionalist and sociological constructivist view can be used in this specific sector: "metaphors, storylines, images and so on, are powerful technologies for transport planners and decision-makers, for they transpose prevailing norms and values into infrastructure rationalities". This is the fundamental idea when using the sociological/constructivist approach to analyse transport policy and megaproject planning.

The Neo-Institutional Political Approach – Institutions as Instrumental Rules of Power

On the other hand, institutions are understood by political scientists as a collection of rules and organised practices, embedded in structures of meaning and resources that are relatively invariant and resilient (March & Olsen, 1989, 1996, 2008). Under this view, formal structures do not explain political behaviours, and a behavioural approach is needed to study the informal distributions of power, attitudes and political behaviour (Thelen & Steinmo, 1992). In this context, the two more developed political approaches to institutions are the historical perspective of institutional analysis and the rational choice perspective (P. A. Hall & Taylor, 1996; Hysing & Olsson, 2017; J. G. March & Olsen, 2008; B. G. Peters, 1999; Scott, 2013).

Using a historical perspective, according to Hall & Taylor (1996, p. 938), institutions are seen as "formal and informal procedures, routines, norms, and conventions embedded in the organisational structure of the polity or political economy". Under this view, social arrangements do not represent an aggregate sum of rational actions. They are related to past choices, and institutions have a continuous effect, generating dependencies on decision-making (Campbell, 2004, p.25). When using this structural approach to understand institutions, therefore, path dependence is a fundamental concept. It can be understood as a reinforced process with roots in positive feedback from initial policy choices (Pierson, 2004).

The rational choice perspective, instead, understands institutions as rules of governance that are deliberately constructed to protect some type of interest. They face problems of collective action and they are means used by winners to pursue their objectives, usually at the expense of losers (Moe, 1984, 1990). According to Hall & Taylor (1996), this approach is based on fixed preferences and strategic calculation, which usually lead to collective dilemmas because general sub-optimisms are reached by pursuing individual political interests.

Regarding transport policy and megaprojects, under this political view, institutions create the framework of rules for policy generation, including megaprojects planning and appraisal, by limiting decision-making and making policy development possible. According to Stone (2014), transport systems can be seen as political objects because policy decisions in this sector reside at the political level. In particular, megaprojects can be understood as "political projects", which preeminent function deals with building political consensus, as explained in section 3.2.2 (see Beria et al., 2018).

The historical institutionalist view has been used, among others, as an approach to address the organisational domain of transport policy, related to formal rules that create and empower organisations (Curtis & Low, 2012). A good example is the work of Dudley & Richardson (2000), who stated that transport policy is usually based on a sustained paradigm that prevails, by which the problem under study is addressed with policy technologies that are supported by powerful organisations and networks of people. However, they explain that change may not happen, although it may be needed so that the transport policy is aligned to the public interest.

Regarding transport policy, organisations have power when they can influence decisions about planning, construction and management of assets, and operate over every function relevant to a particular policy domain with a significant discretionary control over the related expenditure (Curtis & Low, 2012; Low & Astle, 2009). Stone (2008) stated that policy change in this sector is effective if there is a change in these policy networks, which happens if supporters gain influential positions in the context of a new coalition.

On the subject of megaproject planning, the historical-institutionalist view can be useful to analyse how different stakeholders acquire and retain policy leverage. In particular, it can clarify how organisational checks and balances affect the persistence of a particular megaproject planning and appraisal approach, for example the "closed-systems" approach to decision-making at the planning and appraisal stages of MTP development. Under this view, institutional factors related to a specific historical policy path are critical in shaping actors' behaviour in the present (Altshuler & Luberoff, 2003).

On the other hand, regarding the rational choice approach, several authors have studied Congress behaviour, and have paid attention to public works decision-making (Ferejohn, 1974; Jonas & Wilson, 1999; Shepsle & Bonchek, 1997). Under this view, individual rationality and collective rationality are opposed.

Olson (1971) is a relevant author on this subject, having introduced the notion that governments do not equally favour the interests of all groups. This author believes governments favour those who mobilize the most, or those who have the most mobilisation potential, according to their incentive structure. This incentive structure is associated with the size of the groups, with what is at stake in the negotiation process and with the distribution of costs and benefits between the parties.

Specifically regarding megaproject planning, Altshuler & Luberoff (2003), for example, suggest that the rational choice approach is useful to illustrate, among others, the following phenomena: the tendency of public works proposals to be generated from the local government, and not as part of a central plan; and the tendency of Congress to produce extensive studies and public discussions, to a greater extent, as a way of avoiding potential conflicts and, to a lesser extent, as a way of finding technical solutions. Besides, they also allege that this rational approach is useful to analyse the formation of political coalitions in the initial phases of projects.

2.5.3 NIE – The Selected Institutional Approach to Study Formal Rules

In parallel, NIE is a perspective which understands institutions as the formal and informal rules that organize exchanges and human relationships. This approach has its roots in the work of Coase (1937, 1960). He argued that several costs should be considered in order to carry out a transaction. It is necessary and costly to find out who it is that one wishes to deal with, to inform that one wishes to deal (and on what terms), to obtain a bargain, to draw up the contract, and to make sure that the contract is being observed, among others (Coase, 1960).

He named these costs as “transaction costs” (TCs), which affect the delimitation of the potential rearrangements of property rights. Under this body of knowledge, the property rights of an individual or organisation provide an opportunity: 1) to use a particular asset; 2) to appropriate the fruit of their work, including the goods and services they possess; and 3) to change the form of the asset (Barzel, 1989).

Coase argued that a perfect market operated by people, as understood by neoclassical economics, would prevent several transactions taking place due to high TCs. Under his view, firms emerge

as a solution to avoid these TCs (Coase, 1937). This became the foundation for analysing governance structures and institutional environments under the NIE perspective.

Oliver Williamson coined the term NIE, intending to differentiate this body of knowledge from "old institutional economics", as the followers of the old school did not have a backup theory to bind their collection of facts together (Williamson, 1975). Williamson explained that transactions differ in their attributes and should be aligned with governance structures. He proposed a transaction cost economising logic that determines the institutions of governance.

Under this institutional approach, two interrelated concepts arise: institutions as "rules of the game" and institutions as "play of the game". Regarding the former, another seminal author called Douglass North defined institutions as humanly devised constraints that structure political, economic and social interaction. Based on this view, institutions consist of both informal constraints (sanctions, taboos, customs, traditions and codes of conduct) and formal rules (constitutions, laws, property rights) (North, 1991, p.1). From his perspective, institutions and the effectiveness of enforcement determine the cost of transacting. Therefore, it is central to account for the evolution of political and economic institutions that create a particular environment that may or may not foster economic and social development (North, 1991).

Furthermore, regarding institutions of governance, or the "play of the game", as named by Williamson, economizing on transaction costs is held to be the "main case" in relation to which adaptation is the central problem of economic organisation. Governance structures differ in incentive intensity, administrative control and contract law regime. The selection of the governance structure, in transaction cost economising terms, is related to the nature of the transaction, linked to contractual hazards and contractual safeguards.

According to these authors, NIE focuses its efforts on economizing transaction costs at two levels: getting the institutional environment right (formal "rules of the game") and getting the governance structures right ("play of the game"). This is the evident link between NIE and Transaction Cost Economics (TCE). The "rules of the game" impact and are impacted by the "play of the game". Specifically, transactions differ on asset specificity, uncertainty and frequency. Asset specificity refers to the degree to which an asset that is used to support a transaction can be redeployed to alternative uses. Uncertainty presents the need for adaptation. Frequency is also a pertinent dimension as recurrent transactions may support the setup costs of specialised governance and have better reputation effect properties (Williamson, 2000).

The mentioned transaction attributes create contractual hazards, which are basically a consequence of bounded rationality and opportunism. They result in principal agent problems, adverse selection and moral hazards. This is the link between TCE and contract theory, which is

especially relevant in infrastructure development in general and in megaproject planning, appraisal and delivery in particular.

NIE has also influenced the analysis of the link between institutions and infrastructure development. The academia has focused on both the role of institutions within the acquisition of the physical services that infrastructure provides. This includes planning, procuring, financing, delivering and regulating megaprojects in the transport sector, such as airports, bridges, ports, rails, roads, buses, subway and tram networks (see Estache, 2016).

Several authors working under this body of knowledge have formally analysed infrastructure delivery, particularly concentrating their efforts on examining different forms of regulation. This is intimately related to the "play of the game" mentioned in previous sections; it is linked to how transaction costs can be minimised and efficiency can be pursued (Guasch & Spiller, 1999; J. J. Laffont & Meleu, 2001; J.-J. Laffont & Martimort, 1998; J.-J. Laffont & Tirole, 1990; Levy & Spiller, 1996).

Although the previous authors are focused on infrastructure delivery, the logic behind their analyses can inform megaproject planning. An interesting theoretical background is the one presented by Spiller (2008, 2013). He proposes a Transaction Cost Regulation framework to analyse the interaction between governments and investors (Spiller, 2008, 2013).

Spiller explains that public contracting, which is usually the way infrastructure projects are delivered, is exposed to several hazards: standard opportunistic behaviour; governmental opportunism; and third-party opportunism. The first one is related to the existing information asymmetries in investments, the second one is associated with the ability of governments to opportunistically change the rules of the game, and the third hazard is related to public contract scrutiny, considering that the essence of public contracting is its publicity (Spiller, 2013). This is theoretically further explained in section 2.6.

The author mentions that this framework is suited to analyse fundamentally, but not exclusively, the utility industries. He differentiates them as they present a combination of three features: specific investments; economies of scale and scope; and widespread domestic consumption. Transport megaprojects (MTPs) can be reasonably included in this perspective as well.

Another good example of this literature has been the work of Ostrom. With her co-authors, she has deepened the analysis of the relationship between the incentives to deliver key infrastructure services, and the social norms and culture in place. She has analysed collective action in order to obtain collective benefits, in the context of distinct institutional environments (Ostrom, 1990), and discussed how layers of variables related to rules, events and the community affect outcomes

(Ostrom, 2005). Another good example is the work of Greif. He has studied the behaviour induced by self-enforcing institutions, which influence their long-term survival (Greif & Laitin, 2004).

2.5.4 The Institutional Environment of MTP Planning and Appraisal

This thesis adopts the general idea that neither of the three previous broad institutional perspectives is capable of analysing every possible angle regarding the institutional environment of megaproject planning and appraisal. In this context, it is here recommended to follow Scott (2012), who claims that while one approach may be more suited to study a particular institutional dimension, others may be better suited to study other dimensions.

The previous author defines institutions as "regulative, normative and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life" (Scott, 2013, p. 56). This is the definition proposed at the beginning of this section. He claims that these are the three elements or pillars that make up and support institutions.

Scott mentions that the cultural-cognitive is associated with symbols (including words, signs, and gestures) which shape the meaning of objects and activities. They are dynamic and affective. These elements are emphasised by organisational sociologists (Scott, 2012) and constructivists. Secondly, he associates the normative pillar to values and norms. Values are conceptions of standards and norms that specify how things should be done. Norms are beliefs about how specific actors should behave. These elements are usually emphasised by some sociologists and political scientists working under the historical institutionalist approach (Scott, 2003, 2012, 2013).

Finally, this author mentions that the regulative pillar is associated with rule setting, monitoring and sanctioning activities. Based on this view, sanctioning may be highly formalised or operated through informal mechanisms. Under this pillar, scholars study the costs of overseeing systems of governance and their benefits, and use them as an instrumental element. These regulative elements are particularly studied, according to this author, by institutional economists using NIE (Scott, 2003, 2012, 2013).

Scott (2003, p.881) states it is important to accept that any given and developed institutional context is made of diverse elements. There are no "pure cases" where only one element is responsible for the outcomes.

As explained elsewhere, this thesis is concerned with the fact that the institutional environment of MTP development in LatAm does not promote an "open-systems" approach, with a soft thought system, to decision-making at the planning and appraisal stages. Using Scott's framework, it is reasonable to state that there may be cultural-cognitive, normative and regulative

elements that could be promoting a "closed-systems" approach to planning and appraising megaprojects, with a hard thought system.

The cultural-cognitive elements of this institutional environment could be better assessed using a sociological institutional or constructivist approach to the analysis of institutions. Using this body of knowledge, it could be hypothesised that there is a social interpretation of the problem, an idea or intrinsic value, installed in the social and political arena, by which project efficiency and economic efficiency are prioritised over sustainability, equity, regional development, political pay-off, and other equally considerable criteria.

The normative elements, on the other hand, which are the rules that introduce a prescriptive, evaluative and obligatory dimension, could be best analysed using a historical institutionalism view of the political approach to institutions. Under this perspective, it could be hypothesised that there is an institutional inertia or path dependence as a consequence of a sustained paradigm: the economic efficiency and project management efficiency view of megaproject success. This path dependency is linked to particular policy technologies or governance structures, which are supported by powerful organisations, such as the construction industry and the professional/consultancy sector, among others.

Finally, the regulative elements could be probably best assessed using a NIE approach. Under this view, it can be hypothesised that there are specific characteristics of megaprojects that impose contractual hazards, and therefore transaction costs, that are being reduced using this planning and appraisal approach.

Probably, the case for a sustained "closed-systems" approach to megaproject planning and appraisal is based on several institutional elements. It is not reasonable to assume that this is a "pure case" where only one element is responsible for the outcomes. On the contrary, it is the view of the author of this thesis that the whole institutional environment, which includes several institutional elements, is promoting this "closed-systems" approach.

However, it ponders that NIE can be particularly helpful to theoretically isolate the topic proposed by this thesis, which is interested in the formal rules of the game. Although it cannot be comprehensive, it can be a reasonable approach to study potential formal rules enhancements to promote an "open-systems" approach to megaproject planning and appraisal.

2.5.5 Summary of Key Findings

In general terms, there are three approaches to institutional analysis: the sociological approach; the neo political approach; and the NIE approach. The first one deals with institutions as symbolic systems which impact social actions and organisations. Under this view, institutions produce habitus and are not a rational act to encourage some kind of efficiency. From a new-institutional political approach, on the other hand, institutions are conceived as a collection of rules and organised practices relatively invariant and resilient. Depending on the political approach to this issue, institutions can be seen as rules and conventions that promote a moral background and path dependence, or as rule of governance constructed to protect some kind of interest. Finally, NIE's view is the one that relates institutions to formal rules that organize market exchanges and human relationships, considering the economisation of transaction costs in different levels: general environment and government structures.

The three approaches to institutional analysis reviewed can and have been used to assess different issues related to MTP planning and appraisal. The sociological approach to the problem, firstly, has dealt with values that are culturally embedded in the decision-making process. This approach has been useful to understand the nature of "implementation processes" and the relation between strategy and action in this sector, particularly examining ideas and discourse, as they define MTP development objectives that translate into infrastructure policies. The neo institutional political approach studies the role of institutions as they use transport policy, and MTPs, to create and empower political views and interests, benefiting specific stakeholders or minimizing political conflicts. Finally, the NIE approach has been used to examine the relationship of formal rules as tools that can help to economise transaction costs related to MTP development. These transactions are related to contractual hazards that take form when MTP contracting is developed.

Given this theoretical context, it is here alleged, firstly, that Scott's framework for institutional analysis is useful to illuminate the complexity of the topic "institutions" (Scott, 2012). This author claims that there are three pillars of institutions: cultural-cognitive elements, normative elements, and regulative elements. Under his view, adopted in this thesis, there are no "pure cases" where only one element is responsible for the outcomes and, depending on the pillar under analysis, one of the previously mentioned approaches to institutions may be more suited as a conceptual framework to thoroughly analyse the problem.

Building from the previously discussed blocks, this section helped to clarify that the three pillars of the institutional environment of MTP planning and appraisal in LatAm are, probably, jointly promoting a "closed-systems" approach to planning and appraisal at the pre-investment phase. There may be a social interpretation of the problem, an idea or intrinsic value, installed in the social and political arena, linked to a particular view of megaproject success, that promotes this

"closed-systems" approach. Besides, there may be an institutional inertia, linked to particular governance structures and policy technologies, which is supported by interested organisations. Finally, there may also be some specific characteristics of megaprojects that impose specific transaction costs, which are being economised using the current rule-setting when planning and appraisal is developed.

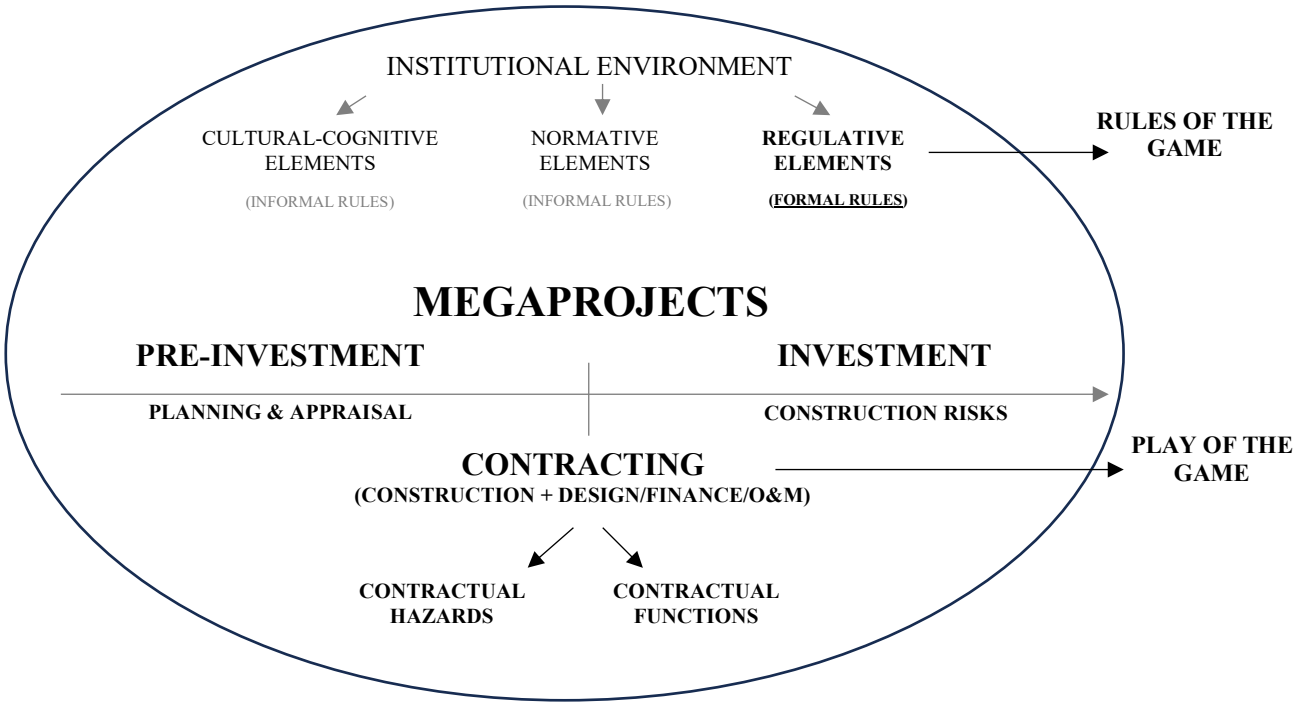
This thesis deals with the regulative element in general and the formal rules of the game behind megaproject planning and appraisal in particular, as tools that impact on the transaction costs that exist as a consequence of contractual hazards. This means using a NIE perspective to study the role of formal institutions in MTP planning and appraisal. This step is theoretically dissected in the following and final section of the Literature Review (2.6).

2.6 NIE to Study the Role of Formal Rules in MTP Planning and Appraisal[6]

After careful consideration, building from the theoretical analysis presented in the previous sections, this thesis focused on the role of the formal institutional environment, as defined by NIE, in the planning and appraisal of selected MTPs in LatAm.

Based on the theoretical background proposed in Section 2.5, particularly 2.5.4, it was reasonable to propose that LatAm countries may be using a "closed-systems" approach to decision-making for MTP planning and appraisal, among other institutional elements, to economise transaction costs, which exists as a consequence of MTPs' special characteristics. This is only one part of a broader institutional environment affecting this topic, but it is the specific part that has been studied in this thesis.

Figure 7 – Literature Review Diagram – New Institutional Economics



2.6.1 Section Overview

In order to fully comprehend the chain of thought related to this NIE perspective applied to MTP planning and appraisal, it is mandatory to understand how are contractual hazards formed and their relationship with MTPs special characteristics detailed in Section 2.2 and 2.3. Furthermore,

[6] Section 2.6 draws on aspects of research undertaken by the author during his PhD studies at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It is based on the following papers, originally published by the Inter-American Development Bank: Alberti, J. (2019b, 2019c).

it is necessary to comprehend how these contractual hazards are related to the formal rules in the context of a contract, for which understanding the concept of contractual functions is compulsory as well. This section theoretically elucidates the said chain of thought, and helps to fully understand the links mentioned as theoretical propositions, presented in Section 1.4 and superficially reviewed, namely:

- There is a link between the typical MTP construction risks and contractual hazards.
- There is a link between formal rules and contractual functions, which affect transaction costs.
- The "closed-systems" approach to the planning and appraisal of MTPs may help decision-makers to minimize transaction costs, in the context of the formal rules of the game in place.

In order to do this, this Section (2.6) is organised as follows. Firstly, Section 2.6.2 recapitulates on the basics of NIE, needed to lay the ground for the theoretical considerations presented afterwards. Then, Section 2.6.3 shows how contractual hazards, and MTPs' special characteristics (especially related to construction risks) are theoretically connected when using NIE. Subsequently, Section 2.6.4 shows the link between formal rules and contractual functions, which are related to the transaction costs that can be economised. Finally, Section 2.6.5 shows the reasonability of proposing that the rules of the game at the pre-investment and investment stages can be the basis for the use of a "closed-systems" approach to decision-making when planning and appraising MTPs.

2.6.2 The Basics of New Institutional Economics – Institutions and Contracts

NIE is a theoretical framework that incorporates a theory of "institutions", including laws, rules, customs, and norms, into economics. As explained in the previous section, institutions are defined as "rules of the game". This theoretical framework has produced seven Economics Nobel Prices, already cited in the previous section (2.5), in the past 35 years: Ronald Coase in 1991; Douglass North in 1993; Oliver Williamson and Elinor Ostrom in 2009; and Daron Acemoglu, Simon Johnson and James A. Robinson in 2024[7].

Under this framework, "institutions" are understood as humanly devised constraints that structure economic interaction. They are normally divided in formal constraints (such as rules and laws) and informal constraints (such as norms of behaviour, conventions, or codes of conduct) (see North, 1994). In simple terms, economic agents interact with a complex set of restrictions, formal and informal, which are called institutions.

[7] The Nobel Prize in Economic Sciences 2024 was announced in the same week that this thesis was uploaded.

Different challenges arise in this context related to the existence of those institutions, particularly on how adequate they are in order to obtain a specific result. Very basically, under this body of knowledge, it is of paramount importance to understand which are the rules of the game in place and how they impact, and are impacted, on how the game is actually played. This is because the NIE framework recognises that institutions structure agents' incentives in any economic exchange or "transaction". As stated by Williamson (1996), and explained before, a transaction occurs when a good or service is transferred across a technologically separable interface.

Exchanges or transactions need a contract, understood as a legally enforceable agreement. A contract, using a NIE view, is a formal, legal commitment to which each party gives express (though not necessarily written) approval and to which a particular body of law applies. According to Brousseau & Glachant (2002, p.3) a contract is an "agreement under which two parties make reciprocal commitments in terms of their behaviour – a bilateral coordination agreement." According to Ghestin (2002), a contract is an exchange of benefits rather than an exchange of consents. Of course, economic exchanges may vary in terms of complexity. Evidently, while relatively simple exchanges require simple contracts, more complex interactions need more elaborated contracts.

In this context, in simple terms, institutions as the "rules of the game" affect the "play of the game" (see Williamson, 1999), the latter being concerned with the governance of contractual relations. For MTP development, which is a complex economic interaction, usually between the public sector and a private party, a complex contract must be developed. In these contractual relations, the former is usually the owner of the said project, and the latter is involved in one or more (depending on the type of contract) of these activities or services: design, construction, finance, operation and maintenance.

As explained, in general terms, a contract may be oral or written, informal or formal. However, in this thesis, following Lyons & Mehta, 1997 (p.241), the term "contract" is reserved to allude to a formal contract, which is understood as a document that describes an agreement in writing, and which is perceived, or intended, to be legally binding. Every MTP, focus of this thesis, is developed using these formal and written contracts between the different parties involved in the development process. In general, in construction-based endeavours, a contract is a two-party agreement that involves a contractee (i.e., project owner or buyer) and a contractor (i.e., construction company or consortium) (Moszoro & Spiller, 2018).

The costs of resources utilised for the creation, maintenance, use, and change of contracts are called "Transaction Costs". According to Furubotn and Richter (1997), they include the costs of information and negotiation, the costs of defining and measuring resources, the costs of utilizing

and enforcing the rights specified, and the costs of enforcement. Logically, the possibility of transaction cost economising is linked to the formal rules of the game in place.

2.6.3 Contractual Hazards and MTPs Special Characteristics

Regarding contracting between economic agents, or the "play of the game", Williamson (1985) states that "transactions should be organised so as to economize bounded rationality while simultaneously safeguarding them against hazards of opportunism" (Williamson, 1985, p.32).

According to Williamson (2002), considering the transaction as the basic unit of analysis is a useful way to analyse these "hazards of opportunism" or "contractual hazards". Basically, if two transactions show different contractual hazards, they must be considered systematically different. Quoting Brousseau (2008, p.38): "The main problem dealt with by the economics of contracts is the control of hazards induced by the performance of transactions which are caused because the parties exchange promises to give (and receive in exchange) which, most of the time, are not fulfilled simultaneously but at moments when the parties agreed it would be mutually beneficial deal." The emphasis of the Transaction Cost Theory is therefore placed on understanding the nature of the hazards inherent to different types of transactions. In the case of megaprojects, it is about analysing the contractual hazards that exist in the interaction between governments and contractors.

To do so, a good framework for analysing such risks is the one proposed by Spiller (2008). As it was introduced in section 2.5.3, this author explains that public contracts are exposed to a larger set of hazards than that held between private transactors. The hazard that these two kinds of transactions share is the one related to idiosyncratic investments. This is normally called "standard opportunistic behaviour". In simple terms, asset-specific investments and idiosyncratic knowledge, in the context of bounded rationality of agents, can generate an opportunistic behaviour of one of the contractual parties by acting in its own benefit, against the benefit of the other contractual party involved. This leads to transaction governance or contract designs in order to limit this opportunistic behaviour. This is possible, for example, by decreasing information asymmetries.

Governmental opportunism, in second place, is associated with the ability of governments to opportunistically change the rules of the game. Governments may use standard governmental powers to extract quasi-rents from the private party. Although the evident determinant is the existence of sunken investments, the limits of governmental opportunism are institutional, generating an impact on the selected regulatory schemes (Spiller, 2013). It may be profitable if direct costs (such as reputation loss when asking for new private investment) are smaller than

potential benefits (quasi-rents to gain political benefits), and indirect costs are not too large (judiciary/administrative processes) (Spiller, 1996). The implication of the existence of governmental opportunism is that stronger safeguards will be required in a contract to avoid opportunistic interpretations (Spiller, 2008).

Finally, third-party opportunism is related to public contract scrutiny, considering that the essence of public contracting is its publicity. This type of opportunism may be practiced by designated agencies, politicians, or other interested groups. The problem is that all of them are biased, and they may be tempted to challenge the probity of the interaction. Both political and economic benefits can be achieved and, given certain complexity, the chance is exploited even if it may be unethical or illegal (Spiller, 2013).

Spiller (2013) mentions that this framework is particularly suited to analyse fundamentally, but not exclusively, utility industries. He differentiates them from other sectors as they present a combination of three features: specific investments; economies of scale and scope; and widespread domestic consumption. Under this view, MTPs can also be included in the group of investments that are affected by the above-mentioned contractual hazards.

Against this backdrop, it is only logical to theoretically propose that the significance of MTPs' contractual hazards is linked to MTPs' special characteristics, and the consequent construction risk structure explained in Sections 2.2 and 2.3. Megaprojects are complex and organic projects that evolve together with their context, continuously changing in terms of their goals and aims. Consequently, it is particularly difficult to effectively foresee every single aspect of the development of a megaproject in its gestation period. The achievement of the resulting proposed objectives, in terms outputs and outcomes, is absolutely uncertain, and context dependent.

Considering that risks can be defined as uncertain events or conditions that have effects on project objectives, MTPs are especially risky in social, technical, economic, environmental and political terms, as thoroughly explained in Section 2.3. In this context, it is possible to theoretically propose that there is a link between construction risks and hazards of opportunism, to be exploited by the contractual parties, in every MTP. By definition, risks are associated to uncertainty. On the other hand, by definition as well, contractual hazards exist as a consequence of the incompleteness of contracts, which are related to the parties' incomplete capacity for foresight (see Williamson, 2002). Therefore, MTPs social, technical, economic, environmental and political risks can be in the basis of potential contractual hazards. *This is the first theoretical proposition used by this thesis to design the multiple-case study.*

2.6.4 Formal Rules and Transaction Costs – The Role of Contractual Functions

The NIE perspective presented in this section implies that the formal and informal rules of the game are the constraints that affect how contracts are developed. One of the challenges, in this context, is that complex contracts, such as those developed in the case of the construction of MTPs, are inevitably incomplete. They contain errors and omissions. According to Williamson (2002), this is intimately related to participating agents' insufficient capacity for foresight, as already mentioned, but also their limited cognitive ability and self-interestedness.

Regarding the capacity for foresight, covering all foreseeable contingencies by both parties is usually impossible in a contract as a consequence of the transaction costs defined previously (Ghestin, 2002). Due to the existence of these costs, the parties can even enter the relationships unspecifying some contingencies, recognizing that if the contingency occurs, it will have to be handled in the following stages, through negotiation and voluntary compliance, or institutionally, by using the judicial power (Klein, 2002).

Regarding limited cognitive ability to deal with uncertainty itself, the literature states that the contract plays the fundamental role of providing a basic set of coordination rules, while the institutions provide the framework for the said coordination and the credibility of sanctions (E. Brousseau & Glachant, 2002). Therefore, assuming imperfect institutions, efficient procedures for negotiation, mediation and arbitration must also be included in the contract, in order to deal with this limited cognitive ability (Ghestin, 2002).

Finally, in terms of self-interest, the source of opportunism and contractual hazards according to Ghestin (2002), specific incentives must be included in the contracts in order to discourage opportunistic behaviour when the future is predictable but there are information asymmetries. This implies, for example, manipulating the costs of breaking the agreement and increasing the duration of the agreement. In addition, it is also central to use mechanisms for the resolution of private conflicts in order to prepare ex ante bilateral procedures to resolve disagreements when judicial institutions are imperfect (Brousseau & Glachant, 2002).

Subsequently, the economics approach to the analysis of contracts proposed by NIE suggests the need for an in-depth analysis of the "rules of the game" in place, in relation to the "play of the game". The "rules of the game" proposed by the NIE approach affect the potential efficiency of the contract, in the context of the agents' characteristics mentioned before, as they enable contracting and frame the context to assist in contract enforcement. As already explained in previous sections, rules can be formal (bureaucracy and the legal and judicial system) or informal (culture, traditions and customs) (Brousseau & Glachant, 2002).

Regarding the formal ones, Schwartz (2002) points out that the State should: “enforce contracts; police the contracting process for fraud and duress; supply parties with common vocabularies to use when writing contracts; and supply parties with governance modes for the conduct of transactions or the resolution of disputes” (Schwartz, 2002, p.116). Imperfect institutions, therefore, affect contract design. It is due to this imperfection that the parties usually implement private mechanisms to guarantee coordination.

According to Brousseau (2008), a joint analysis between contracts and institutions as formal rules of the game is, therefore, called for. Without the costs associated with writing and executing the contracts (transaction costs), coordination would be contractual and between the parties and would focus on voluntary compliance or self-imposition. However, since transaction costs always exist, within the framework of the mentioned characteristics of the participating agents, there is a trade-off between relying on judicial institutions or private arbitration.

When using this NIE conceptualisation to analyse contracts, there are two particularly relevant issues: the institutions that must enforce the contract and compliance rules. Institutions may have different degrees of specialty and flexibility, changing the way contracts should be used. Standards, on the other hand, can also be more or less flexible and can be based on principles that may vary, also affecting the way in which the contract is used more efficiently. Therefore, the characteristics of the formal rules of the game affect the optimal contractual design, which varies according to transaction costs.

In the context of the mentioned agents’ characteristics, and the formal rules, when dealing specifically with complex construction projects, Gao et al. (2018) explain that there are three contractual functions: safeguard or control function, coordination function, and adaptation function. The development of a megaproject construction contract usually requires the specification of contractual clauses related to each one of these functions. This is true both when contracting is developed between the project owner and the contractor, and when contracts are written for the relationship between the contractor and the subcontractors.

The first function, the safeguarding or control function, is related to the need of each party to ensure that the activities carried out by their counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. Basically, this contractual function seeks to reduce opportunistic behaviours.

The intensity of opportunistic behaviour depends, according to Das & Rahman (2010), on economic, relational and temporal determinants. The first one is related to the specificity of the asset, which can impose information asymmetries. The relational determinants, on the other hand, are related to cultural differences; and the third ones, the temporary determinants, are linked to

the temporal horizon of the exchange, which, if low, can stimulate the mentioned opportunistic behaviour. As part of the safeguarding function of the contract, clauses referring to property rights, confidentiality clauses, scope of service and performance guarantee clauses, unilateral termination of the contract clauses and conflict resolution clauses are usually used.

The second function, the coordination function, refers to the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly (Gulati & Singh, 1998). The contract should specify actions that may not be evident due to the complexity and uncertainty that may exist in the construction project that is being developed (Casciaro, 2003; Dekker, 2004).

The need to use this function is a consequence of the potential complexity of the tasks to be performed in the construction stage. Its aim is to align the expectations between the parties. This function is usually specified by using clauses that establish roles and responsibilities, and also when using reporting clauses, clauses referring to the calendar or program of actions to be developed, and clauses for the appointment of people with particular qualifications in required tasks, among others.

The third and last function, the adaptation function, is related to the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. For that purpose, procedures and guidelines that can be specific or generic should be developed, depending on whether an attempt is made to specify (when possible) the different conceivable scenarios which may carry a cost. Basically, it is about putting together different contingency plans. This usually requires the presence of contractual clauses, for example, referring to price adjustments, value engineering clauses, clauses with procedures to address unexpected physical conditions and force majeure clauses, among others.

In summary, a contract for developing a MTP deals with the typical complexity of these kinds of projects using control, coordination and adaptation clauses. In this regard, the work of Gao et al. (2018) is particularly enlightening. They use the framework proposed by Bosch-Rekveldt et al. (2011) regarding project complexity, and hypothesize that there is a link between the use of contractual functions and the relationship between the parties of the contract, and that this is related to project complexity.

The relationship between the parties of the contract is conceptualised by these authors as the satisfaction that one party has regarding the behaviour of the other, and their willingness to collaborate in the future. The authors measure it through the following subjective indicators: (i) satisfaction with this partner's responsiveness to problems in the project; (ii) satisfaction with

respect to the other party, when compared with other parties; and (iii) willingness to reoccurring business with the counterpart.

In this regard, Gao et al. (2018) found that there is a positive impact of the coordination function on governance outcome to deal with every dimension of complexity. They found, moreover, that contractual adaptation clauses have a positive association with performance when there is more environmental complexity. However, these authors found contradictory results regarding safeguarding. They found that there is no association with safeguarding clauses and performance when there is more complexity. Safeguarding on its own cannot mitigate opportunism, and the authors attribute this to the weak legal system.

Extending these authors' argument, with a NIE perspective, it is only reasonable to theoretically propose that the effectiveness of contractual functions is particularly related to the formal rules of the game in place. As explained before, formal rules organize markets and determine the cost of transacting. They include legislation and bureaucracy, which supply parties with governance modes for the conduct of transactions, and common vocabularies to use when writing contracts, and include also the judiciary system, which assists in contract enforcement. *This link, between contractual functions and formal rules, is the second theoretical proposition used by this thesis to design the multiple-case study.*

2.6.5 The Planning and Appraisal Approach for Transaction Cost Economising

In order to materialise a MTP, a contract must be developed between a contractee, usually the public sector, and a contractor, normally a private party. With a NIE perspective, it is safe to say that developing this contract involves incurring in transaction costs. Moreover, as explained by Williamson (1998, p.75), "transactions, which differ in their attributes, are aligned with governance structures, which differ in their cost and competence, so as to effect a (mainly) transaction-cost economising result".

In simple terms, under this theoretical perspective, the contract being used, in the context of the formal rules of the game, is developed in order to economise transaction costs. When a MTP is developed, legislation, bureaucracy and the judiciary system frame, as formal rules of the game, the pre-investment and investment phases of MTP development, and decision-makers shape a contract to economise transaction costs.

However, as previously explained, transaction costs are the costs of resources utilised for the creation, maintenance, use, and change of the contract, considering the information and negotiation processes. Therefore, it is in the pre-investment phase of MTP development when

transaction costs start to take form. It is in the pre-investment phase when decision-makers eliminate possible uncertainties and avoid taking unnecessary risks.

However, MTPs, given their special characteristics, thoroughly explained in section 2.2, entail several construction risks, detailed in 2.3. This is related to the insufficient capacity of foresight, the limited cognitive ability and the self-interestedness of the contracting parties involved. Subsequently, decision-makers will try to minimize transaction costs, acknowledging that the resulting contract will be inevitably incomplete, and hazards of opportunism or "contractual hazards" will inevitably emerge.

Decision-makers will minimize transaction costs in the context of unavoidable contractual hazards, which are: standard opportunism, governmental opportunism and third-party opportunism. However, if they act rationally, as expected with a NIE perspective, it could be argued that decision-makers could make decisions, since the pre-investment phase, to minimise these potential transaction costs of a future contract. They could do so since the pre-investment phase given that transaction costs start to take form at that moment.

In the pre-investment phase, as thoroughly explained in section 2.4, the MTP planning and appraisal process takes place. In Latin America, a "closed-systems" approach to decision-making, when planning and appraisal, is formally requested by governments, confining the process to a model of project life cycle or phased stage-gate approach. However, it is alleged that this control-oriented phased approach that infers the management of structured phases of a project life cycle one after another is not consistent with the nature of MTPs.

Several academics, but also practitioners, support a more holistic perspective, an "open-systems" approach to decision-making when planning and appraisal MTPs. They claim that this approach better frames how the different components that are relevant to their justification are accommodated, given their complex and organic nature. Still, the "closed-systems" approach to decision-making when planning and appraisal remains unchanged.

The third theoretical proposition, used to design the multiple-case study presented in this thesis, is that the said "closed-systems" approach to decision-making may remain unchanged because it could be functional to minimise future transaction costs, as it could minimise contractual hazards, given the formal rules of the game in place. If this is true, at least to some extent, it would be mandatory to change the formal rules in order to promote a change in the planning and appraisal approach used. Evidently, as suggested in section 2.4, there could be other institutional elements, such as the cultural-cognitive and normative strands, which sustain the current status quo as well. However, this thesis focuses only on the regulative element of the institutional environment, the formal rules of the game, with a NIE perspective.

2.7 Summary of the Chapter Findings

Megaprojects in general, and MTPs in particular, are special endeavours given their size, but also considering distinctive characteristics; they are political, human-centred, complex, organic and iconic projects. In this context, at the planning and appraisal stages of MTP development, when dealing with the selection (among options) of the project and when deciding objectives and goals to be adopted for a project, an "open-systems" approach to decision-making, with a soft-thought system, such as those proposed by PSMs, is more consistent. This planning and appraisal approach is needed, according to academics and practitioners, to deliver the widest possible range of positive transformational benefits that megaprojects are able to bring in terms of economic, social, environmental, and territorial outcomes, both in the short run and in the long term.

However, in LatAm, a "closed-systems" approach to decision-making is requested by central governments at the planning and appraisal stages of MTPs. There are institutional forces that sustain this status quo, although there are good reasons to change this. The institutional environment of megaproject development in the region does not promote the alternative, this "open-systems" approach, with a soft thought system, to planning and appraisal. Probably, there are cultural-cognitive, normative and regulative elements that are promoting the sustained "closed-systems" approach to decision-making.

This thesis deals specifically with the regulative element, using a NIE lens of institutions. In particular, it deals with the formal rules in place (legislation, bureaucracy, and judiciary), which, in the context of MTPs characteristics that imply high transaction costs, could be discouraging the use of an "open-systems" approach at the planning and appraisal stages.

The chain of logic for the previous theoretical proposition is the following. Given MTPs' special characteristics described in Section 2.2 and 2.3, MTPs construction risks are complex as well, considering different risk dimensions: social, technical, economic, environmental and political. These risks are addressed by decision-makers when using the construction contract, with a set of contractual clauses related to contractual functions. However, writing very complex contracts, such as the ones related to this type of projects, imply high transaction costs, given the following characteristics of the participating agents: their incomplete capacity for foresight, their limited cognitive ability and their self-interestedness. Those transaction costs are especially high when elevated contractual hazards exist, such as in the case of MTPs.

In this context, it is safe to say, at least theoretically, with a NIE view of the problem, that the formal rules (legislation, bureaucracy and the judiciary), at the pre-investment and investment stages, could be affecting transaction costs, which are elevated as a consequence of inevitably high contractual hazards of complex projects. In the context of these formal rules, there may be

merit on using different strategies to economise transaction costs, such as using a “closed-systems” approach to planning and appraisal. If this is true, the “closed-systems” approach could be, at least in part, a consequence of a rational behaviour.

3 Research Aim, Objectives and Questions

This chapter presents the aims, objectives and key questions addressed by this thesis. The research aim emphasizes what was expected to be achieved within the scope of the research, and the various objectives as they relate to the different parts in which the research scope is divided.

3.1 Overall Research Aim, Objectives and Questions

3.1.1 Overall Research Aim

Drawing from preceding Chapters, this thesis in overall terms aimed to examine the nature of the relationship between the planning, appraisal and development stages of MTP decision-making with a NIE perspective. It specifically analysed the contribution of the formal institutional environment in the selection of a "closed-systems" approach to planning and appraisal in a group of LatAm MTPs as this may help to develop a roadmap of formal institutional enhancements that may contribute to change the status quo towards more sustainable and adaptive decision-making processes.

3.1.2 Research Objectives

The research explored, in the selected cases, how construction risks were related to contractual hazards, and studied if these contractual hazards generated transaction costs that could be reduced by using a "closed-systems" approach to planning and appraisal, given the formal institutional environment.

As previously stated, this thesis used NIE as the theoretical lens. Based on this perspective, it was here proposed that there are construction risks, which are related to contractual hazards, which result in transaction costs that could be economised using a "closed-systems approach" to decision-making at the planning and appraisal stages. This could be related to a particular formal institutional environment that is not functional to economising the transaction costs that this particular type of projects entails, given their special characteristics. This research made an in-depth analysis of this matter in a group of LatAm MTPs.

In this context, the theoretical propositions, drawn from the literature were:

- There is a link between typical MTP construction risks and contractual hazards.
- There is a link between formal rules and contractual functions, which affect transaction costs.

- The “closed-systems” approach to the planning and appraisal of MTPs may help decision-makers to minimize transaction costs, in the context of the formal rules of the game in place.

Therefore, for the selected cases, the research objectives were:

• To identify the contribution of each risk factor and risk dimensions at the construction stage to the general risk of obtaining the expected results (see first theoretical proposition above, and first knowledge gap in section 1.5.1)

• To analyse how these construction risk factors were related to contractual hazards and how those hazards generate transaction costs that can be managed using the construction contract, given the formal institutional background (see second theoretical proposition above, and second and third knowledge gaps in section 1.5.2)

• To explore how governmental decision-makers may perceive that an “open-systems” approach to decision-making at the planning and appraisal stages could generate a positive impact on contractual hazards, and therefore transaction costs (see the third theoretical proposition above and fourth knowledge gap developed in section 1.5.3)

3.1.3 Key Research Questions

The following overarching question is central to the research investigation undertaken and the focus of the research findings offered:

Could the formal institutional environment adversely impact the employment of a more “open-systems” approach to decision-making at the planning and appraisal stages of LatAm MTPs?

The previous overarching research question was subsequently disaggregated into separate but related different subsidiary questions with a view to give order to the research process followed at the selected cases, especially considering a NIE perspective:

• What is the perceived contribution of the different construction risk factors to the overall likelihood that the analysed MTPs obtain the results that governmental decision-makers expect?

• How are these construction risk factors and dimensions perceived, by the governmental decision-makers included in the analysis, to be translated into contractual hazards?

• How can those risk factors and hazards be managed using the construction contract, given the formal institutional background?

• How do governmental decision-makers perceive that an “open-systems” approach to MTP planning and appraisal could impact on the transaction costs, given the formal institutional environment in place?

4 Research Methodology[8]

4.1 Research Study Framework

The research study framework is organised as suggested by Crotty (1998), who describes four levels for developing a research study: 1) Paradigm Worldview; 2) Theoretical Lens; 3) Methodological Approach; and 4) Methods for Data Collection.

4.1.1 Paradigm Worldview

The term "paradigm worldview" is used to describe the philosophical assumptions that guide inquiries. Creswell & Plano Clark (2011) suggest that there are four worldviews that operate at a broad, abstract level: postpositivist, constructivist, participatory, and pragmatist.

This research has used a "pragmatic paradigm" as it has been problem-centred and real practice oriented. It has used multiple methods and different assumptions, as well as different forms of data collection and analysis. It has intended both to provide multiple perspectives and to shed empirical light about theoretical propositions (for more information regarding this paradigm worldview see Creswell & Plano Clark, 2011, p.42).

With this "pragmatic paradigm", the dichotomy between postpositivism and constructivism has been here abandoned, and the focus is on the consequence of research. It is concentrated on the relevance of the questions asked, and on the use of different methods for data collection to inform the problem under study. It is here assumed that research always occurs in social, historical, political, and economic contexts. In the whole process, the research has collected both qualitative and quantitative data in order to mix them; hence, it has designed and conducted a mixed method research.

4.1.2 Theoretical Lens

The theoretical foundation is a lens that provides the researcher with direction in the mixed methods project. It is a theoretical orientation, an explanatory framework. It is a standpoint taken by the researcher that provides direction for many phases of the research project.

[8] Chapter 4 draws on aspects of research undertaken by the author during his PhD studies both at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It includes parts of the following papers, originally published by the Inter-American Development Bank and the *Journal of Mega Infrastructure and Sustainable Development* (see Alberti, 2021, 2022).

In this research process, New Institutional Economics (NIE), as stated in the previous chapters, was the selected social science framework, and it provided the lens that shaped what was looked at and the questions asked. The selected theoretical orientation serves as the explanatory framework from the social sciences that shapes the direction of the research study (Creswell & Plano Clark, 2011, p.47).

As it is a mixed methods study, which is further explained in the next section, the theoretical lens was presented at the beginning of the thesis, in a separate chapter as part of the literature review (see Creswell, 2014, p.69). It is there shown how it provides a framework for both the quantitative and the qualitative data collection efforts.

4.1.3 Methodological Approach: Mixed-Methods Research Design

In light of the stated pragmatic worldview and the theoretical lens, this research process proposed a mixed methods research design; it used an embedded design with a qualitative emphasis (for more information see Creswell & Clark, 2011 & Yin, 2014). The mixed method design was used to produce an analytical generalisation. As opposed to statistical generalisation, where an inference is made about a population, the analytical generalisation is based on advancing the theoretical concepts or theoretical propositions.

Evidently, as a generalisation, it strives for generalisable lessons learned that go beyond the cases, but the logic is different. If the empirical data matches the theoretical propositions, constructed from the social science perspective, this can lead to recommendations for future policy actions (see Yin, 2014:148). In this context, a qualitative emphasis was proposed to thoroughly analyse the decision-making process and the quantitative strand is used in a secondary role to enhance the understanding of a particular aspect of that decision-making process.

Therefore, the methodological approach here presented was developed with the aim of dealing with the following research objectives for the selected cases: 1) to identify the contribution of each risk factor and risk dimensions at the construction stage, to the general risk of obtaining the expected construction results; 2) to analyse how these construction risk factors are related to contractual hazards and how they can be managed using the construction contract, given the institutional background; 3) and to explore if an ‘open-systems’ approach to decision-making at the planning and appraisal stages could impact on the contractual hazards.

According to Yin (2014), the design of a multi-case study involves the specification of five components: questions; propositions; units of analysis; logic to relate data and propositions; and criteria for interpreting results. Following Yin’s specification:

Questions - the questions expected to be answered by this thesis, for the selected cases, were: 1) What is the perceived contribution of the different construction risk factors to the overall likelihood that the analysed MTPs obtain the results that governmental decision-makers expect? 2) How are these construction risk factors and dimensions perceived by governmental decision-makers to be translated into contractual hazards in the selected cases? 3) How can those risk factors be managed using the construction contract, given the formal institutional background, in the selected cases? 4) How do governmental decision-makers perceive that an "open-systems" approach to MTP planning and appraisal would impact on the transaction costs, given the formal institutional environment in each case?

Propositions: Propositions, on the other hand, should direct the attention of the study. Akin to hypothesis, based on theory, Yin (2013) considers them as answers to the previous questions. It follows that case studies should be used to corroborate whether the propositions are met. In this thesis, the most relevant theoretical proposition is that the formal rules of the game in place (legislation, bureaucracy and the judiciary) may not be promoting an "open-systems" approach to planning and appraisal, as they may not help to reduce transaction costs.

The corroboration of this proposition with a multiple-case study would represent an analytical and not statistical generalisation. A theory should not be statistically generalised with this methodology because cases should not be read as samples of a population (Yin, 2014). Cases here should be understood as opportunities to associate theory with practice in a difficult problem.

Units of Analysis: The unit of analysis can be people, groups, decisions, programs, events, projects or, as in this case, Latin American MTPs.

Logic relating Data and Propositions: this research compares predicted patterns, based on theory, with empirically based data. This is called by Yin (2014) as a form of "pattern matching", mixed with explanation building. When empirical and predicted patterns are similar, the results strengthen the internal validity of the case study. The causal links here presented, as explained by Yin (2014, p147), "reflect critical insights into a public policy process", which in this case is MTP planning, appraisal, and delivery. If the empirical data matches the predicted patterns, this is expected to lead to recommendations for future policy actions.

Criterion: Finally, in this research, the criterion for interpreting results refers to the analysis of contrary explanations. A greater robustness of the conclusions will be achieved as other options are considered and ruled out.

A single case analysis can serve to criticize a theory, for being unusual or common, but revealing. Multiple cases, on the other hand, have a logic of replication. The intuition of multiple cases is that they are useful to analyse whether or not the propositions are replicated, in different contexts,

to increase the robustness of the fit of the hypothesis to the propositions. Indeed, this research process works on the second option (multiple-case studies) to reinforce the results obtained.

Each case should be considered as a study in itself, where evidence is sought regarding the propositions, and conclusions are drawn (Yin, 2014). This is done in Chapter 6 when the following are analysed, in general terms: the link between construction risks and contractual hazards; the link between formal rules and contractual functions; and the role of the planning and appraisal process for risk management.

The Qualitative Strand

Specifically, the qualitative strand developed by this thesis refers to a multiple-case study approach to examine how the formal institutional environment, at the pre-investment and investment stages of selected LatAm MTPs, contributes to the selection of a "closed-systems" approach to decision-making at the planning and appraisal stages.

The research relied on Yin's work on cases and replication logic. A theoretical replication has been predicted explicitly at the beginning of the investigation (please see the theoretical propositions in section 2.6 and the previous section). The objective was to use a pattern matching logic in the selected cases, considering the theoretical propositions. Theory is here understood as a set of constructs linked together in relationships that are supported by theoretical arguments, which seek to explain a focal phenomenon (Eisenhardt, 2021). Under the Eisenhardt's method, replication logic refers to repeating an iteration between theory and data, by examining each case as a standalone observation, and not as a data point in a sample for which pooled logic (and statistical analysis) is relevant. In this thesis, NIE theoretical lens was considered an under-represented perspective in the well-researched literature of megaproject planning, appraisal and delivery.

This research studied the contribution of the formal institutional environment to the selected MTP planning and appraisal approach. If cases turn out as predicted, there is compelling support for the initial theoretical propositions (see Yin, 2014). Therefore, it is safe to say that this thesis used a pattern matching logic, which helped in the process of explaining a phenomenon (MTP planning and appraisal), by elaborating on the theoretical constructs proposed.

In this context, the qualitative priority of the mixed methods approach has several advantages. Firstly, although the reviewed literature refers to the generalities of the relationship between the variables here analysed, the focus of the research is the "how", which finally lead to the theoretical

propositions explained elsewhere. For the selected cases, the following questions were considered:

- How are construction risk factors perceived by governmental decision-makers to be translated into contractual hazards?

- How can they be managed using the construction contract, given the formal institutional background?

- How do governmental decision-makers perceive that an "open-systems" approach to MTP planning and appraisal would impact on the transaction costs, given the formal institutional environment in place?

There is little theory and empirical evidence to answer the previous questions and, therefore, as stated by Eisenhardt (2021; p.148), those questions are particularly likely to provide fertile opportunities, as they look inside the "black box" of the megaproject planning and appraisal process, for which there are no obvious answers.

As stated by Yin (2014; p.10), "how" questions are more explanatory and likely to be used in case studies because such questions deal with operational links needing to be traced, rather than mere frequencies or incidence. The selection of the qualitative emphasis in this research, based on a multiple-case study approach, is therefore justified by the nature of the previous questions.

Secondly, the qualitative priority is also advantageous as the research approach here proposed is premised on an important underlying assumption (in part following OMEGA Centre, 2011), namely that knowledge about the planning, appraisal and delivery of MTPs resides very much in the narratives (story-telling) of key stakeholders involved in such projects.

Thirdly, the formal institutional environment at the pre-investment and investment stages, which is here alleged to influence the megaproject planning and appraisal approach employed, is context dependent and it is here assumed that there are other institutional elements in place. The qualitative priority of this research, based on open-ended questions, is useful to consider the interdependence of the regulative element with the normative and cultural cognitive ones (see Section 2.5). The qualitative strand (being based on real case studies) gives an opportunity to provide additional information and insights concerning this topic, which has been insufficiently studied to date in LatAm.

For this qualitative strand, the researcher has gathered information; has analysed data from themes and categories; has looked for broad patterns, and posed generalisations from past experiences and the reviewed literature, to finally return to theory and review how it informed the findings and the results.

The Quantitative Strand

As explained elsewhere, the qualitative approach mentioned in the previous section is complemented by a quantitative research strand in a secondary role to enhance the understanding of a particular aspect of the decision-making process here analysed.

Precisely, as stated in section 2.3, many of MTPs' construction risks cannot be plausibly estimated statistically, based on what happened in other cases. The typical probabilistic approach to risk analysis focuses on the probability and the impact of any given risk, based on historical numerical data. Popular probability-based techniques include sensitivity analysis, decision tree analysis, Bayesian network analysis, and Monte Carlo simulation approach, among others. These tools facilitate risk analysis for construction projects. However, the limitation of probability theory is that it cannot deal with important aspects of project uncertainty, which may arise due to the existence of uncertain and vague risk factors, such as many of the above, during the assessment phase. This may happen with several risks, for example "involvement of many decision-making bodies" or "political indecision" or "lack of transparency and corruption", among others. Although different people can say that one of the above risks is very probable or its potential effect is very high, they could be eventually thinking differently, because those risks are difficult to numerically define.

However, according to what is mentioned in section 2.3, there are other ways of estimating the probability and impact of a given risk. One of them consists of generating linguistic measures and transforming them into a mathematical logical base. This thesis uses FST, within the framework that this computational intelligence paradigm can provide.

Computational intelligence has been consistently used by the academy with the aim of assisting in decision-making when using a multi-criteria approach. With this objective, according to Doumpos & Zopounidis (2013), three paradigms have been especially useful: statistical learning and data mining; metaheuristics; and fuzzy modelling. Data mining requires large amounts of data and is generally used to find unexpected relationships and summarize variables. Metaheuristics is usually used in multi-objective optimisation, without making assumptions about the problem being studied. The third is the one proposed in this document, in the context of the analysis of multiple construction risks.

Fuzzy modelling has the capacity to minimise the inherent imprecision, inconsistency, vagueness and uncertainty imposed by linguistic information. Several authors have worked on this approach, including Zadeh (1975), who introduced it, but also Chan et al. (2000), Chen & Chen (2009), Kaufmann & Gupta (1991), Yang & Hung (2007) and Zimmermann (1991).

Regarding its use in this particular sector, FST has recently been used in the analysis of construction risks. For example, Pinto (2014) develops such a model to estimate occupational safety risk in construction projects; Nasirzadeh et al. (2014) also uses it to treat the natural uncertainty of several risk factors; Kuo & Lu (2013) use a fuzzy multi-criteria decision-making approach to assess risks in the construction of a subway; Tamosaitiene et al. (2013) compare the risks of three construction projects using fuzzy logic; Idrus et al. (2011) develop a model for estimating contingent costs by calculating construction risks based on fuzzy systems; Nieto-Morote & Ruz-Vila (2011) use fuzzy numbers to characterize different construction risks that do not are quantifiable; and Xu et al. (2010) develop a risk assessment model for Public Private Partnership (PPP) projects in China based on fuzzy logic, among others. This work proposes the use of the methodology selected by Samantra et al. (2017), for the reasons that are developed below.

Unlike traditional set theory, where the set is considered a collection of distinct and well-defined objects, fuzzy subset theory implies a fuzzy boundary between sets, and each object is associated with each subset to a certain degree of association. Based on this theory, uncertainty and imprecision can be represented mathematically, and formal tools can be provided to deal with the subjectivity inherent in any decision-making process.

Therefore, these authors consider appropriate to estimate the degree of severity of all the risks factors of megaprojects using FST. By using it, it is possible to effectively explore the subjectivity associated with the uncertain (vague and poorly defined) characteristics of risk factors and the corresponding human judgment when assessing it. In this way, the imprecision, inconsistency and vagueness of risk analysis in megaprojects can be dealt with in an orderly manner, with the support of computational intelligence.

4.1.4 Methods for Data Collection

Replication, not sampling logic, for multiple-case studies

Yin (2014:57) explains that replication logic in multiple-case studies is analogous to that used in multiple experiments. With this methodological approach, cases are selected to predict similar results or a literal replication. If the cases turn out as predicted, they provide compelling support for the initial set of propositions. Replication logic is distinguished by this author from the sampling logic. The latter requires an operational enumeration of the entire universe, and the resulting data are assumed to reflect the entire pool, usually used to determine prevalence or frequency. In the replication approach, on the other hand, the objective is to predict results, and check if empirical data matches the theoretical propositions (see Yin, 2014:57).

In this context, according to Flyvbjerg (2011), cases should be selected considering maximum variation in order to obtain information about the significance of various circumstances for case process and outcome. With this in mind, this author suggests three to four cases studies are to be undertaken. Each should be very different in terms of at least one dimension: size, form of organisation, location, budget, etc. In this research process, the most important dimension in which the selected cases differ in this thesis is the Latin American country where they are located, which implies relevant differences in the broad elements of the institutional context.

Furthermore, in order to develop the research here presented, the selected case studies were not to be in an initial planning phase, nor very far from the contracting stage. This is on account of the fact that, firstly, in an initial phase, the interviewees would not have a good idea of the possibilities of dealing with construction risks and contractual hazards at the contracting stage. In addition, secondly, this research utilised the decision-makers' risk perceptions in a subjective manner rather than in an objective way. Selected projects, therefore, were not to be in an advanced construction stage since, in such circumstances, several risks would already have materialised. Consequently, the selected megaprojects should be at -or near- the contracting phase, or at the beginning of the construction.

The list of MTPs in Latin America that were relatively near the contracting phase, or at the beginning of the construction, was relatively small at the moment this research project was proposed. In this context, both cases and participants were selected for the replication logic (not sampled) in a strategic way, so that they were relevant to the research questions that have been posed. Cases and participants were chosen where the focal phenomenon was occurring, and case designs were developed to apply the pattern matching logic. This common process design involves choosing cases about the same focal phenomenon in purposefully different settings (see Eisenhardt, 2021: 150). The analogous form of selection when using a sampling logic is purposive sampling, specifically theoretical sampling, as a non-probability form of sampling (Bryman, 2018, p.418; Eisenhardt, 2021).

Regarding the number of cases necessary to develop the proposed study, three MTPs were chosen, as three cases were understood as sufficient to consider that an acceptable replication of the theoretical propositions could be obtained (following Flyvbjerg, 2011). After an initial consultation with transport specialists from the Inter-American Development Bank, the following projects were recommended for this study: the Ferroanel North Railway project in São Paulo, Brazil (FNSP); the Central Railway Project in Uruguay (CRPU); and the Metro Line 1 in Bogotá, Colombia (ML1B). These megaprojects complied with the following conditions.

Firstly, they were being developed in different countries, which additionally belong to different sub-regions according to IDB's qualification (the Andean Group – Colombia; South Cone -

Uruguay; and Brazil). Moreover, this group of cases included MTPs that were going to be constructed in unitary states (Colombia and Uruguay) and a federal state (Brazil). Therefore, they covered the requirement of diversity as the institutional context where they were expected to be constructed was evidently different.

Secondly, the three selected MTPs were being developed in countries characterised by a "closed-systems" approach to their decision-making at the initial phases of the project and, furthermore, they were relatively near the contracting phase or at the beginning of the construction. Consequently, interviewees were expected to have a good perception of the characteristics of construction risks and contractual hazards, and the possibilities of dealing with them at the contracting stage. FNSP had the complete basic design studies, as well as the environmental and social assessment, but decision-makers had not resolved to advance to the contracting stage. For ML1B, on the other hand, decision-makers had decided to move forward to the contracting stage, and were about to award the project at the moment the questionnaire was deployed. Finally, in the case of the CRPU, the project was awarded and contracted, and the final design and construction stage was developing its first steps. The three MTPs can be seen as a natural experiment to study the issue proposed in this thesis, considering they all refer to the rail transport subsector, and thus, technical variability between cases is reduced.

Finally, from a pragmatic viewpoint, in these three proposed cases the IDB had an ongoing relation with the governmental bodies in charge. In line with the case study experiences of the OMEGA 2 Project (See OMEGA Centre, 2011), where an average of 10 stakeholders were interviewed per megaproject, the IDB was capable of arranging 8 to 12 interviews with governmental decision-makers, in each of the selected cases, to undertake the research. The participants were selected in a strategic way, as a recommendation of IDB transport specialists working in the countries, considering their knowledge about the projects' pre-investment and investment phases.

The mixed method embedded design here proposed implied qualitative and quantitative data were collected both sequentially and concurrently. Firstly, the researcher reviewed and analysed public documents related to the selected projects. Subsequently, in a meeting with each of the selected participants, both qualitative (semi-structured interviews) and quantitative (closed-ended questionnaires) were completed.

The names and positions of the participants are not disclosed in order to preserve confidentiality, which was ensured at the beginning of the meetings, so that they could speak freely on a sensitive topic such as the risks associated with a planned or ongoing MTP. Based on the coordination undertaken by the IDB's local specialist in each country, participants in all cases were mid- and senior-level officials linked to the projects, with responsibilities spanning the social, technical,

economic, environmental, and political dimensions of project planning and management included in the analysis. Meetings with participants were held on the following dates: October 2019 for ML1B in Bogota, Colombia; December 2019 for CRPU in Montevideo, Uruguay; and February 2020 for FNSP in São Paulo, Brazil. By 2025, when this thesis is published, ML1B remains under construction and operational launch is projected for 2028, CRPU is operational as of 2024, and FNSP remains in the planning stage.

Qualitative Data: Semi-Structured Interviews (Appendix A)

As explained by Bryman (2018), the semi-structured interview for the qualitative strand was used here to refer to the context where the interviewer has a series of questions in a general form and schedule, but is able to vary the sequence of questions. Although there was a list of questions of fairly specific topics to be covered, here referred as the "interview guide" (presented in Appendix A), questions were relatively general in their frame of reference. Besides, the interviewer had some freedom to ask further questions given the perceived significance and nature of replies. The interview process was flexible and the emphasis was on how the interviewee understood the issue here selected. However, as this is a multiple-case study research, some structure was needed in order to ensure cross-case comparability.

The interview guide took the form of a list of relatively structured questions. However, research questions were not as specific as to close alternative opportunities of enquiry that might arise during the collection of fieldwork data. Some basic elements considered when developing the interview guide were (Bryman, 2018, p.473): 1) Create an order of topic areas or interview topics; 2) formulate interview questions or topics in a way that it can help to answer research questions; 3) Use language that is comprehensible; 4) Do not ask leading questions. The final interview guide is included in Appendix 1.

Using this interview guide, the researcher conducted and recorded semi-structured interviews, transcribed them, and developed a thematic analysis of interview transcripts. Semi-structured interviewing was used for pattern matching and building explanations (see Bryman, 2018; Yin, 2014), while keeping an open mind about the shape of what he needs to know about, and concepts can emerge out of data (Bryman, 2018).

As proposed by Creswell (2014, p199), given that this research includes a distinct theory to be examined, a preliminary and flexible codebook, which could develop and change based on the information learned during the data analysis, was developed for coding the data. With the raw data collected (public documents and transcripts from the interviews), the researcher followed the next steps (taken from Creswell, 2014, p.199):

1) Organised and prepared data for analysis;

2) Read/looked at all the data;

3) Developed a qualitative codebook (see Guest et al., 2012), permitting the codebook to develop and change based on the information learned;

4) Used the coding for generating a number of categories and themes (the heading in the research findings), and analysed them for each individual case and across different cases.

Results of the thematic analysis are presented using the research questions and topics, as mentioned by Guest et al. (2012). These authors allege that this is particularly useful when the analysis is targeted and is part of a mixed methods analysis, as in this case. Themes are reviewed considering the different topics or domains of inquiry presented in the interview guide. Under each domain, the narrative included descriptions of dominant themes and the nexus among them.

Quantitative Data: Close-Ended Questionnaires (Appendix B)

Data collection was conducted using a supervised self-completion questionnaire where respondents answered questions by completing it themselves. When this method is applied, as explained by Bryman (2018), the respondent does not interact with the researcher. Therefore, the questionnaire needs to have easy-to-follow designs to avoid mistakes.

The questionnaire constructed in this case (presented in Appendix b) had the objective to capture the opinions of the participants related to the likelihood of occurrence and impact of each one of the risks presented in Table 1, identified in section 2.3.4. The collection of this data (as thoroughly explained in section 4.2.2) facilitates a quantitative analysis of the contribution of the different construction risk factors to the general probability that the selected megaprojects will obtain the results expected by government decision-makers at the construction stage. It can be used, as in this case, to generate an analysis using Fuzzy Set Theory, which is helpful to compare risks of different kinds, both well-structured and ill-structured.

4.2 Proposed Analysis

4.2.1 Qualitative Strand: Narrative Analysis and Pattern Matching

Coding: Structural and Content Coding of Semi-Structured Interviews

The terminology used here is the following (see Guest et al, 2012: p. 3):

- Data: The textual representation of a conversation, observation, or interaction.

- Theme: A unit of meaning that is observed (noticed) in the data by a reader of the text.
- Code: A textual description of the semantic boundaries of a theme or a component of a theme.
- Codebook: A structured compendium of codes that includes a description of how the codes are related to each other.
- Coding: The process by which a qualitative analyst links specific codes to specific data segments.

Developing a codebook, while systematic, is an iterative process as well. A codebook is finalised when the last text has been coded.

This research used a combination of deductive and inductive methods and is expected to inform decision-making (see Guest et al 2012, p.17). It was initially centred in structural topics which were imposed by the research design, and concentrated on content themes that described what was observed or discussed in the context of the imposed research design.

The objectives presented elsewhere in this document, and the relative structure imposed by the interview guide gave the opportunity to segment the text based on the questions asked. The first step was "Structural Coding" as suggested by Guest (2012). For each topic of the "Interview Guide", both introducing questions and structuring questions were used as a basis of a structural code. Structural coding was used to identify the structure imposed on the qualitative data set by the research questions and design, and to explore the relationship between the questions asked and the elicited responses. Therefore, using the interview guide as a starting point, a set of structural codes was developed. They can be understood as the grounding constructs.

Subsequently, the second step was "Content Coding". Codes were developed for content/ themes, which described what was observed in the context of the imposed research design. Content codes were developed considering the previous well-identified theoretical constructs and are related to the relationships observed, given a set of the theoretical arguments generated. Thus, content coding was developed to deal with each of one of the following objectives. These objectives framed how the text was viewed and which themes were worth coding:

- To analyse how construction risk factors are related to contractual hazards (Theoretical Proposition 1)
- To study how contractual hazards can be managed using the construction contract (via contractual functions), given the formal institutional background (Theoretical Proposition 2)

- To explore how the approach to decision-making at the planning and appraisal stages can impact in the contractual hazards (Theoretical Proposition 3)

The first of the previous objectives was approached by both the quantitative and qualitative strand of this research. The quantitative strand enhanced the understanding of this particular aspect of the decision-making process. Specifically, it dealt with how the group of interviewees assessed the importance of the different risk factors and dimensions in each project.

For the qualitative strand, content was coded considering explanations that were similar. Repetition was the most common basis for grouping the text, given the potential explanations led by the theoretical propositions. Besides, other techniques used to identify themes were metaphors and analogies, transitions, comparisons and linguistic connectors (see Ryan and Bernard, 2003).

This section summarizes the theoretical logic behind the content codes that were used. It summarizes the theoretical arguments which emerged from the literature related to NIE, and were thoroughly explained in Section 2.6 of the Literature Review. They take relationships between constructs from patterns of association to theory. They are the boundary conditions that serve to clarify the scope of this research process, and also the domains to which it is likely to apply (Eisenhardt, 2021).

Subsequently, this section also shows the different codes finally used in the thematic analysis. For each code, the following elements are included: code label (short, descriptive mnemonic); short definition (20-80 characters); full definition (2-10 sentences); when to use (textual cues and context that signify thematic meaning linked to the code); when not to use (textual cues and context that signify thematic meaning linked to other codes). The NVIVO package was used to facilitate coding.

Description of Themes drawn from the Selected Social Science Framework

- Link between Construction Risks and Contractual Hazards

Given the characteristics of megaprojects, there is no consensus in specialised literature on construction management, specifically in the case of large-scale projects, when it comes to risk identification. Different concepts and approaches appear that generate a range of terminology, definitions and explanations about risk factors and dimensions. There is no consolidated risk identification model for megaprojects. On the contrary, as demonstrated by Sanchez-Cazorla & Alfalla-Luque (2016), there is a large number of variables and tools analysed and used.

Success in megaprojects can be evaluated in terms of outputs and intermediate/final outcomes, and the first issue that should be considered in order to develop a list of risk factors is what is the

potential result that would be affected by the materialisation of a particular risk. Although recognising that outputs may be contingent on and influenced by objectives in terms of outcomes, the focus of this document is the study of the risks associated with achieving output (construction) objectives, given the resulting transaction costs. Considering the construction contract, to be developed or already signed, it is expected that the project will be executed with the desired scope, at the scheduled time and within the projected cost.

Even if the previous restriction is used, the consolidation of a comprehensive group of construction risks is difficult because literature shows differences regarding the dimensions that may be used to classify the different risk factors. Discretionary, this thesis used the social, technical, environmental, economic and political dimensions (STEEP) proposed by Boateng et al. (2017), because it is presented as a more intuitive division, in the opinion of the author of this document, than the rest of the options presented in the academic literature.

Obviously, as Boateng et al. (2017) explain, there are interdependencies between these risk factors, and this is part of the complexity of working on this issue with this division. Thus, gathering the construction risks in megaprojects proposed by the literature, Table 1 included a list of risk factors based on STEEP axes.

With a NIE perspective, one could argue that the different risk factors included in the previous list could be translated into the contractual hazards listed in section 2.6.3: standard opportunistic behaviour, governmental opportunism, and third-party opportunism. According to Williamson (2002), considering the contract as the basic unit of analysis is a useful way to analyse contractual hazards. Quoting Brousseau (2008, p. 38): “The main problem dealt with by the economics of contracts is the control of hazards induced by the performance of transactions which are caused because the parties exchange promises to give (and receive in exchange) which, most of the time, are not fulfilled simultaneously but at moments when the parties agreed it would be mutually beneficial deal. The gap between the moment at which a promise is made and the time it has to be honoured generates risks because the reason that made parties likely to give what they promised may have changed”.

In this context, it is safe to theoretically propose that contractual hazards, in megaprojects, could be related to construction risks, which do not permit the parties to fulfil their obligations. This document studies how this actually happens in the selected MTPs.

- Link between Formal Rules and Contractual Functions

The NIE perspective can also be used to analyse the relationship between formal rules and contractual functions (detailed in section 2.6.5 – safeguard function, coordination function and adaptation function) in complex projects, such as MTPs. It is reasonable to theoretically propose that the formal "rules of the game" may affect the potential efficiency of the contract as they enable contracting and frame the context to assist in contract enforcement. According to Williamson (2000), formal rules are the legislation, the judiciary and bureaucracy.

Schwartz (2002) points out that the State should: "enforce contracts; police the contracting process for fraud and duress; supply parties with common vocabularies to use when writing contracts; and supply parties with governance modes for the conduct of transactions or the resolution of disputes" (Schwartz, 2002, p. 116). Consequently, imperfect institutions should affect contract design.

That is why, according to Brousseau (2008), a joint analysis between contracts and institutions as rules of the game is called for. Under this view, the reasonability of the use of the different contractual functions is expected to be related to the formal institutional background, which is very context specific. The rules of the game and the nature of the transaction vary from case to case, and the reasonableness of using contractual functions should be related to those rules. This document studies *how* this actually happens in the selected MTPs as well.

- Link between Planning/Appraisal and Risk Management

Therefore, considering the previous NIE approach, a final theoretical proposition was that there could be specific characteristics of megaprojects that could generate contractual hazards, and therefore transaction costs, that could be reduced using a "closed-systems" approach to planning and appraisal.

The special characteristics of MTPs which were presented generate the particular set of construction risks that megaprojects imply. Assuming that the link presented in 2.6.3 is actually happening, and this research can illustrate how risk factors are translated into contractual hazards in the selected cases, special transaction costs could be theoretically proposed for megaprojects as well.

Furthermore, if the relationship explained in 2.6.4 is also illustrated, and this research can elucidate the details related to the link between formal rules and contractual functions, it could also be theoretically proposed that, in the case of MTPs, the previous transaction costs are particularly related to the legislation, the judiciary and bureaucracy.

Under this NIE approach, consequently, the management of particular contractual hazards, related to special construction risks of megaprojects, could be one of the reasons behind the use of a "closed system" approach to planning and appraisal. This could be actually happening if the decision-makers, in the selected MTPs, perceive that the planning and appraisal approach employed prior to the commencement of the contractual negotiations is useful to reduce construction risks, contractual hazards, and therefore transaction costs.

It was here theoretically proposed that decision-makers could perceive that a "closed-systems" approach to project planning and appraisal is functional to reducing transaction costs at the contracting and executing stages of the project. This is related to the "rules of the game" in place (judicial, administrative and legal aspects of the system), which do not protect the interests of the contracting parties against some of these contractual hazards that have their origins in the pre-investment phase of MTPs' development. This document studied how this actually happens in the selected cases, with the following codebook.

Resulting Codebook

Table 2 - Structural Codes – Grounding Constructs

INTERVEIW TOPIC	Q#	Structural Code/Name	Structural Code Definition
Risk management with construction contract	1	RiskMwC	Brief Definition: Risk management with construction contracts Full Definition: The interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context, construction risks (social, technical, economic, environmental and political) "are managed" or "could be managed" with the construction contracts in different ways. When to use: Apply this code to all references regarding how risks were managed or would be managed by the construction contracts When not to use: Do not use this code for the link between construction risks and "rules of the game", and the link between construction risks and the planning and appraisal approach
Risk management with construction contract	1	RiskMwC-Soc	Brief Definition: Management of social risks with construction contracts Full Definition: The interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context, construction risks related to the social dimension "are managed" or "could be managed" with the construction contract in different ways. When to use: Apply this code to all references regarding how social risks were managed or could be managed by the construction contracts When not to use: Do not use this code for the link between social risks and "rules of the game", and the link between social risks and the planning and appraisal approach

Risk management with construction contract	1	RiskMwC-Tech	Brief Definition: Management of technical risks with construction contracts Full Definition: The interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context, construction risks related to the social dimension “are managed” or “could be managed” with the construction contracts in different ways. When to use: Apply this code to all references regarding how technical risks were managed or could be managed by the construction contracts When not to use: Do not use this code for the link between technical risks and "rules of the game", and the link between technical risks and the planning and appraisal approach
Risk management with construction contract	1	RiskMwC-Ec	Brief Definition: Management of economic risks with construction contracts Full Definition: The interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context, construction risks related to the economic dimension “are managed” or “could be managed” with the construction contract in different ways. When to use: Apply this code to all references regarding how economic risks were managed or could be managed by the construction contracts When not to use: Do not use this code for the link between economic risks and "rules of the game", and the link between economic risks and the planning and appraisal approach
Risk management with construction contract	1	RiskMwC-Env	Brief Definition: Management of environmental risks with construction contracts Full Definition: The interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context, construction risks related to the environmental dimension “are managed” or “could be managed” with the construction contract in different ways. When to use: Apply this code to all references regarding how environmental risks were managed or could be managed by the construction contracts When not to use: Do not use this code for the link between environmental risks and “rules of the game”, and the link between environmental risks and the planning and appraisal approach
Risk management with construction contract	1	RiskMwC-Pol	Brief Definition: Management of political risks with construction contracts Full Definition: The interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context, construction risks related to the political dimension “are managed” or “could be managed” with the construction contract in different ways. When to use: Apply this code to all references regarding how political risks were managed or could be managed by the construction contracts When not to use: Do not use this code for the link between political risks and "rules of the game", and the link between political risks and the planning and appraisal approach

Risk management with construction contract	2	ContractFun	Brief Definition: Contractual functions used in the construction contract Full Definition: Contracts have three main functions: coordination, control and adaptation. Coordination refers to the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. The control function is related to the need of each party to ensure that the activities carried out by their counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. The adaptation is related to the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. They can be correctly used or not, considering the previous risks When to use: Apply this code to all references regarding how contractual functions were used or could be used in the construction contract When not to use: Do not use this code for the link between contractual functions and the formal rules
Risk management with construction contract	2	ContractFun-Coor	Brief Definition: Coordination function used in the construction contract Full Definition: One of the main functions of the construction contract is the coordination function. It refers to the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. It can be correctly used or not, considering the previous risks. This function is usually specified by using clauses that establish roles and responsibilities, and also when using reporting clauses, clauses referring to the calendar or program of actions to be developed, and clauses for the appointment of people with particular qualifications in required tasks, among others. When to use: Apply this code to all references regarding how the coordination function was used or could be used in the construction contract When not to use: Do not use this code for the link between the coordination function and the formal rules
Risk management with construction contract	2	ContractFun-Con	Brief Definition: Safeguard or control function used in the construction contract Full Definition: One of the main functions of the construction contract is the control function. It is related to the need of each party to ensure that the activities carried out by their counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. It can be correctly used or not, considering the previous risks. It includes clauses to deal with: (i) property rights; (ii) confidentiality; (iii) service scope and performance guarantee; (iv) unilateral early termination; and (v) conflict resolution. When to use: Apply this code to all references regarding how the control function was used or could be used in the construction contract When not to use: Do not use this code for the link between the control function and the formal rules
Risk management with construction contract	2	ContractFun-Adap	Brief Definition: Adaptation function used in the construction contract Full Definition: One of the functions of the construction contract is the adaptation function. It is related to the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. It can be correctly used or not, considering the previous risks. This usually requires the presence of contractual clauses, for example, referring to price adjustments, value engineering clauses, clauses with procedures to address unexpected physical conditions and force majeure clauses, among others. When to use: Apply this code to all references regarding how the adaptation function was used or could be used in the construction contract When not to use: Do not use this code for the link between the adaptation function and the formal rules

Risk management with construction contract	3	ContractHaz	Brief Definition: Contractual Hazards of the construction contract Full Definition: The contractual hazards of the construction contract are: the standard opportunistic behavior which is related to asset-specific investments, which are linked to bounded rationality and idiosyncratic knowledge; the governmental opportunism, in the second place, which is associated with the ability of governments to opportunistically change the rules of the game; the third-party opportunism is related to public contract scrutiny, considering that the essence of public contracting is its publicity - this type of opportunism may be done by designated agencies, politicians, or other interested groups. In any given contract, one hazard may be more relevant that the others or not, and they could be correctly or incorrectly handled. When to use: Apply this code to all references regarding the relative importance of each hazard and the way they were handled When not to use: Do not use this code for the link between the contractual hazards and construction risks
Risk management with construction contract	3	ContractHaz-Id	Brief Definition: Idiosyncratic or standard opportunistic behavior Full Definition: The standard opportunistic behavior is related to asset-specific investments, which are linked to bounded rationality and idiosyncratic knowledge. This leads to transaction governance or contract designs in order to limit opportunistic behavior. This is possible, for example, by decreasing information asymmetries. When to use: Apply this code to all references regarding the relative importance of standard opportunistic behaviour When not to use: Do not use this code for the link between standard opportunistic behavior and construction risks
Risk management with construction contract	3	ContractHaz-Gov	Brief Definition: Governmental opportunistic behaviour Full Definition: The governmental opportunism the governmental opportunism, in the second place, which is associated with the ability of governments to opportunistically change the rules of the game. Governments may use standard governmental powers to extract quasi-rents from utility investors. or contract designs in order to limit opportunistic behavior. This is possible, for example, by decreasing information asymmetries. When to use: Apply this code to all references regarding the relative importance of governmental opportunism When not to use: Do not use this code for the link between governmental opportunism and construction risks
Risk management with construction contract	3	ContractHaz-3dP	Brief Definition: Third-party opportunistic behaviour Full Definition: The third-party opportunism is related to public contract scrutiny, considering that the essence of public contracting is its publicity - this type of opportunism may be done by designated agencies, politicians, or other interested groups. When to use: Apply this code to all references regarding the relative importance and management of third-party opportunism When not to use: Do not use this code for the link between third-party opportunism and construction risks

Contractual Risk Management and the institutional context	4	FormalRules	Brief Definition: Formal Rules relevant to the megaproject. Full Definition: The "rules of the game" proposed by the New Institutional Economics approach affect the potential efficiency of the contract as they enable contracting and frame the context to assist in contract enforcement. Formal rules, in particular, are those related to the executive, legislative, judicial, and bureaucratic functions of government, as well as the distribution of powers across different levels of government. When to use: Apply this code to all references regarding the relative importance of the formal rules of the game When not to use: Do not use this code for the link between third-party opportunism and construction risks
Contractual Risk Management and the institutional context	4	FormalRules-Leg	Brief Definition: The relevance of legislation for megaproject contracting and construction. Full Definition: The "rules of the game" proposed by the New Institutional Economics includes the legislation as it may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. When to use: Apply this code to all references regarding the relative importance of the legislation in the megaproject When not to use: Do not use this code for the link between legislation and contractual functions
Contractual Risk Management and the institutional context	4	FormalRules-Jud	Brief Definition: The relevance of the judiciary for megaproject contracting and construction. Full Definition: The "rules of the game" proposed by the New Institutional Economics include the judiciary as it may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. When to use: Apply this code to all references regarding the relative importance of the judiciary in the megaproject When not to use: Do not use this code for the link between the judiciary and contractual functions
Contractual Risk Management and the institutional context	5	FormalRules-P&B	Brief Definition: The relevance of the polity and bureaucracy for megaproject contracting and construction. Full Definition: The "rules of the game" proposed by the New Institutional Economics include the polity and bureaucracy, as executive power, which may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. When to use: Apply this code to all references regarding the relative importance of the polity and bureaucracy in the megaproject When not to use: Do not use this code for the link between the polity and bureaucracy, and the contractual functions
Planning approach and contractual hazards	7	PlanningApproach	Brief Definition: The planning approach used – an open system approach or a closed system approach Full Definition: An "open systems" approach to decision-making at the planning stage encourages an examination of the political, economic, social, environmental and institutional aspects that lie beyond the more technical and engineering boundaries of decision-making, in which a closed system approach is concentrated, when treating the project as an independent unit of analysis. When to use: Apply this code to all references regarding the planning and appraisal approach used When not to use: Do not use this code for the link between the planning and appraisal approach used and contractual hazard management

Table 3 - Content Codes – Relationships

INTERVEIW TOPIC	Q#	Content Code/Name	Content Code Definition
Link of Risk Dimension and Contractual Hazard, given the Formal Institutional Environment	1	LRHF-SocId	Brief Definition: Link between the social dimension of risk and idiosyncratic opportunism Full Definition: the social risk dimension may be translated in Idiosyncratic opportunism if legislation, judiciary or bureaucracy generate information asymmetries regarding: 1) impossibility of obtaining land and access rights; 2) compensations higher than expected; 3) protest and interference by residents; 4) claims by third parties; 5) costs of contractual disputes; 6) threats to the safety of personnel or assets; 7) vandalism; 8) involvement of many decision-making bodies When to use: Apply this code for those references to an actual or potential link between the social dimension of risk and the idiosyncratic opportunism. When not to use: Do not use this code for the relevance of social risk management or the importance of the idiosyncratic opportunism
Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRHF-SocGov	Brief Definition: Link between the social dimension of risk and the Governmental opportunism Full Definition: the social risk dimension may be translated in Governmental opportunism if legislation, judiciary or bureaucracy generate incentives for the government to change the rules given the: 1) impossibility of obtaining land and access rights; 2) compensations higher than expected; 3) protest and interference by residents; 4) claims by third parties; 5) costs of contractual disputes; 6) threats to the safety of personnel or assets; 7) vandalism; 8) involvement of many decision-making bodies When to use: Apply this code for those references to an actual or potential link between the social dimension of risk and the governmental opportunism. When not to use: Do not use this code for the relevance of social risk management or the importance of the governmental opportunism
Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-Soc3P	Brief Definition: Link between the social dimension of risk and the third-party opportunism Full Definition: the social risk dimension may be translated in Third-Party Hazard if legislation, judiciary or bureaucracy generate incentives for third parties (politicians, society, NGOs, etc.) to interfere given the risks of: 1) impossibility of obtaining land and access rights; 2) compensations higher than expected; 3) protest and interference by residents; 4) claims by third parties; 5) costs of contractual disputes; 6) threats to the safety of personnel or assets; 7) vandalism; 8) involvement of many decision-making bodies When to use: Apply this code for those references to an actual or potential link between the social dimension of risk and third-party opportunism. When not to use: Do not use this code for the relevance of social risk management or the importance of third-party opportunism

Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-TechId	Brief Definition: Link between the technical dimension of risk and the idiosyncratic opportunism Full Definition: the technical risk dimension may be translated in idiosyncratic opportunism if legislation, judiciary or bureaucracy generate information asymmetries regarding: 1) Engineering design (measurement errors on the site, conflicting interfaces between work items, inaccurate estimates, etc.); 2) Construction Management (poor quality construction plan, insufficient capacities in construction work, fall in the supply chain, etc.); and 3) Safety in Construction (insufficient protection of adjacent buildings and facilities, insufficient worker safety, etc.). When to use: Apply this code for those references to an actual or potential link between the technical dimension of risk and idiosyncratic opportunism. When not to use: Do not use this code for the relevance of technical risk management or the importance of idiosyncratic opportunism
Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-EcId	Brief Definition: Link between the economic dimension of risk and the idiosyncratic opportunism Full Definition: the economic risk dimension may be translated in idiosyncratic opportunism if legislation, judiciary or bureaucracy generate information asymmetries regarding: 1) Changes in funding vehicles; 2) Changes in the taxes; 3) Multinational sanctions; 4) General inflation; 5) inflation; 6) Changes in material costs; 7) Changes in the cost of energy; 8) Exchange rate; 9) Economic recession; 10) Economic effects of an environmental catastrophe; 11) Legislative or regulatory changes in financing When to use: Apply this code for those references to an actual or potential link between the economic dimension of risk and idiosyncratic opportunism. When not to use: Do not use this code for the relevance of economic risk management or the importance of idiosyncratic opportunism
Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-EnvId	Brief Definition: Link between the environmental dimension of risk and the idiosyncratic opportunism Full Definition: the environmental risk dimension may be translated in idiosyncratic opportunism if legislation, judiciary or bureaucracy generate information asymmetries regarding: 1) environmental risks due to construction (underground water filtrations, affectation of flora and fauna); 2) unfavorable weather conditions (heavy rain, windstorms and earthquake). When to use: Apply this code for those references to an actual or potential link between the environmental dimension of risk and idiosyncratic opportunism. When not to use: Do not use this code for the relevance of environmental risk management or the importance of idiosyncratic opportunism
Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-Env3P	Brief Definition: Link between the environmental dimension of risk and third-party opportunism Full Definition: the environmental risk dimension may be translated in third-party opportunism if legislation, judiciary or bureaucracy generate incentives for third parties (politicians, society, NGOs, etc.) to interfere given: 1) environmental risks due to construction (underground water filtrations, affectation of flora and fauna); 2) unfavorable weather conditions (heavy rain, windstorms and earthquake). When to use: Apply this code for those references to an actual or potential link between the environmental dimension of risk and third-party opportunism. When not to use: Do not use this code for the relevance of environmental risk management or the importance of third-party opportunism

Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-Pol3P	Brief Definition: Link between the political dimension of risk and third-party opportunism Full Definition: the political risk dimension may be translated in third-party opportunism if legislation, judiciary or bureaucracy generate incentives for third parties (politicians, society, NGOs, etc.) to interfere given: 1) political instability; 2) lack of political support; 3) war or regional conflicts; 4) opposition or political influence; 5) government discontinuity; 6) changes in the funding policy; 7) delays in obtaining approvals and permits; 8) lack of transparency and corruption; 9) Protectionism; 10) lack of regulatory adaptation; 11) Other unexpected legislative or regulatory changes. When to use: Apply this code for those references to an actual or potential link between the political dimension of risk and third-party opportunism. When not to use: Do not use this code for the relevance of political risk management or the importance of third-party opportunism
Link of Risk Dimension and Contractual Hazard given the Formal Institutional Environment	1 & 2	LRFH-PolGov	Brief Definition: Link between the political dimension of risk and governmental opportunism Full Definition: the political risk dimension may be translated in governmental opportunism if legislation, judiciary or bureaucracy generate incentives for the government to change the rules given: 1) political instability; 2) lack of political support; 3) war or regional conflicts; 4) opposition or political influence; 5) government discontinuity; 6) changes in the funding policy; 7) delays in obtaining approvals and permits; 8) lack of transparency and corruption; 9) Protectionism; 10) lack of regulatory adaptation; 11) Other unexpected legislative or regulatory changes. When to use: Apply this code for those references to an actual or potential link between the political dimension of risk and governmental opportunism. When not to use: Do not use this code for the relevance of political risk management or the importance of governmental opportunism
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-p&BCoor	Brief Definition: Link between the Polity and Bureaucracy (as formal rules) and the coordination function of the construction contract Full Definition: the polity and bureaucracy, as executive power, may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the coordination function works, which deals with the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. When to use: Apply this code for those references to an actual or potential link between the polity and bureaucracy, and the coordination function of the construction contract. When not to use: Do not use this code for the relevance of the polity and bureaucracy or the importance of the coordination function of the contract
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-p&BCon	Brief Definition: Link between the Polity and Bureaucracy (as formal rules) and the control function of the construction contract Full Definition: the polity and bureaucracy, as executive power, may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the control function works, which ensures that the activities carried out by their counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. When to use: Apply this code for those references to an actual or potential link between the polity and bureaucracy, and the control function of the construction contract When not to use: Do not use this code for the relevance of the polity and bureaucracy or the importance of the control function of the contract

Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-p&BAdap	Brief Definition: Link between the Polity and Bureaucracy (as formal rules) and the adaptation function of the construction contract Full Definition: the polity and bureaucracy, as executive power, may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the adaptation function works, which deals with the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. When to use: Apply this code for those references to an actual or potential link between the polity and bureaucracy, and the adaptation function of the construction contract When not to use: Do not use this code for the relevance of the polity and bureaucracy or the importance of the adaptation function of the contract
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-JudCoor	Brief Definition: Link between the Judiciary (as part of the formal rules of the game) and the coordination function of the construction contract Full Definition: the judiciary may affect the potential efficiency of the contract, by framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the coordination function works, which deals with the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. When to use: Apply this code for those references to an actual or potential link between the judiciary, and the coordination function of the construction contract. When not to use: Do not use this code for the relevance of the judiciary or the importance of the coordination function of the contract
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-JudCon	Brief Definition: Link between the Judiciary (as part of the formal rules of the game) and the control function of the construction contract Full Definition: the judiciary may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the control function works, which ensures that the activities carried out by their counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. When to use: Apply this code for those references to an actual or potential link between the judiciary, and the control function of the construction contract When not to use: Do not use this code for the relevance of the judiciary or the importance of the control function of the contract
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-JudAdap	Brief Definition: Link between the Judiciary (as part of the formal rules of the game) and the adaptation function of the construction contract Full Definition: the judiciary may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the adaptation function works, which deals with the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. When to use: Apply this code for those references to an actual or potential link between the judiciary, and the adaptation function of the construction contract When not to use: Do not use this code for the relevance of the judiciary or the importance of the adaptation function of the contract

Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-LegCoor	Brief Definition: Link between the Legislation (as part of the formal rules of the game) and the coordination function of the construction contract Full Definition: the legislation may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the coordination function works, which deals with the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. When to use: Apply this code for those references to an actual or potential link between the legislation, and the coordination function of the construction contract. When not to use: Do not use this code for the relevance of the legislation or the importance of the coordination function of the contract
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-LegCon	Brief Definition: Link between the Legislation (as part of the formal rules of the game) and the control function of the construction contract Full Definition: the legislation may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the control function works, which ensures that the activities carried out by their counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. When to use: Apply this code for those references to an actual or potential link between the legislation, and the control function of the construction contract When not to use: Do not use this code for the relevance of the legislation or the importance of the control function of the contract
Link of Formal Rules and Contractual Functions	1 & 2	LFRCF-LegAdap	Brief Definition: Link between the Legislation (as part of the formal rules of the game) and the adaptation function of the construction contract Full Definition: the legislation may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the adaptation function works, which deals with the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. When to use: Apply this code for those references to an actual or potential link between the legislation, and the adaptation function of the construction contract When not to use: Do not use this code for the relevance of the legislation or the importance of the adaptation function of the contract
Link Planning Approach and Risk Management	3	LPARM	Brief Definition: Link between the planning approach (open/closed) and risk/hazard management Full Definition: A closed system approach to planning could be used in the first stages of the project in order to start a construction risk/contractual hazard management process, given the formal institutional environment. When to use: Apply this code for those references to an actual or potential link between the planning approach and risk hazard management When not to use: Do not use this code for the relevance of the planning approach or the importance of risk management

The previous codes were applied to the transcriptions by only one researcher, the author of this thesis. Therefore, typical validation strategies used to ensure consistency between coders were not needed. On internal validation, this research used pattern matching logic, so it compares an empirically based pattern with a theoretically predicted one. Hence, internal validity is demonstrated if empirical and predicted patterns appear to be similar. Besides, to ensure external

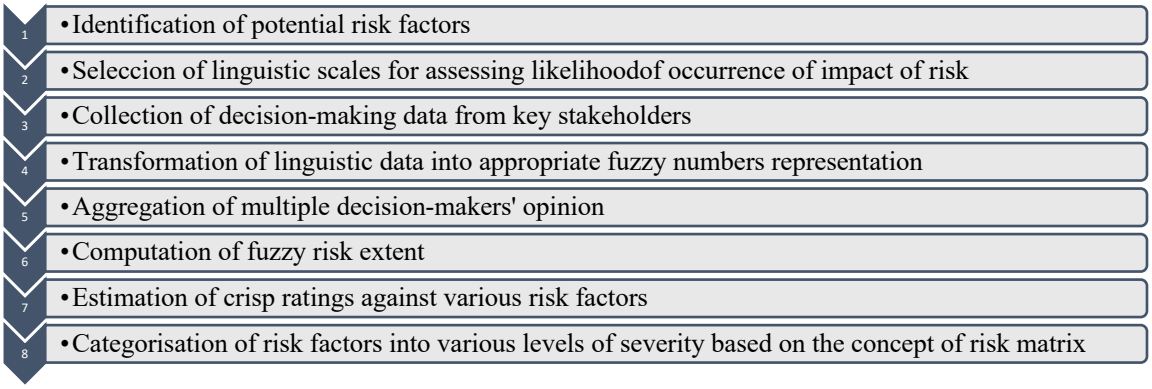
validity, this research used replication logic in the multiple-case study, as explained in Section 4.1.3 and 4.2.1 (see Yin, 2014).

Furthermore, on construct validity, this research used the coding process to tag text for retrieval. It was not intended to assign values such as frequency or amount of information. To justify construct validity, all the coded segments that were used to substantiate the existence of the theoretical constructs are presented as citations in Section 6.3, when making the arguments. Consequently, the chain of evidence has been maintained, allowing external observers to trace the steps, from conclusions back to research questions and vice versa (Yin, 2014) .

4.2.2 Quantitative Strand: Fuzzy Set Theory Application

The proposed approach involves a 7-step methodology as outlined in Figure 8 below (see Samantra et al. 2017).

Figure 8 – Steps for Risk Assessment Using FST



Step 1, the identification of potential risk factors and their respective STEEP dimensions, was explained in Sections 2.3.4 of the Literature Review and 4.1.4 of the Methodology, based on an extensive bibliographic review. The linguistic scale proposed in this study, is a standard form following Samantra et al. (2017) and is outlined in Table 4 as follows.

Table 4 – Linguistic Scales

Linguistic scale for quantifying likelihood of occurrence	
Likelihood of occurrence	***Linguistic Variable***
Expected to occur with absolute certainty	*Absolutely certain (AC)*
Much frequent to occur	*Very Frequent (VF)*
Likely to occur frequently	*Frequent (F)*
Likely to occur several times in the life of the operation	*Probable (P)*

Likely to occur sometime in the life of the operation	*Occasional (O)*
Unlikely but possible to occur sometime in the life of the operation	*Rare (R)*
So unlikely that it can be assumed that the possibility of occurrence is negligible	*Very Rare (VR)*

Linguistic scale for quantifying risk impact	
Impact of risk	***Linguistic Variable***
Very High	*VH*
High	*H*
Moderate	*M*
Low	*L*
Very Low	*VL*

Step 3 is explained in Section 4.1.3. Step 4 of this methodology refers to a computation of fuzzy preferences using fuzzy aggregation rules. Following Chen (2000) and Samantra et al. (2017), assuming a group of expert interviewees (E_t, $t = 1, \dots, k$), who are responsible for assessing the risks of n risk influencing factors ($F_{i,j}$, $j = 1 \dots, n$), under m risk dimensions (D_i, $i = 1, \dots, m$), the aggregated fuzzy preference of each risk influencing factors ($\tilde{F}_{ij}$), both for the probability of occurrence (P) and the potential impact (I), can be computed as follows:

$$\tilde{F}_{ij} = \frac{1}{k}\left[\tilde{F}_{ij1} \oplus \tilde{F}_{ij2} \oplus \dots \oplus \tilde{F}_{ijk}\right]$$

Then, the corresponding fuzzy risk rating of each individual risk factor can be obtained as follows:

Fuzzy risk rating = $(\tilde{F}_{ij})_P \otimes (\tilde{F}_{ij})_I$

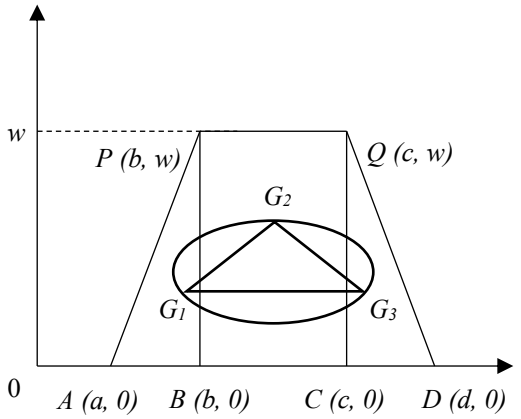
Several types of fuzzy numbers (membership functions) have been used in the past, such as triangular, trapezoidal and Gaussian, for translating the linguistic data into quantitative form. This research used trapezoidal fuzzy numbers, which is the most common class with a linear membership function. It has been extensively used given its intuitive mathematical representation and easy computation (see Chen, 1985; Chen & Chen, 2003; and Chen & Chen, 2009).

For the subsequent steps 5 & 6, referred to the use of a methodology to calculate sharp values, in this case the methodology proposed by Rao & Shankar (2011), adjusted by Samantra et al. (2017), is used for the assessment of construction risks. To order the fuzzy numbers, the method proposed by these authors is the circumcentre of centroids. The method provides a mathematical formulation for ranking the fuzzy numbers based on their crisp score.

Considering a trapezoidal fuzzy number, firstly, the trapezoid is split into three plane figures like a triangle, a rectangle, and then a triangle again. Then the centroids of these plane figures are

calculated followed by the calculation of the circumcentre of these centroids, which is considered as the reference point to define the ranking of generalised fuzzy numbers.

Figure 9 - Circumcentre of Centroids



number $\tilde{A}$=(a,b,c,d; w), the centroids of the three plane figures are the following:

$G_1 = ((a + 2b)/3, w/3)$

$G_2 = ((b + c)/2, w/2)$

$G_3 = ((2c + d)/3, w/3)$

Equation of the line $\overleftrightarrow{G_1G_3}$ is $y = w/3$ and G_2 does not lie on the line $\overleftrightarrow{G_1G_3}$. Consequently, G_1 , G_2 and G_3 are non-collinear and they form a triangle.

Let us define the circumcentre $S_{\tilde{A}}(\tilde{x}_0, \tilde{y}_0)$ of the triangle with vertices G_1 , G_2 *and* G_3 of the generalised trapezoidal fuzzy number $\tilde{A} = (a, b, c, d;\ w)$ as:

$$S_{\tilde{A}}(\tilde{x}_0, \tilde{y}_0) = \left(\frac{a + 2b + 2c + d}{6}, \frac{(2a + b - 3c)(2d + c - 3b) + 5w^2}{12w}\right)$$

As a special case, for triangular fuzzy number $\tilde{A} = (a, b, c, d;\ w)$, that is, $c = b$ the circumcentre of centroids is given by:

$$S_{\tilde{A}}(\tilde{x}_0, \tilde{y}_0) = \left(\frac{a + 4b + d}{6}, \frac{4(a - b)(d - b) + 5w^2}{12w}\right)$$

The ranking function of the trapezoidal fuzzy number $\tilde{A} = (a, b, c, d;\ w)$ which maps the set of all fuzzy numbers to a set of real numbers is defined as:

$$R(\tilde{A}) = \sqrt{\bar{x}^2{}_0 + \bar{y}^2{}_0}$$

$R(\tilde{A})$ is the Euclidean distance from the circumcentre of the centroids and the original point. This distance serves as a measure of the combined crisp risk rating between the interviewed agents.

As a robustness check, this research conducted the quantitative analysis using alternative membership functions (triangular and Gaussian) applied to the data obtained in the multiple case-study. While these exercises produced minor variations in some cases in the ordering of the top risks, they did not alter the substantive conclusions. For the sake of simplicity, clarity, and methodological consistency, the results presented in this document follow the proposed trapezoidal membership functions combined with the circumcentre of centroids method.

4.3 Summary

This Research Methodology chapter was organised as suggested by Crotty (1998), who describes four levels for developing a research study: 1) Paradigm Worldview; 2) Theoretical Lens; 3) Methodological Approach; and 4) Methods for Data Collection.

This thesis has used a pragmatic paradigm, using New Institutional Economics as the selected social science framework. A mixed-methods research design with a qualitative priority has been used to deal with the overall research aim and objectives proposed in Chapter 3, considering the nature of the research questions proposed.

The qualitative strand developed was a multiple-case study approach to examine how the formal institutional environment, at the pre-investment and investment stages, contributes to the selection of a "closed-systems" approach to MTP planning and appraisal in the selected cases. This was complimented by a quantitative strand in a secondary role to enhance the understanding of a particular aspect of the decision-making process: the construction risks assessment from the perspective of decision-makers.

5 Initial Description of the Selected MTPs

5.1 Ferroanel North Railway of São Paulo, Brazil[9]

5.1.1 Context

The rail system of the Metropolitan Region of São Paulo (MRSP) was implanted predominantly in the second half of the 19th century. Initially, it was destined to transport coffee production from the interior of the State towards the Port of Santos. Over the years, the cargo and passenger rail systems began to share the lines until, in view of the increased demand, preference was given to the transport of urban passengers, resulting in the transport of cargo by road.

Eighteen railroads were developed from 1867 to the 1930s and, of this total, half had a length of less than 100km. This rail network consisted, therefore, of branches for the collection of large and medium-sized companies' cargo. These railroads also became important means of transporting passengers. As a result, they played a relevant role in urban expansion in the State and in the consolidation of a structured network of cities.

Later, from the 1940s onwards, with the intense process of urbanisation in the country, railways became an important element of the urban transport system in the country's large metropolitan centres. For a certain period, due to the capacity of the tracks in front of the demand, it was possible to make the coexistence of the passenger and freight rail systems compatible in the MRSP.

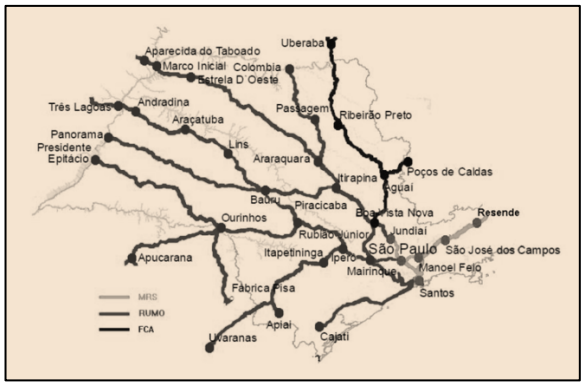
However, the significant increase in demand, passengers and cargo, led to preference being given to serving urban passengers. The transport of cargo, notably transit cargo (which has its origin and destination outside the MRSP), was absorbed by the road system which, despite not having ample capacity slack, had fewer restrictions for expansion than the rail system. Throughout the second half of the 20th century, the development of the road network in the State was remarkable, especially in terms of the access to the MRSP.

The institutional organisation of the sector has led to the separation of passenger and cargo transportation services into different companies. Currently, the São Paulo freight transport network is operated by the concessionaires MRS Logística S.A., Rumo Logística and Ferrovia

[9] Section 5.1 is based on the author's own faithful translation and adaptation of relevant technical background information related to the project presented in the Environmental Impact Assessment contracted by the Planning and Logistics Company (EPL) of Sao Paulo and the Highway Development Company (DERSA) of Sao Paulo.

Centro Atlântica (FCA); and urban transport is managed by Companhia Paulista de Trens Metropolitanos - CPTM.

Figure 10 - São Paulo Freight Railway Network



Source – EPL & DERSA (2017).

From the 2000s onwards, the saturation of the road system and the impact of cargo transportation on metropolitan and urban traffic led decision-makers to conceive a new logistics platform for the MRSP, with an increase in the participation of other modes, such as railways.

5.1.2 Planning and Appraisal Process

A Transport Development Master Plan was developed by the São Paulo State Secretariat for Logistics and Transport for the period 2000-2020. Among the proposals presented by this plan, two stand out: the implementation of infrastructure for cargo transport flows between the interior of the MRSP and the Port of Santos; and the reorganisation of flows with origin or destination in the region.

The proposed new logistics platform included the implementation of the Rodoanel (a 170 km highway to completely bypass the metropolitan region and to interconnect the ten highways that access the region); the Ferroanel (implementation of three railway segments to interconnect the existing railways and allow the metropolitan transposition), and the Integrated Logistics Centres – CLIs, which function is to allow intermodality and increase the efficiency of the intra-metropolitan cargo distribution system.

The Ferroanel, in the same way as the Rodoanel, aims to provide the MRSP with a perimeter track (in this case, a railroad track), with the function of overcoming the cargo-related bottlenecks in this region. As mentioned, MRSP's lanes are increasingly being used by urban passenger

transport, which restricts the capacity of cargo lines that access the Port of Santos from the Center-West Region of the country and from the entire interior of the State of São Paulo.

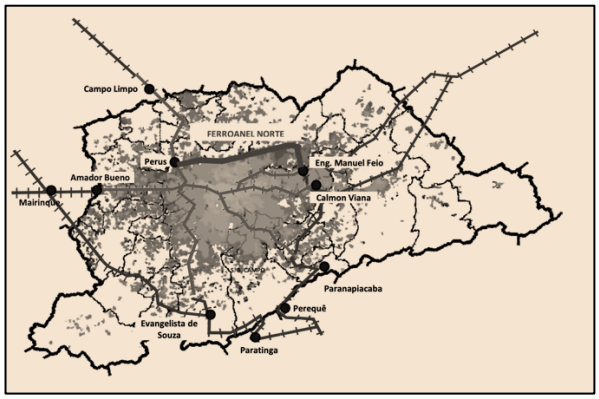
The Ferroanel (according to ANTT, 2012) was designed with three main branches (south, north and northwest) that interconnect railway sections located outside the densest urbanised area of the metropolitan region.

Figure 11 - Projected Ferroanel Branches

Source – EPL & DERSA (2017).

Ferroanel's north branch, called Ferroanel Norte do São Paulo (FNSP), was envisioned to replace the route of the line operated by MRS between the west and east areas of the metropolitan region (between Perus and Itaquaquecetuba). The use of this route for the transport of cargo is severely restricted by the modernisation of operating systems and the increase in the frequency of C'TM's urban trains. The segregation of freight and passenger lines between Suzano and Manuel Feio stations has been already carried out; the one between Perus and Campo Limpo Paulista stations is in the design phase.

Figure 12 - Location of the Ferroanel North Project



Source – EPL & DERSA (2017).

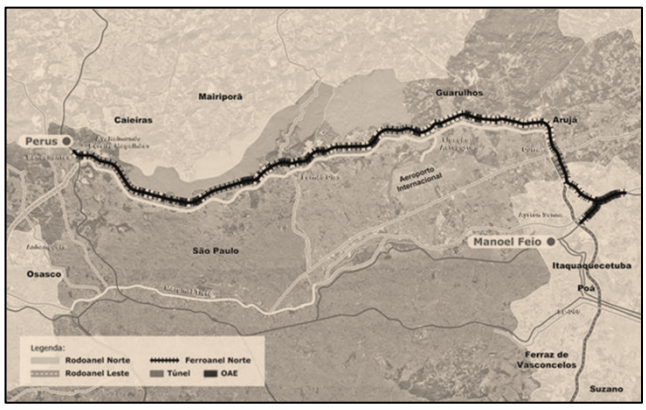
In 2015, Empresa de Planejamento e Logística (EPL – Federal company) and Desenvolvimento Rodoviário S/A (DERSA – State company) partnered to prepare an engineering project that would allow the federal government to budget and include the project in its concession program, as well as obtain the prior environmental license.

DERSA was chosen because of its experience throughout the planning and implementation process of the Rodoanel. The Environmental Impact Assessment (EIA) served as the basis for the environmental feasibility analysis of the project.

5.1.3 Technical Description

FNSP will be a 53 km long railway branch that will connect the stations of Perus, in São Paulo, and Manoel Feio, in Itaquaquecetuba, in an area contiguous to the route of the Rodoanel. Its implementation will make the freight trains that currently share the same tracks with the trains of CPTM to be diverted, eliminating the conflict between cargo and passengers.

Figure 13 - Ferroanel North Final Project



Source – EPL & DERSA (2017).

The new branch will allow the movement of cargo from the interior of the State to the Port of Santos, as well as the passage of trains between the interior and the Paraíba Valley. It will have the function of transferring cargo, currently transported by road, to the railroad mode. The projections indicate the medium-term withdrawal of 2,800 trucks/day from the roads, with a good chance that this number will surpass 7,300 trucks/day over time.

The migration of cargo from roads to railroads will relieve the São Paulo transportation matrix, which is currently stifled by the absolute predominance of trucks in the provision of this type of

service (currently over 80%). In addition, studies carried out indicate that about 40% of the trips destined to the transportation of cargo are made with empty trucks, as the companies are not always able to provide the service on the two ways. This heavy road movement converges primarily to MRSP and to the Port of Santos. The result is traffic saturation, where congestion is becoming more and more frequent.

The railroad will be deployed on a double track, with a gauge of 1.60m and a length of 4.25m, exclusively for the transport of loads on trains with diesel-powered locomotives. The permanent road will consist of monobloc prestressed concrete sleepers with a width of 280 cm (1,640 sleepers/km); TR68-type rails, with 240m welded rail extension and elastic fixation; 1:14 lane switching devices (AMV), Arena standard; and crushed stone ballast, with a minimum height of 30cm under the sleeper, minimum shoulder of 30 cm and slope 2V: 3H, or softer.

In this context, the basic objective of FNSP is to provide the articulation of the rail network in the MRSP, segregating the movement of cargo from the movement of passengers, in order to eliminate the interference between the two movements. Currently, this interference prevents the necessary expansion of both the passenger service and the cargo service, at the risk of compromising the two of them.

The use of a territorial strip adjacent to the Rodoanel will concentrate the disadvantages of territorial sectioning and associated environmental impacts on a single strip, thus focusing control efforts and reducing the total use of resources for these activities. Therefore, this was considered an exceptional opportunity to minimise the negative impacts resulting from this type of infrastructure.

The way the FNSP was conceived, connecting the Manuel Feio and Perus railway stations, allows for a future sequence to Jundiaí, enabling the connection of the regional rail network for cargo handling, the approach through the interior of the State of São Paulo, and the states of Minas Gerais, Mato Grosso, Mato Grosso do Sul and Goiás, not only with the Port of Santos, but also with the port sector of Rio de Janeiro, generating logistical service alternatives, mainly, international trade cargo.

As for the cargo sector, in addition to the benefits of logistics alternatives, with longer validation periods, the benefits of reducing the time involved in crossing the MRSP (basically the city of São Paulo) and eliminating costly operational manoeuvres (of disassembly and reassembly of railway compositions) are manifested directly and immediately.

Regarding passenger transport, which infrastructure currently needs to have its operating time shared in order to allow the movement of cargo, which increases the expenditure and frequency of maintenance activities of the railway superstructure, the benefits incorporate, in addition to a

relief in this maintenance, the possibility of implementing a project to expand service capacity, with a reduction in the interval between compositions and improvement in passenger service.

As for the relief of the already highly requested access road system to the metropolitan region (notably to the city of São Paulo), the strategic importance of the FNSP can be verified by comparing cargo demands with routes passing through the MRSP, captured by the rail system, in situations without and with its existence.

The funds for the construction of the FNSP will come from the grant amount of the anticipated extension of the MRS concession contract. The investment is expected to cost approximately USD 1 billion, and the project is expected to be developed in 48 months, once the construction has formally started. On January 29, 2019, a Memorandum of Understanding (MoU) was signed between the Ministry of Infrastructure and the Government of the State of São Paulo, with the purpose of encouraging mutual collaboration, making the best efforts for the construction of the project.

5.2 Central Railway Project, Uruguay[10]

5.2.1 Context

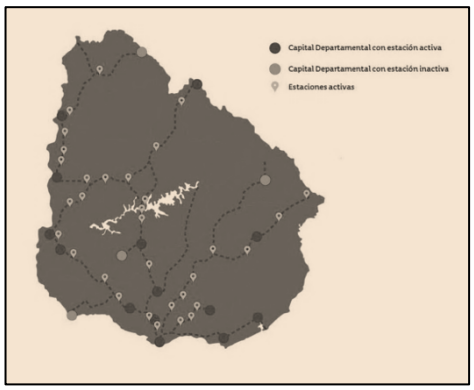
The Railroad in Uruguay began to operate between 1867 and 1869, and spread throughout the country as the main means of transportation in the last decade of the 19th century. Many of the current structures, works of art (culverts, bridges, etc.) and even rails and sleepers are, in different sections of the railroad, from the late 19th and early 20th centuries. The design of the system also dates back to the 19th century and was conceived radially and with the purpose transporting goods from rural areas towards the port of Montevideo (MTOP 2018, own translation).

In particular, the corporation "Ferrocarril Central del Norte" was founded in 1866 with national capitals beginning its operation on January 1st, 1869, with a section of 17 km. However, as it was not economically sustainable with local management, English capitals entered the company. In 1874, for the first time, the railway connected the cities of Montevideo and Durazno with a route of 205 km. Subsequently, in 1878, the railway became a property of a British company called The Central Uruguay Railway and, decades later, after the World War II, this company was acquired by the Uruguayan State as a payment from the British Government to honour the debts that Britain had with Uruguay (MTOP 2017, own translation; AFE, n.d.).

[10] Section 5.2 is based on the author's own faithful translation and adaptation of technical background information related to the project presented in several sources cited at the end of each paragraph.

After decades of abandonment of the railroad infrastructure in the country, the network, before the project here analysed, had an extension of 1,652km in operation, and a fleet of 52 main line locomotives and 764 wagons. It connected with the Argentine networks through the El Precursor branch, over the Salto Grande Dam, which links the city of Salto and Concordia with the same gauge in both countries, and with Brazil at the Rivera-Livramento Border Crossing, with a different gauge, although technology currently allows to solve this difference in the width of the road. Approximately 35 million tons are moved annually in Uruguay by land transport, of which 60% correspond to bulk and wood. Less than 1% is transported by rail, the vast majority by truck (Uruguay XXI, 2017; AFE, 2015).

Figure 14 - Uruguay's Rail Network



Source: Uruguay XXI (2018)

The institutional framework of the railway system is currently made up of the following organisations: the Ministry of Transportation and Public Works (MTOP) is responsible for designing, executing, and controlling the national policy regarding the mode; the National Railway Transport Directorate (DNTPF), on the other hand, is a decentralised entity, dependent on the MTOP, which main function is to regulate the system. In addition, there is a Railway Accident and Incident Investigation Body (OIAF), which mission is to investigate the causes of accidents and incidents, and determine responsibilities, acting with technical autonomy, submitting reports to the MTOP and DNTPF (Uruguay XXI 2017, MTOP 2018, own translation).

At the same time, the State Railway Administration (AFE) is the autonomous entity in charge of building, modifying and maintaining the national railway infrastructure, and exercising as infrastructure manager. By virtue of its powers, it can delegate or agree on the performance of works and the provision of rail services. In addition, the figure of Railway Operator refers to those entities which main activity consists of providing passenger and/or freight transport services by rail and that have a Railway Operator License issued by the DNTF (Uruguay XXI 2017, own translation; MTOP, 2018).

Within this institutional framework, the Uruguayan railway has just over 3,073km of standard gauge lines (1,435 meters), almost all of which are single track (Uruguay XXI, 2018). The network has 1641km in operation and, of these, only a part has a level of use of some entity.

In parallel, the rolling stock in Uruguay is generally scarce and old, with high accumulated maintenance liabilities, which means that the effectively available fleet is considerably less than that inventoried. There were 25 units in 2018, of which only 10 were available, and 2 locomotives had been added for manoeuvres. Besides, by the same year, the fleet of operating wagons in the system comprised approximately 628 units. It was generally old equipment, with a great lack of uniformity in its type (Uruguay XXI 2017, own translation).

5.2.2 Planning and Appraisal Process

In 2005, the Finnish multinational company UPM installed its first cellulose pulp plant on the banks of the Uruguay River in the department of Río Negro, promoting forestry monoculture. Since 2018, the process of installing its second eucalyptus pulp plant with a capacity of 2.1 million tons has been underway in the North of the Department of Durazno, a few kilometres away from the Negro River (OPP, 2017; Uruguay XXI, 2017).

The contract for the second plant, between Uruguay and UPM, was signed in 2017, establishing a series of rights and obligations for both parties that have generated much controversy at the sociopolitical and economic level due to the concessions that were made: Uruguay was expected to develop the Central Railway Project, a viaduct project on the Rambla de Montevideo, road projects, dredging in charge of the National Ports Administration (ANP), electricity works and any other project in accordance with the contract. UPM, on the other hand, agreed to carry out the Pulp Mill Project and, at UPM's choice, a captive electric power generation plant, a chemical plant, a Free Trade Zone of the Pulp Mill Project and other necessary facilities (OPP, 2017; Uruguay XXI, 2017).

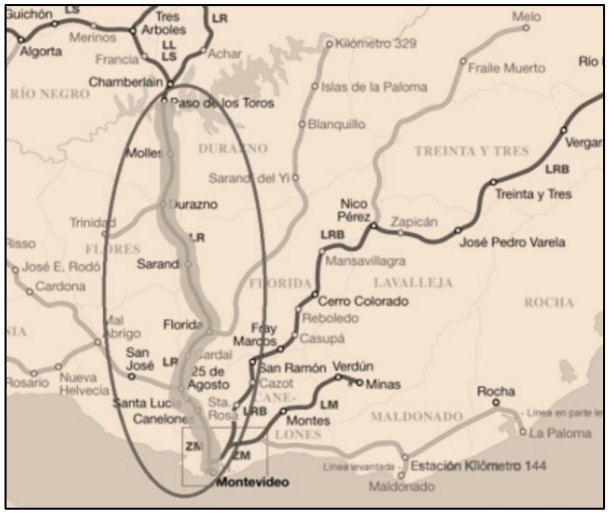
Therefore, Ferrocarril Central was a project promoted by the Uruguayan government and emerged as a priority because it was a necessary condition for the transport of cellulose pulp from the future second plant of the Finnish forestry company UPM, the UPM 2 plant. The project was announced on August 15th, 2017, in the second administration of former President Tabaré Vázquez (2015-2020). After almost 2 years of pre-investment studies, the works began on May 31st, 2019. The MTOP, through an agreement signed with AFE, is in charge of the execution of this project, and decided to develop it as a PPP (OPP, 2017, Uruguay XXI, 2017).

This PPP includes the design, construction, funding, refurbishment and maintenance of the 273-kilometer (km) railroad. Grupo Vía Central Consortium, which comprises the companies NGE (France), Sacyr (Spain), Berkes (Uruguay) and SACEEM (Uruguay), has been awarded the international public tender for the construction and maintenance of the new railroad (OPP, 2017, Uruguay XXI, 2017).

5.2.3 Technical Description

The project entails the construction of a railway section that connects the Port of Montevideo with the city of Paso de los Toros, applying the highest safety standards based on technical specifications of the European Community. It is a Linear Project; its geographical location is defined mainly by the longitudinal component of the project or layout, which is located in the central-southern area of the country (MTOP, 2017, Uruguay XXI, 2017).

Figure 15 - The Central Railway Project



Source: Sacyr Infraestructuras

The railway line, with a clear S-N orientation, crosses mostly rural areas, and specifically district capitals (Canelones, Florida, Durazno) and some localities (La Paz, Las Piedras, Progreso, Sarandí Grande, Santa Lucía, Carlos Reyles, among others), in many sections following the geometry of Route 5 that connects Montevideo with Paso de los Toros. The suburbs of Montevideo and the district of Canelones are located in the southern area of the railway line. These areas are the most anthropised, with large sections destined to rain-fed and irrigated agriculture, and lands destined to horticulture and fruit production. At the limit between the Canelon–s - Florida districts, the railway crosses the Santa Lucía River, which is part of the basin of the De la Plata River and its Maritime Front. The area associated with the central part of the

railway has less farmland and more land dedicated to livestock grazing and dairy farms. To the north, in the Negro River basin, extensive livestock farming predominates (IDB Invest, 2019; MTOP, 2017).

The project covers the mentioned section of railway, with an approximate length of 273 km. Different interventions and modifications to the existing route will be developed in this section, such as rectifications and diversions, which will modify the current length of the railway, reducing the connection distance between both points (the Port of Montevideo and Paso de los Toros Station) by approximately 10km (MTOP, 2017).

It is estimated that the railroad will transport 8 million tons of gross cargo per year, of which 4 million tons will be of pulp, when it operates continuously 365 days a year. The other 4 million is estimated to be related to the transportation of several products such as grains, livestock, and containers, especially considering the connection with the dry port of Rivera and through this with Brazil. In general terms, the Central Railway project (CRPU) is expected to be a central part of the country's competitiveness policy, through which it is expected that Uruguay increases its potential as a Logistics Hub (MTOP, 2017; MTOP & Uruguay XXI, 2018).

Fifteen freight trains with a maximum length of 800 meters are expected to run daily in each direction of the railroad, as well as 9 passenger trains in each direction, which are expected to connect Montevideo with the locality of 25 de Agosto. The expected trains will run at a maximum speed of 60 kilometres per hour (km/h) between Montevideo and Las Piedras, and 80 km/h between Las Piedras and Paso de los Toros. The cargo capacity will increase from the current 18 ton axle load (ton/axle) to 22.5 ton/axle (MTOP, 2017; MTOP & Uruguay XXI, 2018).

The main works include: i) change of tracks, crossties and renovation of existing civil structures (such as slopes, bridges, culverts, etc.); ii) improvements in the geometry of the track layout involving the construction of detours to population centres; iii) trench crossing works in several towns to avoid cross-track crossings; iv) new double track for passenger transportation; v) track renewals; vi) new signalling and traffic control system, including an automatic protection system for trains and interfaces with connecting tracks; vii) construction, reconstruction or reinforcement of bridges; viii) tunnelling of roads and highways; ix) the installation of acoustic screens in noise-sensitive sites; and x) fencing of the railway strip along the entire route (MTOP, 2017; MTOP & Uruguay XXI, 2018).

Besides, the project will include the improvement of stations and passenger transport service between Montevideo and Progreso and the construction of 32.5km of new maintenance access roads. However, due to corrections in the layout and detours of population centres, it will also

imply the expropriation of 642 registers, as well as the demolition and involuntary displacement of 40 homes and various facilities (MTOP, 2017).

In this context, the objectives of this infrastructure are: 100% track availability; a rail system with a useful life of at least 50 years; safe and disturbance-free trains and tracks; increase the current load capacity of the tracks to 22.5 tons per axle (currently 18 ton/axle) with a maximum circulation speed of 80 km/h for freight trains (currently 40 km/h); and a railway system built with new materials, equipment and systems (MTOP, 2017).

Regarding traffic criteria, the project has the following expectations: the annual amount of cargo between Paso de Los Toros and the Port of Montevideo will be 4 million tons; transit time is expected twenty-four (24) hours/day and three hundred and sixty-two five (365) days/year; the infrastructure allows for a feasible standard train schedule for freight trains 15 + 15 between Montevideo - Paso de Los Toros with train speed of 60-80 km/h; the infrastructure allows passenger traffic of 2 trains/hour in one address between Montevideo and Progreso, or whatever the DNTF–authorizes; the average maximum length of the train of eight hundred (800) m; UPM rail operator and other rail operators may use infrastructure at the same time; there will be no manoeuvring movements on the main line, only on the locomotive; all trains and rolling stock must meet the requirements defined in the Maintenance Rules (MTOP, 2017).

The estimated period for the construction of the project was 33 months. The original estimated cost of the project was USD 1070 million. Once the work is completed and the railroad has been delivered to the MTOP, the Vía Central Group will receive an availability payment of USD 406 thousand per day until June 24, 2037 (MTOP, 2017).

5.3 Line 1 Metro of Bogota, Colombia.[11]

5.3.1 Context

In the last 20 years, the population of Bogotá has increased by 40%. This demographic growth and related economic activities made it the fourth most dynamic city in Latin America in the next decade. Bogotá alone concentrates 25% of the country's Gross Domestic Product (GDP), and its transportation system, a determining factor for economic development and quality of life, faces great challenges due to population growth, high motorisation and urbanisation.

[11] Section 5.3 is based on the author's own faithful translation and adaptation of relevant technical background information related to the project presented in the Inter-American Development Bank's loan proposal and project profile (IDB, 2018a; IDB, 2018b), as well as in the official history published by Empresa Metro de Bogotá (n.d)

Bogotá was one of the first Latin American cities to propose an Integrated Public Transport System (SITP) for passengers. In 1998, the city proposed a network of high-capacity subways and trunk bus corridors. Given the country's fiscal situation at that time, only high-capacity buses were chosen, specifically the Transmilenio project, based on Bus Rapid Transit (BRT), as a low-cost, high-impact solution.

Other mobility efforts made by the district authorities (increase in the gasoline tax, restrictions on the use of private cars, control of vehicle emissions, better pedestrian sidewalks and bicycle lanes) have made public transport the main mode of transportation in Bogotá. In 2015, of the nearly 12.5 million daily trips, 5 million (45%) were carried out in this mode. Meanwhile, motorcycle and automobile trips participate with 24% of the daily total.

Despite the district's public transport policies, its use between 2005 and 2015 fell by 12% in modal share. The lack of expansion of the public transport offer contributed to these trips being replaced by non-motorised trips and trips in private transport. Between 2007 and 2016, the economic and population growth of Bogotá generated an increase of 81% in private vehicles and 308% in motorcycles, which deteriorated the conditions of mobility and public transport service, generating high levels of saturation and an increase in travel time.

The impairment in mobility generates high levels of saturation that affects the degree of satisfaction of the public transport user, which has fallen from a satisfaction level of 4 to 2.6. In terms of accessibility, the mobility survey reports that the travel rate of people with disabilities did not change compared to 2011, an aspect that may be partially related to the deterioration and loss of capacity of the PT network. The increase in the rate of motorisation has also contributed to the deterioration of air quality. In 2015, more than 2,400 deaths from respiratory and cardiovascular causes in the city of Bogotá were associated with air pollution by particulate matter. The emissions inventory reports that vehicles emit 99.9% CO_2 emissions, 96% NOx and 84% SO_2. Likewise, the city emits 10.6 million tons of CO_2, equivalent to 6% of the country's total emissions, of which the transport sector contributes with 61%.

5.3.2 Planning and Appraisal Process

Debates over the construction of a metro system in Bogotá have spanned several decades, consistently linked to the structural deficiencies of a bus-dominated transport system. As far back as the 1960s, overcrowding on conventional buses was so severe that passengers clung to doors, while the introduction of smaller vehicles such as microbuses eventually led to a fragmented and oversupplied system.

By the 1980s, planners began to look at alternatives, including trolleybus corridors, but the metro increasingly stood out as the long-term solution. Despite this, local administrations alternated between emphasizing bus-based improvements and deferring the metro, illustrating enduring tensions between financial feasibility and long-term aspirations.

The 1990s brought the first significant institutional commitments to a metro line, though these proved short-lived. The focus continued to shift back toward bus rapid transit, seen as more affordable and faster to implement. By 2005, the metro remained unbuilt: a recurrent objective of urban transport policy, repeatedly reinserted into planning debates yet consistently deferred by fiscal constraints and shifting institutional priorities. During this period, however, the groundwork was laid for a more integrated vision of urban mobility, with the metro increasingly framed not as a stand-alone project but as part of a multimodal transport system.

From the 2000s onward, steps were taken to move beyond discussion. Initial land acquisitions were undertaken even as the city expanded its bus rapid transit network, and the 2006 Master Mobility Plan formally embedded the metro within a broader multimodal framework. Subsequent years were marked by cycles of technical design, revisions, and adjustments in response to macroeconomic volatility, culminating in the adoption of an elevated alignment as a more cost-effective solution.

The creation of the Bogotá Metro Company in 2016 and new financing agreements with the national government finally gave the project firm institutional backing. By the end of the decade, these measures marked the clearest sign yet that Bogotá’s long-awaited metro was closer than ever to becoming a reality.

The 2016-2019 District Development Plan "Bogotá Better for Everyone" included the "Better Mobility for Everyone" program, in which the structuring axis is the Public Transport Integrated System (SITP), made up of Transmilenio (the BRT system of the city) and the First Line of the Bogotá Metro (L1MB). For this reason, the National Council for Political and Social Economy (CONPES), in its document CONPES 3900, declared the first line of Bogotá Metro (L1MB) as strategic. Its objective is to achieve a comprehensive solution to Bogota's transportation system.

At the pre-investment phase of this project, eight options of track lengths, both with elevated and underground sections were compared. Several studies evaluated these alternatives in terms of typologies and costs, considering construction, financial requirements, environmental and urban impact, among others.

The analysis concluded that an elevated line would generate investment savings of USD 61 million/km, would have operating costs 28% less than the underground one (since it does not

require mechanised ventilation, or pumping for water extraction and only night lighting). Besides, it would present fewer construction risks and the works could be executed in less time.

The alternative finally selected is a viaduct metro that runs along the strategic road axes in the southwest of the city, connecting with the Transmilenio route on Avenida Caracas between Roads 1a and 729, which is the corridor with the highest demand in city, where a large part of the services and jobs are concentrated. In this corridor, the metro will act as a line with greater capacity and regularity, while the Transmilenio trunk will complement the metro for short trips and/or to the final destination of the trip.

Figure 16 - L1MB Project Final Route

Source: Alcaldía de Bogotá

This option will also allow Transmilenio to recover the level of service. Likewise, the design of the metro includes the redesign of the urban space along the corridor and around the stations, consistent with a sustainable transport-oriented strategy which will prevent the deterioration of public spaces under the viaduct or surrounding areas.

The District authorities created the Bogotá Metro Company S.A. (EMB), a public limited company with 100% public capital. In 2014, the Urban Development Institute (IDU) and the FDN signed the Inter-Administrative Agreement 1880 of 2014, which aims to unify efforts for the development of activities related to the comprehensive structuring of the L1MB project. In 2016, within the aforementioned agreement, the IDU ceded its contractual position to the EMB.

5.3.3 Technical Description

The L1MB will have 16 stations in 24 km, 10 of which interconnected with Transmilenio. The selection for the location of the stations was carried out jointly with the District Planning Secretary, the District Secretary of Mobility, and Transmilenio to promote urban renewal.

Figure 17 - L1MB Project Stations

Source: IDB Document – Project Profile - CO-L1234

The layout of the metro is the product of an analysis carried out in 2010 that determined that the first line should pass through some of the most populated sectors with the greatest transport needs in the city. The L1MB will mobilize 72,000 passengers per hour/direction (more than one million passengers per day), directly benefiting the inhabitants of 78 neighbourhoods in 9 localities.

The structure of the viaduct will be earthquake resistant and will have a height of 13.5 meters (at rail level), depending on the conditions of the road and the existing infrastructure. As a result of the complementary works, Bogotá will gain 1.4 million square meters renovated and generated public space, including platforms, separators, squares, bike paths and roads. The 140 m long and 2.9 wide trains will have six or seven wagons, with a capacity for 1,800 people, and will operate in an estimated interval of 180 seconds during peak hours at the start of the operation.

Moreover, the metro's electric train technology is expected to reduce approximately 36,000 tons of CO2, which is a major Greenhouse Gas (GHG), and local pollutants by approximately 4,400 tons of CO, 1,150 tons of NOX, 71 in PM10 and 70 in PM2. These reductions are expected to increase the well-being and health of the population. Empirical evidence reports that, after two years of operation, Transmilenio achieved a reduction in CO2 emissions equivalent to 82,128 tons (CO2 equivalent vehicle/km).

The total cost of the L1MB and the trunks amounts to approximately USD 6,620 million, of which it is estimated that the trunks will cost USD 2,220 million. The District Development Plan includes these trunks, the designs of which are being carried out. The financing scheme is being defined by Bogotá Distrito Capital and Transmilenio. According to estimates, the total cost of the technical structuring amounts to USD 4,400 million.

Section 1, fully financed by the State, the District and the multilateral bank, will go from Portal Américas to Caracas Avenue, along Villavicencio Avenue, Primero de Mayo Avenue, South 8th Street and 1st Street, where it will turn north along Caracas Avenue to 78th Street. The almost 24 kilometres of the route include a technical branch, between the workshop patio and the first station, and a section for return manoeuvres on Caracas Avenue between 4th and 78th Streets.

In February 2019, seven international groups made their requests official to participate in the public tender to build and operate the first line of the Bogotá metro. On June 28th of the same year, the Mayor of the city, together with the President of Colombia, officially opened the international tender to select, among the 6 consortia that were approved, the one in charge of building and operating the L1MB. In August 2019, five of the consortiums remained on the list of participants in the tender, after publishing the internal recomposition requirements at this stage of the tender. On October 3, the date on which the international tender was closed, two consortiums were finally presented: «Metro de Bogotá», a consortium composed in its majority of Mexican capital, and "APCA Transmimetro" of Chinese capital. Finally, on October 16th, 2019, the tender was awarded to the group "APCA Transmimetro".

The L1MB will be the backbone of the PT system in the city which, together with the investments and integration of new and existing trunk lines, will allow the offer to be increased and diversified, reducing travel times on public transport. This integration of routes and the metro will benefit more than 3.6 million inhabitants of the communities of Soacha and the South of Bogotá who currently find the transport offer insufficient. It is estimated that the comprehensive project mobilizes 990,000 passengers every day; 656,000 for the PLMB and 334,000 for the trunk lines.

Around 2.92 million inhabitants (mostly low- and middle-income) will benefit in the area of influence of the project the towns of Kennedy (with a high population density), Puente Aranda, and Antonio Nariño (western section). The population in the eastern corridor will connect with the expanded centre, where there are services, job offers and a considerable number of government entities, among which the Mayor's Office and the Palace of Nariño stand out. The PLMB will allow travel at more than 40 km/h (more than double the current average speed). The stations will be equipped with privileged pedestrian and bicycle lanes, which are estimated to be used by approximately 180,700 people.

5.4 Summary

The three projects have been planned as a result of the economic needs of the different countries. The information reviewed shows that the three MTPs have been envisioned as technical artifacts that need to be develop to solve the demand for transportation services related to cargo and passengers.

The planning and appraisal process shows a "closed-systems" approach to decision-making, with a hard thought system, by which different alternatives have been studied in the context of a stage gate approach used in the pre-investment process. There were no formal methodologies to include

different stakeholders in the planning process. Technical descriptions were therefore developed considering a technocratic view of the problem that each one of the MTPs are supposed to solve.

This “closed-systems” approach has avoided a consistent participation of the different stakeholders involved, and the most persistent characteristics of the megaprojects, including their complex and organic nature, have been eluded as well.

6 Findings

6.1 Chapter Overview

This chapter presents the findings resulting from the application of the mixed method research design proposed in Section 4, after understanding the context of the selected MTPs, which were illustrated in Chapter 5.

Section 6.2 presents the results of the application of the quantitative strand of this research, expected to help to understand how decision-makers perceive that risk factors and dimensions contribute to the general risk of the selected MTPs.

Section 6.3, subsequently, presents the results of the application of the qualitative strand, dividing them based on the qualitative questions detailed elsewhere in this thesis. Firstly, the results of the analysis of decision-makers' perception regarding the link between construction risks and contractual hazards is reported in Section 6.3.1. Then, the results of the analysis regarding their view on the link between formal rules and contractual functions is offered in Section 6.3.2. Finally, section 6.3.3 shows the results of the analysis of their view on the role of the planning and appraisal process for transaction cost economising.

6.2 Quantitative Data Analysis and Results[12]

6.2.1 Contribution of Risk Factors to Overall Construction Risk

The questionnaires presented in Appendix B were completed by 8 experts working on the development of Ferroanel Norte from São Paulo (FNSP), 8 experts working on the development of the Central Railway Project of Uruguay (CRPU), and 11 experts in the case of Line 1 of the Metro of Bogota (L1MB). Experts were identified by IDB specialists and project counterparts, in each one of the countries, considering their experience and their familiarity with the characteristics of the projects and context. The data obtained from these questionnaires was analysed via the mathematical processed outlined in methodological steps 4 to 7 (section 4.2.2).

Following the proposed methodology, the full outputs from the FST are presented in Tables C1, C2 and C3 in Appendix C. As a result of the analysis, Table 5 below shows the 10 most relevant risk factors in the case of the FNSP, Table 6 shows the 10 most relevant risk factors in the case

[12] Section 6.2 draws on aspects of research undertaken by the author during his PhD studies both at the Bartlett School of Planning at University College London and employment, as an external consultant, at the Inter-American Development Bank. It is based on the following papers, originally published by the Inter-American Development Bank and the Journal of Mega Infrastructure and Sustainable Development: Alberti, J. (2021, 2022).

of the CRPU, and Table 7 shows the 10 most relevant risk factors in the case of the L1MB. The X on the side of some of the risk factors indicates those that are ill-defined in nature, and non-quantifiable by traditional statistical methods. Ergo, it shows the importance of using FST in complex projects such as the selected MTPs.

Table 5 – Ferroanel North, São Paulo – Top 10 Risk Factors

TOP 10 Risks	Risk Ranking
Lack of political support/Political indecision	1X
Involvement of many decision-making bodies	2X
Lack of transparency and corruption	3X
Economic recession	4
Changes in funding policy	5
Compensations higher than expected	6
Changes in material costs	7
Heavy rain	8
Government discontinuity	9
Opposition or political interference	10X

Table 6 – Central Railway Project, Uruguay – Top 10 Risk Factors

TOP 10 Risks	Risk Ranking
Changes in project scope requirements	1
Involvement of many decision-making bodies	2X
Delays in obtaining approvals and permits	3
Inaccurate estimates of project cost	4
Other changes in the engineering design of the project	5
Lack of human resources for the development of the works	6
Inappropriate design due to lack of technical capabilities	7X
Insufficient capacities in construction work	8X
Protests and interference by residents	9X
Costs of contractual disputes with contractor	10

Table 7 – Metro Line 1, Bogotá, Colombia – Top 10 Risk Factors

TOP 10 Risks	Risk Ranking
Government discontinuity	1
Delays in obtaining approvals and permits	2
Exchange rate	3
Involvement of many decision-making bodies	4X

Opposition or political interference	5X
Protests and interference by residents	6X
Special Conditions on the site	7
Inaccurate estimates of project cost	8
Costs of contractual disputes with contractor	9
Lack of updating or regulatory adaptation	10X

In terms of risk dimensions, it is also necessary to make a specific remark regarding the methodology proposed in this thesis. Without delving into the data, the mathematical calculations give equal weight to all risk factors, regardless of the STEEP dimension to which they belong, and of how many factors make up the dimension. Thus, by construction, if one risk dimension is constructed using more risk factors than another, it is extremely likely that the first represents a higher level of total risk.

In the proposed model, the technical dimension is associated with 20 factors, and the environmental dimension is related to 5. Based on this methodological framework, the technical dimension is expected to be the most relevant, the environmental dimension being the least important. This is not exactly a wrong proposition, inasmuch as the complexity of a MTP involves a large number of technical risks. That is what the results from tables 8, 11 and 14 show, for each of the three case studies respectively. In the case of the FNSP, the technical dimension as a whole would thus represent 35.5% of the project risk, while on the Central Railroad of Uruguay it would be 37.2% and on L1MB it would be 36%.

However, this aggregation strongly simplifies the analysis. Firstly, it adds risk factors of different natures and, secondly, it does not consider interdependencies between risks. To capture this, the numbers can be further analysed to give more information by reconfiguring the distribution of variables within each STEEP dimension, and that is why the subsequent tables (tables 9, 10, 12, 13 ,15 and 16) are constructed.

First, technical risks associated with engineering design and construction management can be separated. In addition, environmental and social risks, which are usually managed together, can be associated. This is what the second table of results by dimension shows in each case (tables 9, 12 and 15). With this aggregation, in all three cases the environmental and social dimension becomes more relevant, and the importance that is usually given to this dimension as a whole, with specific evaluations and plans, is confirmed.

Likewise, by construction, the same relative weight can be assumed per dimension, adjusting that each one had the same number of risk factors. That is what is presented in the third table (tables

10, 13 and 16), and in the spider graphs (figures 18, 19 and 20), considering each one of the three cases.

Tables 9 to 10 show the most relevant dimensions with different aggregations for the FNSP case.

Table 8 – Ferroanel North, São Paulo – Risk Dimensions

UNRELATIVIsED STEEP DIMENSIONS	VALUE	%
SOCIAL	3,74	14,9%
TECHNICAL	8,94	35,5%
ECONOMIC	5,04	20,0%
ENVIRONMENTAL	2,23	8,9%
POLITCAL	5,21	20,7%

Table 9 – Ferroanel North, São Paulo – Risk Dimensio

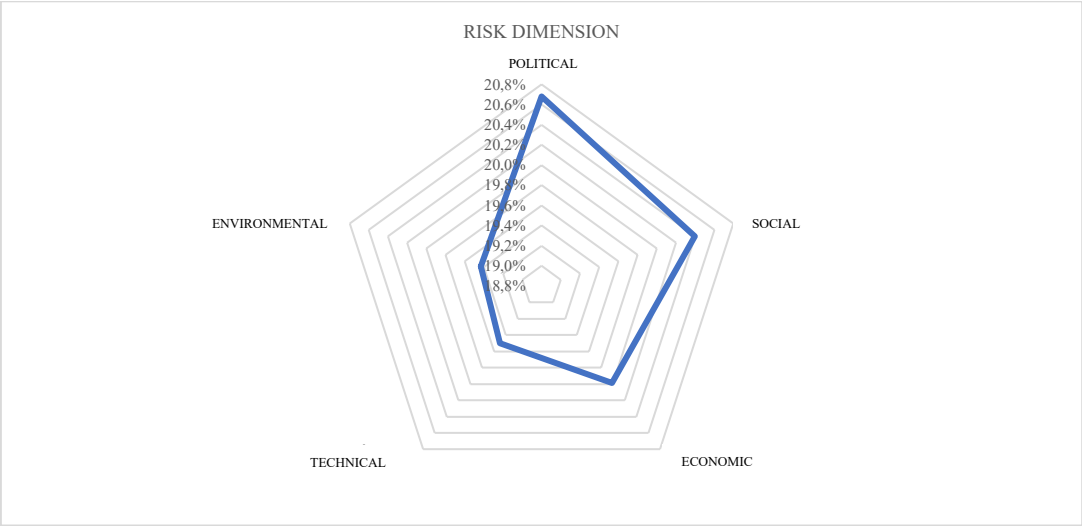
DIMENSIONS WITH ALTERNATIVE AGGREGATION	VALUE	%
SOCIAL-ENVIRONMENTAL	5,97	23,7%
POLITICAL	5,21	20,7%
ECONOMIC	5,04	20,0%
TECHNICAL – ENGINEERING DESIGN	4,07	16,2%
TECHINCAL – CONSTRUCTION MANAGEMENT	4,87	19,4%

Table 10 – Ferroanel Norte, São Paulo – Risk Dimensions (relativised by number of factors)

RELATIVISED DIMENSIONS BY NUMBER OF FACTORS	VALOR	%
POLITICAL	0,474	20,7%
SOCIAL	0,468	20,4%
ECONOMIC	0,458	20,0%
TECHINCAL	0,447	19,5%
ENVIRONMENTAL	0,445	19,4%

Considering the interrelation between risks, Figure 18 plots the percentage contribution of the relativised risk dimensions for FNSP.

Figure 18 – Percentage contribution of risk dimensions in Ferroanel Norte, São Paulo.



Subsequently, tables 11 to 13 show the most relevant dimensions with different aggregations for the case of the CRPU.

Table 11 – Central Railway Project – Risk Dimensions

UNRELATIVISED STEEP DIMENSIONS	VALUE	%
TECHNICAL	9,01	37,2%
ECONOMIC	4,76	19,7%
POLITICAL	4,71	19,5%
SOCIAL	3,57	14,7%
ENVIRONMENTAL	2,16	8,9%

Table 12 – Central Railway Project – Risk Dimensions (with different aggregation)

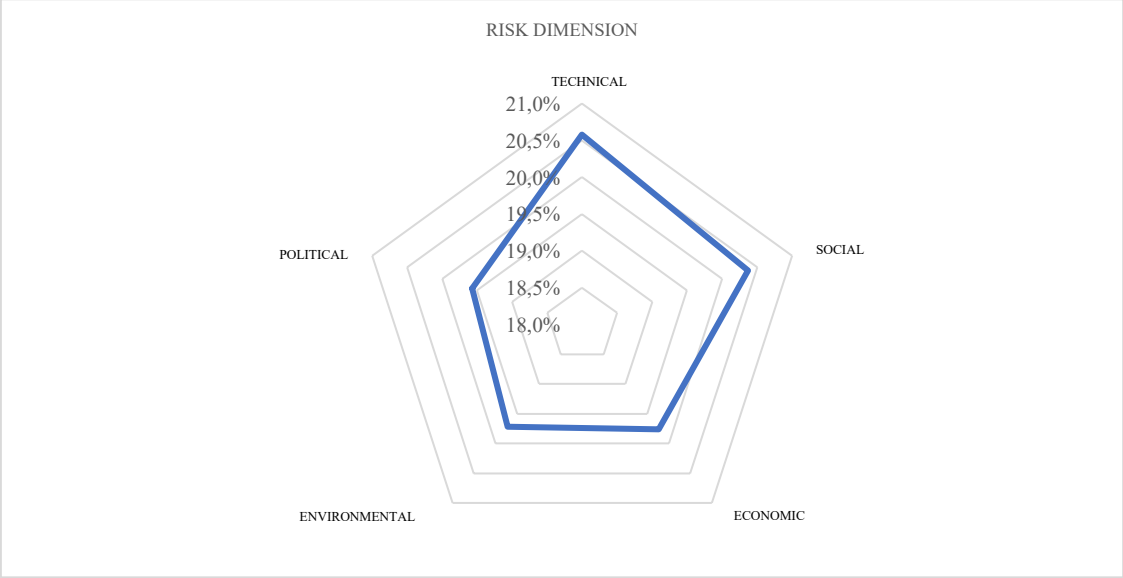
DIMENSIONS WITH ALTERNATIVE AGGREGATION	VALUE	%
SOCIAL-ENVIRONMENTAL	5,72	23,7%
TECHNICAL – CONSTRUCTION MANAGEMENT	4,93	20,4%
ECONOMIC	4,76	19,7%
POLITICAL	4,71	19,5%
TECHNICAL – ENGINEERING DESIGN	4,08	16,8%

Table 13 – Central Railway Project – Risk Dimensions (relativised by number of factors)

RELATIVISED DIMENSIONS BY NUMBER OF FACTORS	VALUE	%
TECHNICAL	0,450	20,6%
SOCIAL	0,446	20,4%
ECONOMIC	0,433	19,8%
ENVIRONMENTAL	0,432	19,7%
POLITICAL	0,428	19,6%

Considering the interrelation between risks, Figure 19 plots the percentage contribution of the relativised risk dimensions for the CRPU:

Figure 19 – Percentage contribution of risk dimensions in Central Railway Project Uruguay



Finally, Tables 14 to 16 show the most relevant dimensions with different aggregations for the L1MB:

Table 14 – Metro Line 1, Bogotá, Colombia – Risk Dimensions

UNRELATIVISED STEEP DIMENSIONS	VALUE	%
TECHNICAL	9,55	36,0%
POLITICAL	5,55	20,9%
SOCIAL	4,01	15,1%
ECONOMIC	5,24	19,8%
ENVIRONMENTAL	2,18	8,2%

Table 15 – Metro Line 1, Bogotá, Colombia – Risk Dimensions (with different aggregation)

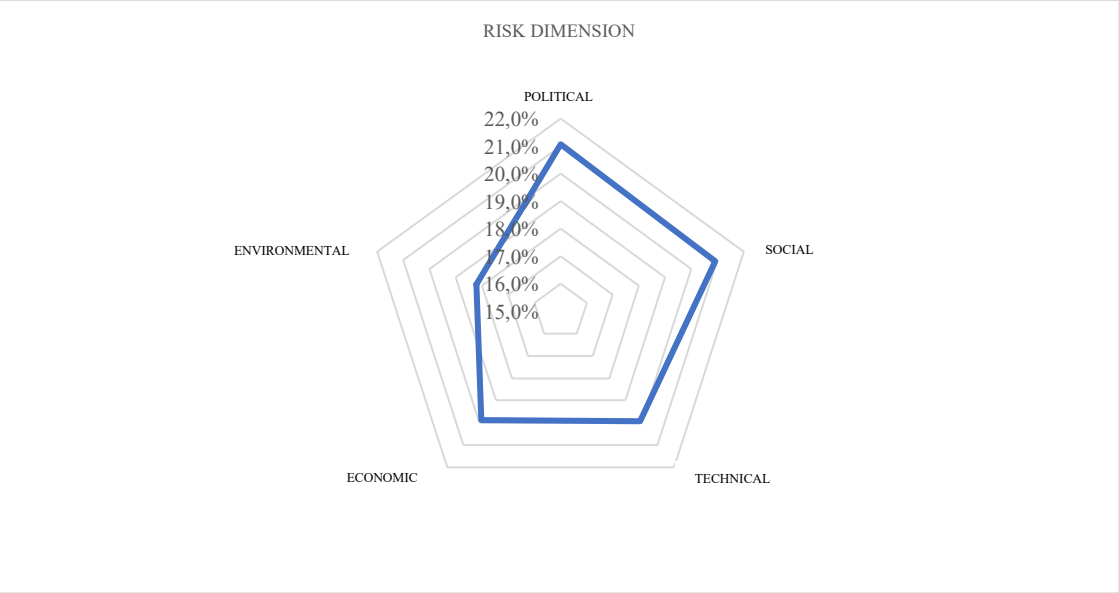
DIMENSIONS WITH ALTERNATIVE AGGREGATION	VALUE	%
SOCIAL ENVIRONMENTAL	6,19	23,3%
POLITICAL	5,55	20,9%
ECONOMIC	5,24	19,8%
TECHNICAL – CONSTRUCTION MANAGEMENT	5,13	19,3%
TECHNICAL – ENGINEERING DESIGN	4,42	16,7%

Table 16 – Metro Line 1, Bogotá, Colombia – Risk Dimensions (relativised by number of factors)

RELATIVISED DIMENSIONS BY AMOUNT OF FACTORS	VALUE	%
POLITICAL	0,505	21,1%
SOCIAL	0,501	20,9%
TECHNICAL	0,477	19,9%
ECNOMIC	0,476	19,9%
ENVIRONMENTAL	0,436	18,2%

Considering the interrelation between risks, Figure 20 plots the percentage contribution of the relativised risk dimensions for L1MB:

Figure 20 – Percentage contribution of risk dimensions in Metro Line 1 Bogotá



6.2.2 Discussion

Regarding risk factors, FNSP shows a higher prevalence of the political dimension in the 10 most relevant risk factors. The first 5 include: political indecision; lack of transparency and corruption; and a change in the Government's funding policy. The list of the first 5 is completed with the following 2 risk factors: the involvement of many decision-making bodies (of the social dimension); and economic recession (of the economic dimension).

In the case of the CRPU, on the other hand, there is a higher prevalence of technical risks in the first 10, as assessed by the experts included in this research process. Within the first 5, there are: changes in project scope requirements; inaccurate estimates of project cost; and changes in the engineering design of the project. The first 5 risks are completed with: involvement of many decision-making bodies (from the social dimension); and delays in obtaining approvals and permits (from the political dimension).

Finally, in the case of L1MB, there is a higher prevalence of political risks, again, and the following risk factors are included within the first 5: government discontinuity; delays in obtaining approvals and permits; and opposition and political interference. This list of first 5 is completed with: exchange rate (of the economic dimension); and involvement of many decision-making bodies (from the social dimension).

The comparative results between cases show that the recurring risk factor is "involvement of many decision-making bodies". At the same time, in terms of the dimensions corresponding to the most important factors, politics prevail in two of the cases. In the case of FNSP, political indecision, lack of transparency, and changes in funding policy and, in the case of L1MB, the discontinuity of the Government, delays in obtaining permits, and opposition or political interference. On the other hand, in the case of the CRPU, the dimension to which the most relevant factors correspond is the technical one, and it includes changes in scope requirements, and changes in engineering design, both especially tied to inaccurate estimates of the cost of the project.

Finally, in general terms, considering every risk included, the risk dimensions were rated as follows in order of importance in each of the selected cases:

- Ferroanel North from São Paulo: political, social, economic, technical and environmental.
- Central Railway of Uruguay: technical, social, economic, environmental and political.
- Line 1 of the Bogotá Metro: political, social, technical, economic and environmental.

As previously mentioned, “Involvement of many decision-making bodies” is the recurring risk factor in the TOP 5 risks, in the three analysed cases. This risk is not possible to assess with historical numeric data. It is “ill-defined” in nature, and assessing it involves subjectivity. It is not quantifiable by traditional statistical methods.

This kind of risk is related to what some authors call as “imprecision arising from ambiguity”, or fuzziness, in project parameters (see for example Ebrat and Ghodsi, 2014; Pender, 2001). Probability based techniques assume that the risks that are involved are well defined and mutually exclusive. This is not the case as “many” in “many decision-making bodies” is not well-defined.

As it is here showed by the multiple-case study, not only a lot of the risks assessed are ill-defined (please see the “X” in the Tables 3, 4 and 5), but several of the most important ones fall in this nature (4/10 in the three cases are ill-defined). Therefore, overall, it is safe to say that risk assessment is an ambiguous task and classic models are not able to deal with this kind of problems in projects of this nature.

Of course, this is not only true for the specific cases studied in this thesis. Considering the risk factors listed in Table 1, 63% of political risks are ill-defined, 37,5% of technical risks are ill-defined, and 33% of social risks factors are ill-defined. If at least one of them is considered by decision-makers, then it is safe to say that risk assessment involves subjectivity.

This is particularly the case, as explained elsewhere, for MTPs, given the typical definition and characteristics detailed at section 2.2, 2.3 and 2.4. They involve several actors and conflicting interests, and deal with problems that are ill-structured (and interdisciplinary), complex (several variables are involved) and dynamic (environment and factors change over time). In this kind of projects, the magnitude of fuzziness increases due to their nature.

The classical project management approach and techniques for project assessment have been particularly used to study cost overruns. Therefore, it has been especially used for assessing the following risk factor: “inaccurate estimates of project costs” as it was particularly considered in the case of FCU in this research. However, a more careful analysis of the source of the risks, specifically regarding the role of the context, can show that classical methodologies may be inadequate as well.

The analysis shows that the risk factor “inaccurate estimates of project costs” may be especially associated with changes that arise from changes in scope and design priorities, after the start of construction. The other technical risk factors in the TOP 5 are: changes in project scope requirements and changes in the engineering design of the project.

Hence, it is perfectly assumable that inaccurate estimates of projects costs are related to change in preferences of objectives in terms of outputs and outcomes, due to the organic nature of the project itself. This is associated with issues that are context specific, in spatial and temporal terms. A probabilistic classical approach to risk assessment, using MTPs of different nature in different countries, can lose sight of this particularly relevant characteristic of MTPs, which influences the decision-making process. As explained by Dimitriou et al. (2012), context embodies varied dimensions for decision-making, for example: culture and societal beliefs/values, time and space concerns, economic circumstances, institutional and planning frameworks and political circumstances.

Regarding risk dimensions, each MTP, within each country, and at each moment of time, had a notoriously specific, and complex, risk structure. At the time of developing this study, FNSP was a project that had the basic engineering designs completed, but its contracting had not yet been resolved. In this framework, and considering the transparency problems that arose in Brazil in previous years, it is logical that political issues were the most relevant, especially political indecision.

The project of the Central Railroad of Uruguay, on the other hand, was already contracted at the time of this analysis. However, Uruguay is a country with little recent railway developments and culture, with low technical capacity for the sector. It was reasonable, then, that technical topics were the most relevant.

Finally, regarding L1MB, the analysis was made before the award of the contract and before the change of Government. It was expected that political issues would then be the most important, especially those related to the discontinuity of the Government and political opposition.

6.2.3 Summary of Key Findings

The risk assessment here presented confirms that ill-defined risk factors were among the most relevant construction risks in the analysed LatAm MTPs. Besides, it was here also illustrated how risk assessment can be related to the context in which MTPs are carried out, given their complex nature.

Therefore, it sounds especially reasonable to use a methodology that incorporates specific perceptions of the spatial context, of the country and/or city where the project is developed, because it includes the institutional environment: cultural; normative and regulative. Likewise, it is particularly relevant that the methodology considers the exact moment in which the analysis is carried out. It is expected that this same exercise done 6 months before or after will have a

different result in all cases. The set of construction risks of a megaproject is an inherently dynamic phenomenon. In both senses, both the spatial and temporal context, the fuzzy logic risk assessment methodology presented in this thesis when trying to capture the perceptions of a group of decision-makers, seems to be more accurate than a probabilistic analysis.

Once the risks have been effectively assessed, using this methodology, it is possible to carry out a continuous and improved risk management process. It allows a joint analysis of accumulated perceptions, which capture the knowledge and impressions of different relevant agents. In this regard, it is a flexible methodology, in that it allows discretionary grouping of the different risk factors assessed to study the weight of different dimensions. This grouping can be done with a theoretical perspective, as in the case presented here, but also following, for example, fixed risk management structures of the megaproject developers.

FST minimises the inherent imprecision, inconsistency, vagueness and uncertainty that linguistic information imposes, and thus improves objectivity and comparability in an inherently subjective analysis. It mathematically represents the subjectivity of the words used by those who assess risk and, therefore, is useful to analyse al risk factors, including ill-defined (vague) risks.

With this methodology, it has been here illustrated that ill-defined risks were of substantial importance in the 3 Latin American MTPs studied. For the selected cases, the first subsidiary question presented in 3.1.3 was: what is the perceived contribution of the different construction risk factors to the overall likelihood that MTPs obtain the results that governmental decision-makers expect?

In particular, risk factors from the political, social and technical dimensions have been particularly identified by the decision-makers included in this research, and especially considered factors on these dimensions in the top 10 risks assessed. This finding is crucial for the following section, where constructions risks are linked to contractual hazards in the proposed multiple-case study.

6.3 Qualitative Data Results and Analysis

6.3.1 The Link Between Construction Risks and Contractual Hazards

The second research question presented in Section 3.1.3, in the context of the multiple-case study design, was: how are construction risk factors and dimensions perceived, by the governmental decision-makers included in the analysis, to be translated into contractual hazards? This question was built from the theoretical proposition that there is a link between typical MTP construction risks and contractual hazards, as thoroughly explained in Section 2.6, and it is important to understand how it works.

Theoretically, a link between the different risk factors and standard opportunism exists as legislation, the judiciary or bureaucracy can be the basis for the information asymmetries related to a specific risk dimension. For example, formal rules could be explaining information asymmetries on economic or technical variables, changing how risks on those dimensions are perceived. This is relevant as standard opportunistic behaviour is related to asset-specific investments, which are linked to bounded rationality and idiosyncratic knowledge.

Besides, a connection between risk factors and governmental opportunism theoretically exists as well, given that the formal rules of the game can change how risks are perceived, as they may promote the ability of governments to opportunistically change contractual or regulatory context conditions. Finally, a link between the different risk factors and third-party opportunism can be theoretically justified as legislation, the judiciary or bureaucracy can generate incentives for third-parties (political opposition, society, NGOs, etc.) to interfere, due to political risks, when the project is being developed. This type of opportunism is related to public contract scrutiny.

This section, building from this theoretical framework, and the description of the themes as explained in 4.2.1 (with the related structural and content codes), analyses the qualitative data obtained from the semi-structured interviews related to this particular topic. Results are presented in a case-by-case basis, and are then used to elaborate a discussion regarding this and other topics, with a cross-case view, in Chapter 7.

6.3.1.1 Ferroanel North Railway São Paulo, Brazil

- Political Risks and Contractual Hazards

Firstly, the most relevant risk factors of FNSP regarding the political dimension of risk, given the information presented in Table 5, were: lack of political support/political indecision, lack of transparency and corruption, government discontinuity and opposition or political interference.

In this context, some participants revealed how the link between the previous risk factors and third-party opportunism was actually working in this case:

"Third-party risk is less predictable. In the case of Ferroanel, the issue is more political, because the social issue is already addressed, through what was developed with Rodoanel Norte."

"There is a political risk, political will. (...) It depends on the moment. If there are municipal elections, the Mayor will change. So, even if all parties agree at this moment, six months from now perhaps nobody else agrees."

The first of the previous participants stated that political instability, political indecision, government discontinuity -as part of the political dimension of risk- could be translated into third-party opportunism. According to that participant, this contractual hazard was unpredictable. Unpredictability in megaprojects is well documented by specialised literature, and it is basically linked to complexity. Oades & Dimitriou (2008) explain that most human systems, such as megaprojects, are complex adaptive systems and, when they are disturbed, unpredictability arises as they will not return to an equilibrium. Unpredictable forces have an impact on the control of project planning and delivery processes.

Besides, the second participant explained how lack of political support, opposition or political interference, government discontinuity, among others, associated with the political dimension of risk, could also be translated into third-party opportunism. He mentioned that politicians may change their point of view as the project is being developed. This is particularly related to the organic nature of megaprojects, as this kind of endeavours need to adapt to changing political ideas and agendas (see Dimitriou et al., 2012).

- Social Risks and Contractual Hazards

Secondly, concerning the social dimension of risk, Table 5 shows that the most relevant risk factors in this project were: the involvement of many decision-making bodies, and compensations higher than expected. A link between these risk dimensions and third-party opportunism was also perceived by a participant in the semi structured interview, who mentioned the following:

"Social and environmental (risks) are the most important because it (the project) passes through highly urbanised areas. And, in the case of Ferroanel Norte, it is related to the protection of water sources (...) You need to have the licenses and be thinking about them (...) This is difficult because the railroad is a Federal concession, the territory is a State territory and passes within the municipalities. So, you have Municipal, State and Federal legislation."

The involvement of many decision-making bodies (and possibly other factors), as part of the social dimension of risk, may generate third-party opportunism, as politicians may want to interfere given the social risks that could be materialised. Apparently, according to this participant, legislation and bureaucracy, considering the different levels of government, can incentivize this source of opportunism. This is also documented by specialised literature. As eloquently illustrated by Priemus & van Wee (2013) decision-making on megaprojects is mostly a case of "multilevel governance". Moreover, Altshuler & Luberoff (2003) show how power can be exercised from different levels of governments and may influence the decision-making process when dealing with megaprojects.

- Technical Risks and Contractual Hazards

Moreover, the most relevant risk factors regarding the technical dimension of risk, in FNSP, were: technical difficulties in making changes to the affected utilities, changes in technology or in industry standards, and changes in project scope requirements. A link between the technical risk dimension and idiosyncratic opportunism (as a contractual hazard) was visualised by participants. This quote was eloquent:

"The technical aspect, in complex engineering projects, usually interferes. These are the ones that generate some turbulence during the term of the contract. (...) If I did a survey with the inadequate depth and quantity in the initial phase and, when the execution arrived, the company that is developing the implementation found that the soil quality is different from what the project said in terms of soil, etc., and if the contract has already been signed and the bidding has already been done, price targets will be modified, due to the discovery of a quality of material which is different from that in the project. This change, the demand for additives creates a conflictive situation between the contractor and the contractee, and the situation can reach a critical point at which the contractor can stop the work. (...). So, this technical issue usually happens. This is because the projects made for the bid are basic projects, not executive designs. So, a lot of new things are discovered throughout the project, moving forward with a basic project. This is a problem from a technical point of view."

Measurement errors, special conditions on the site, and insufficient site inspections, as part of the technical dimension of risk, can be translated into idiosyncratic opportunism, as it may generate information asymmetries. This may be related to typical uncertainty in complex projects, which implies making decisions with ignorance, but also a bet from decision-makers, as mentioned by the participant. In the second case, information asymmetries may be generated and the contractor could eventually take advantage.

Some authors, such as Flyvbjerg (2014), explain that ignorance may be a strategic decision. The developer may be interested on not knowing about some project details because ignorance helps get projects started. It is somehow a "creative error" that is crucial to get the project going. In that case, the lack of information is not an error, it is basically a bet, as explained in Section 2.3. In those cases, decisions have to be made under ignorance as it is not possible to form rational expectations about the probability of the different alternatives, as suggested by Zinn (2004). In this example, incomplete initial engineering studies and design can lead to delivery problems. This is known by both parties when signing the contract and the private sector can take advantage, in certain circumstances, once the project is being developed.

- Economic Risks and Contractual Hazards

The most important risk factors related to the economic dimension were economic recession and changes in the costs of materials. A link between this risk dimension and idiosyncratic opportunism was also visualised by a participant, who made an eloquent contribution:

"If I had to list the main risks, I believe that the politician making the decision is the most important. For example, we did not imagine that this would be paralyzed. We thought it would follow a quick sequence. This is a political risk. At this stage, that is the problem. After the project is signed, contracted, financed, during execution, this is not frequent. It flows. But there are some problems that arise from the economic situation, from the economic crisis in the country, that can affect the companies that are constructing the project."

Economic recession is related to the economic dimension of risk. According to this participant, it may have a particular impact on the contractor. It could eventually generate information asymmetries if the contractor is not transparent about the company's situation ex-ante, and if the contract does not consider the potential effects of the recession. This would be related to the bureaucratic status quo, as the sponsor should be able to capture this problem before signing the contract.

As explained for example by Dimitriou et al. (2011), one of the most critical and frequently mentioned sources of external project risk and uncertainty is the wider economic climate. Changing economic cycles and global economies have major impacts on the development of MTPs. It can have considerable impacts on budget costs during construction, as mentioned by Boateng et al. (2017). It can be considered an exogenous parameter but can led to economic uncertainty and escalate to coordination problems and ambiguity of project scope. Moreover, it is related to different prices such as wages, energy, or other materials, and information asymmetries generated by this issue can give an advantage to the private party of the contract.

6.3.1.2 Central Railway Project of Uruguay

- Political Risks and Contractual Hazards

The political dimension of risk was the less important in the CRPU, given the results obtained by the quantitative strand of this research process. However, it was related to third-party opportunism by one participant. The following quote was clear regarding the political risk in this project:

"The project was developed within a process; although it began in 2016, the most significant events occurred at the end of the Government period, and that generates political positions. In one way or another, there are political opinions that sometimes are related to the project management itself, or to positions more related to the strategy of each of the referents on the issues that determine the opinion about the project (…) One is the real situation (…) and the other is the situation in the media, which transmits, to those who are not in the specific place what the project situation is. So, there I do believe that there was a positioning of various referents at the media level, which is what strengthened some positions that for very different reasons -most of them acceptable, from the perspective of those who promote it- have generated some levels of resistance."

Although the political dimension of risk, in its own, is considered minimum by participants in this case, it is also clear that there can be a link between this risk and third-party opportunism, as political objectives may generate some level of resistance to the project that is being developed. This is due to the relationship of social and political risks, materialised as potential third-party opportunism. As clearly stated by Sanchez-Cazorla & Alfalla-Luque (2016) bad performance of megaprojects can be explained by a number of factors that often occur, of which one of them is public stakeholder resistance as consequence of political interest.

- Social Risks and Contractual Hazards

Concerning the social dimension of risk, Table 6 shows that the most relevant risk factors of this project were: the involvement of many decision-making bodies, and protests and interference by residents. Regarding this subject, a specific link between social risk dimension and third-party opportunism was perceived in the semi-structured interviews. One participant, for example, mentioned the following:

"Perhaps the social issue could have been improved. Complaints have arisen from some residents, who do not see it (the project) with good eyes, because the train passes close to their area. In the social part, maybe it was not given sufficient disclosure. Although public hearings

were held, and people were summoned, people who were interested were not summoned. Not all participated. Yes, there were agitators who perhaps were not so affected, who did have problems with the purpose of the train -that of serving a future pulp mill in Uruguay-. The project was presented, and although there were people who generated social demonstrations, it was not so relevant. Once the work was awarded, public manifestations began to appear. At the beginning, we even had (...) meetings with the departmental political forces, with the mayors and construction managers and, at a certain point, many politicians told us that they agreed, but given the complaint of the people of their Department they began to change."

Protests and interference by residents, as part of the social dimension of risk, can be translated into third-party opportunism. According to this participant, this is related to the way of doing, to bureaucracy. Specifically, the participant mentions that the communication with the affected groups was insufficient. When social groups started to protest, politicians, in order to obtain political benefits, started to generate noise around the project as well. This resulted in new demands that affected the development of the project. To avoid protests and interference by residents, compensations in the form of new infrastructure were developed along the project, once the initial specifications with the designer were already developed.

This is consistent with specialised literature on this topic. As a matter of fact, Scholten (2006) explains that one of the most relevant external risk factors are public protests. As mentioned by Graham, (2009), deliberate infrastructural disruption can be used as a political strategy. The relationship between the social and political phenomena has been well documented.

- Technical Risks and Contractual Hazards

In parallel, the technical dimension of risk, given the information presented in Table 6, was the most relevant risk dimension of the CRPU, including the following risk factors: changes in project scope requirements, inaccurate estimates of project costs, other changes in the engineering design of the project, lack of human resources for the development of the works, inappropriate design due to lack of technical capabilities, and insufficient capacities in construction work. In this context, a link between the previous risk factors and idiosyncratic opportunism was revealed by some participants. On that subject the following three participants were very clear:

"Regarding the contractor taking advantage of any ambiguities that may exist in the specifications, this usually happens. In this case it is going to happen and it is happening."

"I believe that the great flaw in this contract, and in many contracts, is that contracts are written exclusively by lawyers and, since they have no knowledge of technical issues, there are omissions

that should not happen. (Omissions occur) precisely for not having a multidisciplinary team to develop the contract. I believe this is the great fault (…) It results in contractual grey areas that affect technical issues."

"On the other hand, on the technical study of this project, when the diagnosis of the current state of the railroad and other matters were made, and of the standards that it is intended to have, there was an urgency there (…) On the technical side, and I put it in the questionnaire, it seems to me that there may be some design issues that may have an impact, and that the investment cost may be higher."

Technical complexity, which implies several risk factors, could be translated into idiosyncratic opportunism. According to the first of the previous participants, this was certainly going to happen in this project, and this was due to the lack of detail and clearness of the contract. The lack of a multidisciplinary team at the structuring phase, to deal with the development of the contract, may generate the space for asymmetric information, and the contractor take advantage of this issue. This may be even more relevant, furthermore, if the pre-investment phase has been done with urgency, as the last participant explains.

The previous ideas are consistent with the literature on this topic. As explained by Ryall and Samspon (2006), contracts are more detailed when similar deals have been done before, which is not the case for megaprojects. According to these authors, there is a learning effect in contracting, whereby the capacity to draft detailed contracts increases with experience. Moreover, contract specificity is negatively impacted on by uncertainty (for more information this issue check Furlotti, 2007) and the urgency of the pre-investment phase. As illustrated by Genus (1997), decision-makers should avoid the urgency of a project's schedule when there is technical uncertainty. In this context, it is reasonable to use multidisciplinary project teams (see Gann et al., 2017), considering adaptive solving processes, given that public-private information asymmetries increase with complexity (Spiller, 2008).

- Economic Risks and Contractual Hazards

Besides, the economic dimension of risk can be translated in idiosyncratic opportunism if legislation, the judiciary or bureaucracy generate information asymmetries regarding relevant economic variables. The following participant shed light around on this issue:

"I think they (risks) were managed as best as possible, perhaps some aspects escaped but, in general, the worst that could happen is that the contractor consortium does not have enough financing and the work is halved. In that sense, the contractor was asked for a complete list, a

rubric, with unit prices, quantities, and that those quantities closed in a total price that is the construction price, so that if the work is cut in at some point, the amounts of the different items and the progress can be measured…and it will go to an arbitration, and it will be paid, but hey, there is a basis on which to negotiate, compensate the company for what it could build, and eventually make a new contract to finish the work."

Financial structuring risks could be translated in idiosyncratic opportunism if information regarding construction costs and quantities is retained solely by the contractor. If this is a source of information asymmetries, the contractor could use it in several ways. For example, it could obtain more benefits if the contract is cancelled, or it could exert pressure to retain the contract.

In order to have accurate estimations and an effective cost management, it is relevant to have excellent quantity surveyors and experts with understanding of material prices, estimation techniques and contract types, as well-explained by Luu et al. (2008). This is important in order to minimise information which is asymmetrically possessed by the parties, which could enable the holder of information to behave opportunistically in dealing with its partners (see Gao et al., 2018).

- Environmental Risks and Contractual Hazards

A link between the environmental dimension of risk and standard opportunistic behaviour was also visualised. The following quote shed light on this topic as well:

"Sometimes there is some grey, some aspect to be defined. There are risks that the State manages differently than private companies. For example, the risk of an environmental catastrophe, a storm, is managed by the State depending on the severity. The contractor takes insurance, and that insurance is currently being paid by the State. Of course, not all risks were transferred, because of their nature. But there are some grey cases; what is a strong storm? (…) and what is an environmental catastrophe. (…) The limits are blurred, they become limits agreed between contractors and contract supervisor, a posteriori. You cannot tabulate everything."

Heavy rain, and windstorms, among other possible environmental catastrophes, as part of the environmental dimension of risk, could be translated into idiosyncratic opportunism, in case the definition of the clauses in the contract are too narrow. This is related to bureaucracy (the way of doing), legislation (the need to be detailed in the contracts), and the judiciary, because it may give the chance to the contractor to be opportunistic around this issue.

As explained by Boateng et al. (2017), unfavourable climatic conditions could generate environmental uncertainties which in turn are related to worksite coordination problems, error generation and, eventually, project quality deficiency. This could escalate to project cost overrun. In this context, transactors enter contracts knowing that some unlikely contingencies are unspecified as it may be too costly to make a detail specification on the said contingency, including measurement, search and negotiation costs (see Klein, 2002). This seems reasonable, but if contracts are too incomplete, they can create an opportunity for one party to try to enforce the literal imperfect contract which is contrary to the intent of the initial understanding (Klein, 2002).

6.3.1.3 Line 1 of Metro of Bogota

- Political Risks and Contractual Hazards

Firstly, given the information presented in Table 7, regarding the political dimension of risk, the most relevant risk factors were: government discontinuity, delays in obtaining approvals and permits, opposition and political interference, and lack of regulatory adaptation. On that subject, one participant mentioned the following:

"In my opinion, political conditions surrounding the execution of this project made it necessary to exercise caution, to consider in a preventive way many details that I have not seen in other projects, for example the high-level complaint mechanism office."

Evidently, this office helped to manage those complaints that arose at the planning and appraisal stage. However, it was also relevant to prevent the interference from third-parties at the contracting and execution stages, which could occur due to government discontinuity and opposition or political interference. Basically, this is third-party opportunism. To avoid this, changes in the bureaucratic status quo were needed, and a high-level complaint mechanism office was developed.

This is usually considered by specialised literature. Social resistance can generate bad publicity, which in turn can have political effects, particularly when there is a change in the political actors. As political support is not always sure because of the rotation of the political leadership, an effective management of external factors, such as social groups that are affected by the megaproject, are imperative. Giezen (2012) explains that this is relevant in order to maintain clarity about the project and minimise uncertainty and risk.

- Social Risks and Contractual Hazards

Secondly, concerning the social dimension of risk, table 7 shows that the most relevant risk factors were: the involvement of many decision-making bodies, and protests and interference by residents. A link between this risk dimension and third-party opportunism was also perceived by some participants. One participant, for example, mentioned the following:

"I consider that social issues are going to be complex, but I think that the city has experience in building urban works, it has a knowledge of how to approach them, what the needs of the people are, what their main concerns are."

The participant is linking potential protests and interference by residents to the level of experience Bogota's Government has to deal with those issues. Logically, legislation and bureaucracy are fundamental to discourage the interference of third-parties. Then, there might be an evident association between the social dimension of risk and third-party opportunism.

External factors are a source of risk in megaprojects, as explained previously and illustrated by Giezen (2012). The megaproject could be blocked in several ways, by legal means or by preventing workers to arrive to the site if, for example, affected inhabitants are not managed correctly. It is important to respond quickly and openly to worries that people might have, and to involve them in the project. This desirable project management activities led by the bureaucracy in place is particularly relevant to minimise uncertainty and risk (see Giezen, 2012).

- Technical Risks and Contractual Hazards

The most relevant risk factors regarding the technical dimension of risk were: special conditions on the site and inaccurate estimates of project costs. A link between this risk dimension and idiosyncratic opportunism was visualised by participants. The following two quotes are eloquent on that subject:

"First, the metro company had a structuring company. A government company was hired that had more experience than the company, which is very new. An entity was hired that knew how to structure the different components, in particular the three main components: technical, legal and financial."

"One may think that there are not so many experienced people in the Metro of Bogotá, but there are many people who have a lot of experience from the Metro of Medellin. So, I think they have lessons learned, which allow us to minimise risks as much as possible. And let's say that in all areas I have noticed that there is experience and a lot of knowledge and qualification."

Most technical risks were translated to the contractor by means of the concession contract. Nevertheless, the experience that the public company had when structuring the concession contract was absolutely relevant to reduce information asymmetries, which can diminish standard opportunistic behaviour.

Governance arrangements around megaprojects need to contemplate the experience and expertise of project managers. This is relevant, according to some authors (please see Sanderson, 2012), given that project managers are key actors responsible for producing a plan of action and the relevant contractual documents, which have an impact on the projects' outcome. Experience and judgment of decision-makers are important to minimise the exploitation of information asymmetries that their counterparts could be able to develop, considering that they are prone to opportunistic behaviour in order to maximize their benefits.

- Economic Risks and Contractual Hazards

The most important risk factor related to the economic dimension was exchange rate. A link between this risk dimension and idiosyncratic opportunism was also visualised by participants. The following quotes show how participants visualize the previous link:

"There is a risk that is unpredictable, which is also controlled as far as possible, the exchange rate risk. Contingency funds may be well anticipated or greatly underestimated because the management of a weak currency like ours, against the dollar- that there is an important component in dollars- obviously means that one cannot say with full certainty that one is hedged."

"The exchange risk is covered a little by the company, but it has always been known to be managed in projects; any financial institution and the Ministry of Finance know how to handle these risks. It is manageable."

Again, the importance of the previous risk is related to what happens with the country's economy, but it is also relevant to have a solid team who knows how to manage this risk in order to reduce potential information asymmetries at the moment the contract is being developed, which, if not, could lead to the opportunistic behaviour of the contractor.

Where capital expenditures, operating expenses, revenues and borrowings are not in the same currency, the foreign exchange rate risk appears, and one part of the contract can assume it or share it with the other. Sometimes lenders can hedge this risk (see Youjie, 2004). Undesirable behaviours regarding this subject, include frauds and cheating in foreign exchange rate control

and the team in charge of the contract must be prepared to manage this in order to limit opportunistic behaviours of the private party.

- Environmental Risks and Contractual Hazards

According to the results obtained by the quantitative strand of this research process, the environmental dimension of risk was the less important in the L1MB project. Nevertheless, a link between this risk dimension and standard opportunistic behaviour was observed by participants. The following two quotes can shed light on this topic:

"From the environmental and social point of view, there is a detailed breakdown, because we have an ingredient, one of the pluses of the contract, which is that it is financed by Multilateral Banking, which makes us be stricter and more demanding (…) Yes, there is a very detailed follow-up from the point of view of a safeguards approach, from the point of view that there are clauses and points that are very specific."

"In work concession contracts in Colombia, the main ones (risks) that always stand out in the city are social, environmental and property. (…) Here, regarding environmental issues, I consider that there are not so many risks; there is a probability of environmental issues, but in the urban environment that is well studied."

Again, the importance of the previous risk is related to what may happen with things that are not under control, but is also relevant to have a solid team to generate or uncover the relevant information to manage these risks, in order to reduce potential information asymmetries at the moment the contract is being developed, which could lead to the opportunistic behaviour of the contractor.

As illustrated by Priemus et al. (2008), the area surrounding infrastructures can be eventually burdened with negative side-effects such as noise or pollution, and other forms of nuisance. In these cases, opportunistic behaviour can lead to higher prices and eventually investments failing to materialize. It is therefore necessary to have extensive regulation and management of these issues to have an effective control of the negative effects.

6.3.1.4 Summary of Key Findings

Megaprojects are special projects in several ways, as thoroughly explained in Section 2.2. In particular, these special endeavours are politized, human-centred, global, complex, organic, and

iconic, and this is related to a complex set of construction risks (see Section 2.3). This chapter shows that, when using a NIE perspective in the multiple-case study presented, the mentioned construction risks were actually related to some of the contractual hazards detailed in Section 2.6.

Contractual hazards that are usually considered by the specialised literature are: idiosyncratic opportunism, governmental opportunism and third-party opportunism. This section showed **how** the complex set of construction risks were related to these contractual hazards in the cases included in the multiple-case study. It showed that constructions risks are related specifically to idiosyncratic opportunism and third-party opportunism. This is thoroughly analysed in Section 7.2.

Using the NIE perspective proposed in this thesis, these contractual hazards are basically generating transaction costs. Based on this NIE view, this transaction costs should be minimised by the selected contract, considering the formal rules of the game (bureaucracy, legislation and the judiciary). Theoretically, these rules could help to reduce contractual hazards, by enabling an effective use of the contractual functions (control, coordination and adaptation), or not. This link is studied in depth, for the selected cases, in the following section.

6.3.2 The Link Between Formal Rules and Contractual Functions

The third subsidiary question presented in Section 3.1.3 was: how can risk factors and hazards be managed using the construction contract, given the formal institutional background? The previous section (6.3.1) illustrated how the relationship between risk factors and contractual hazards was perceived by the participants. This section (6.3.2) studies how formal rules (the formal institutional background), according to the interviewees, impact on contractual functions, which are needed to deal with construction risks and, therefore, with contractual hazards. This is relevant as, intuitively, the depth and precision with which these contractual functions are developed generate more or less transaction costs.

It is vital to understand the following in order to fully comprehend how this can theoretically happen. Bureaucracy and legislation may affect the potential effectiveness of the contract, by enabling contracting and framing the context to assist in contract enforcement. The judiciary, on the other hand, may affect its effectiveness by framing the context to assist in contract enforcement. At least theoretically, these formal rules may affect the contract in three ways. Firstly, they may do so by changing the way the coordination function works, which deals with the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. Secondly, they may also affect the potential effectiveness of the contract, by changing the way the control function works, which ensures that the activities carried out by the counterparts are not pursuing separate and undesired objectives, which may negatively affect property rights. Finally, they may affect how the adaptation function work, which is associated to the need to face the predictable incompleteness of the contract, due to potential changes in circumstances that potentially distress the baseline scenario.

Building from this theoretical framework, the description of themes explained in 4.2.1 with the related structural and content codes, this section analyses the qualitative data obtained from the semi-structured interviews on this subject. Results are presented by cases, which are then used to elaborate a discussion in Chapter 7, with a cross-case view of the topic.

6.3.2.1 Ferroanel Railway São Paulo, Brazil

- The Link between Polity/Bureaucracy and Contractual Functions

Firstly, as explained, it is not unreasonable to theoretically propose that bureaucracy may affect the potential effectiveness of the contract by changing the way the coordination function works. Several participants confirmed this link in practice and explained how it was working in FNSP:

"Which is the worst (contractual function)? Coordination. Because you have so many interfaces with so many organs."

"As for coordination, in the management of Ferroanel Norte's contract, you would have the risk of having a problem, as it is a complex engineering project and, as we said, as an executive project was not carried out, the basic project has a margin to discover flaws, interferences that are not foreseen in the contract, and the coordination is poorly defined."

"Adaptation generates changes, but coordination is the most complex (...) Given that it is a megaproject, you need to have a good planning and management. If you haven't had that, there are loose things. This generates everything; lack of control. There is a need to do a good planning, a work plan, the steps you have to do and each one sees where it fits in the construction process."

The first participant explained that the coordination function is especially difficult given the number of public actors and agents involved in the project. Therefore, the reliability of this function is related to the formal rules, specifically bureaucracy. The next two participants alleged that the coordination function is also problematic given the technical complexity of the project. Therefore, the reliability of the mentioned function, for example for determining roles and responsibilities and work schedule, among others, is not clear. This could be part of the nature of the project, but could also be related to bureaucracy, because it is linked to how much information is generated before construction, at the pre-investment phase.

This is particularly relevant for the relationship between risk factors and contractual hazards mentioned in the previous section. It is only logical to assume that problems in the coordination of activities between different public actors involved may generate problems to manage, for example, third-party opportunism. It may also be important to deal with controversies that may arise from different ways of understanding the contract, which may be a source of standard opportunistic behaviour.

Besides, the bureaucracy could also, at least theoretically, affect the control function, as previously explained. On that subject, the following quote was eloquent for this case:

"Construction risks are managed based on what you have placed in the bid and what you have signed in the contract. The problem is that construction companies that have relatively great economic power, hire mega law firms to deal with legal issues. The legal office of the executing agency does not have enough knowledge to deal with this problem. (...) Yes, there is a lot of culture of interpretation here. So, it affects a lot. Once a contract is signed, you will find that a conflict is difficult to resolve, because there are always different interpretations."

The previous statement illustrates a link between bureaucracy and the control function. According to this participant, contracts are written in a way that they are plausible of being interpreted in several ways, and the bureaucracy in place is in disadvantage when dealing with conflict resolution. It is therefore difficult to ensure that the activities carried out by their counterparts are not pursuing separate and undesired objectives. This may be related to all risk dimensions. However, given the link between the most relevant risk dimensions and contractual hazards explained in the previous section, bureaucracy may be incapable of minimising standard opportunistic behaviour and third-party opportunism.

- The Link between Legislation and Contractual Functions

Legislation could also affect how the coordination function works. The following quote shows how this link was working for the FNSP case:

"You can read the same rule and have a different interpretation of mine. Everyone looks at the rules differently. (…) If you are a lawyer and I am an engineer, we have different opinions. I think we have to do this, then this and then this, and I get here. And I'm not imagining that you think you had to think otherwise. This understanding between various bodies, whether environmental, social and technical (…) is not unique. That is why delays occur."

Formal rules, specifically legislation, can be related to the success of the coordination function. According to this participant, the complexity of some tasks related to environmental, social, and technical risks of the project leads to different potential interpretations of each problem. This usually leads to delays. This is again related to how the contract is interpreted by, in this case, the different public actors.

This is, again, important for the relationship between risk factors and contractual hazards mentioned in the previous section. Problems with the coordination function of the contract, as a consequence of inadequate legislation, may generate an increase of different risks, which are related to standard opportunistic behaviour and third-party opportunism.

Furthermore, the following two quotes are as clear as possible on the legislation changing the way the control function works in this type of projects:

"There is a lot of culture of interpretation here. So, it affects a lot. Once a contract is signed, you will find that it is difficult to solve a conflict, because there are always different interpretations. This has to do with legislation and a way of writing contracts that are not adequate to meet the needs of a project like this."

"The first is the issue of regulations. As for the existence of rules and the ease of applying them, I think there is a consensus, no one will disagree, that Brazil has many rules. Rules that even conflict, that overlap; it is difficult to identify which rule is valid. When it comes to assessing risks, I believe that, in Brazil, regulations are not clear, people do not know which rules are going to cause problems; it is not like in other countries. The rules give rise to interpretation."

Legislation was clearly related to the control function in this case. According to the first of the previous participants, contracts are written in a way that they are plausible of being interpreted in several ways. It is therefore difficult to ensure that the activities carried out by the counterpart are not pursuing separate and undesired objectives, which may negatively affect the results. Furthermore, the second participant explains that it is difficult to know which law or regulation is going to generate problems, and the source seems to be the different possible interpretations, given how ambiguous legislation is. This may be related to all risk dimensions and contractual hazards.

Finally, the following quote is enlightening regarding legislation changing the way the adaptation function works:

"I think it would be the third, adaptation, because adaptation is a change. And when there is a change, there are many different opinions about everything. The ideal would be to define the competence of each one…"

The adaptation function can be especially problematic given the difficulty to agree on the importance of the change in the context. The reliability of the adaptation function, for example for price adjustments or unexpected physical conditions or force majeure, is not clear. This could be related to level of specificity of the legislation as well. Legislation, therefore, may not be helping the public sector with the management of standard opportunistic behaviour.

- The Link between Judiciary and Contractual Functions

The judiciary could also change the way the coordination function works. The following participants were eloquent regarding this topic:

"For example, for environmental risks. What the Public Ministry (the Judiciary) says against any State intervention. Often, they have weak arguments and, on the other hand, you need to spend a lot of energy to fight it and respond."

Formal rules, specifically the way the judiciary works, is related to the success of the coordination function. According to this participant, the complexity of some tasks related to environmental

risks of the project has the consequence of the intervention of the Public Ministry. Although the EIAS steps are in place, prosecutors may affect the schedule. This, in turn, has consequences on the relationship between the Government and the contractor, as the sponsor needs to deal with these issues, which may slow the projected schedule. This is again related to how the contract is interpreted by, in this case, independent public prosecutors.

If the judiciary does not have the needed degree of specialisation and judges may delay without reasonable arguments, they increase the potential pressure that can be exerted by different parties. More political and social risks may be present if the judiciary lacks specialisation. Hence, the judiciary may promote third-party opportunism.

The judiciary could also affect the way the control function works and the following participant was clear regarding this issue for this case as well:

"Then, another important issue also arises, an aggravating factor in recent years, which is the issue of the judicial decision. Brazilian justice is usually very slow in its decisions. So, this generates insecurities. Today, it makes technical decisions, but it does so with an opinion, without knowledge. The weight of the judge's opinion becomes very important in law enforcement. As a result, it is very difficult to know what a judge will decide. I give you an example. It is certain that the project will be challenged in court in the environmental licensing phase. In all projects, there comes a time when society criticizes, for some rule that has not been followed, information that they believe is not true (...) I do not remember that something like this has paralyzed an enterprise, it made it unfeasible, but it is a risk that affects the team's decisions. There are different interpretations, the process may or may not be judicialized, but a second point appears. There is an emotional issue in the judge's decision, due to his lack of knowledge, not rational."

Formal rules, specifically the judiciary, are related to the success of the control function. It changes the applicability of property right clauses. According to this participant, the judiciary lacks the knowledge that is needed to deal with issues related to the megaproject. This slows the project, and may generate social and political risks, which are related to third-party opportunism.

6.3.2.2 Central Railway Project of Uruguay

- The Link between Polity/Bureaucracy and Contractual Functions

As explained, bureaucracy, as executive power, could theoretically affect the potential effectiveness of the contract by changing the way the coordination function works. The following quote shows how a participant visualizes the previous link in this project:

"The problem, the characteristic of the project, is that it began with a public works contract approach. There is a specification that has a very large amount of detail, characteristic of a public works contract. And it ended due to an issue of financing capacity, solved by Law 18786, which is the PPP Law, which has a risk division, and regulatory decree 17012 specifies how that division has to be managed. So, there is a mix. The contract was quite well designed. (…) If one sees the Law, all the design and construction risks are the contractor's and should not even be mentioned in the documents, but when one reads them, one sees the detail as much as possible, including thicknesses, heights, values, etc. It's all specified. So, the contradiction, or the contradictions, occur mainly because, conceptually, the tool with which the project was financed was not based on the perspective with which the solution was designed."

Formal rules are related to the success of the coordination function, especially those clauses related to roles and responsibilities. According to this participant, bureaucracy was not aligned; the contract was developed considering one tool (public works contract) by the MTOP, and the Ministry of Economy and Finance decided to use another tool: a PPP contract. This could eventually generate problems regarding what is expected that the different parties in the contract should do.

This is relevant for the relationship between risk factors and contractual hazards mentioned in the previous section. In particular, standard opportunistic behaviour could be used by an experienced contractor, versus the unexperienced public sector, taking advantage of the contradictions that the contract shows. It could discretionarily make decisions regarding technical issues in order to maximize its profit, without considering the other party's interest.

Besides, it was theoretically proposed that bureaucracy could also affect the way the control function works. The following two quotes are eloquent on that subject:

"As I was telling you, many times the discussion arises between what a PPP control would be, where the contractor chooses the technical solution, and the control itself. That problem will come to us later, when we are building. The contractor may decide to include something that they initially do not agree with (...) I would like there to be an agile dispute resolution system, a conciliator. There is no such thing, what we have is a supervision, (...) we inform the steering committee, that talks with the company and there they reach or not an agreement, or not."

"The one that would be weaker would be the control part. In Uruguay we do not have much experience in this stage of PPP contracts. We have very isolated experiences in control and monitoring (...) I believe that there is a long way to go."

According to the last participant, given the experience of the public sector, the control function is relatively weaker than the others. He relates the reliability of the control function, for example,

those clauses related to property rights, the scope of service and performance guarantee clauses, to the experience of bureaucrats. Again, and for the same reason, this is important for the relationship between risk factors and contractual hazards mentioned in the previous section. These participants agree that there is a difference between what is written in the contract, and the capabilities of the public sector to deal with the problems that may arise at the construction stage.

Finally, the bureaucracy could change the way the adaptation function works and the following quote shows how a participant visualises the previous link for this project:

"And well, regarding the other part, adaptation, the casuistry is enormous, and well, if it is a cause of force majeure, or milestones that merit a rebalancing of the economic and financial equation, I must also say that we do not have experience in renegotiation either (...) I think the program here is very good, but it is very incipient. The structuring is very good and, getting to contracts, the contract is good as well. Now we have to see the execution of the contracts, the second part."

This participant explains that the adaptation function has been included in the contract, but the success of the adaptation at the execution stage will depend on the experience of the public sector. He says that there is little experience in this matter in Uruguay, as the PPP program is still incipient. He basically links the reliability of the adaptation function to the experience of the public sector when using those clauses. This is also important for the relationship between risk factors and contractual hazards mentioned in the previous section; experience can be particularly needed to deal with standard opportunistic behaviour.

- The Link between Legislation and Contractual Functions

As expected, legislation could affect the way the coordination function works, and the following two quotes from the same participant give a good idea of this issue:

"This project, as it transcends several departments, there is departmental legislation that in not all of the same tenor, and that may have had some degree of affectation (...) to obtain approvals, say, of the project in what has to do with land use planning."

"In a project of this nature, so that work does not fall on people who do not have to be dealing with issues that do not correspond to them, I would change something (...) For example, when you face an expropriation process, I would try to accelerate; there is a Law and everything, I would try to see that it is more agile than it really is. Because the State is sized for a certain job."

"This is a project that goes beyond what the State has as a normal dimension of task. So, I say we should take that into account."

Formal rules, specifically legislation, are related to the success of the coordination function, especially those clauses related to roles and responsibilities. According to this participant, this may hinder the possibilities of dealing with some social risks, like the involvement of several public bodies (first quote), or the impossibility of obtaining land and access rights (second quote).

This is, again, important for the relationship between risk factors and contractual hazards mentioned in the previous section. Problems with the coordination function of the contract, as a consequence of inadequate legislation, may generate an increase of social risks, which are related to third-party opportunism.

Moreover, legislation could also affect how the control function works, and the following quote from one participant clearly shows how this was working for CRPU:

"The one that would be weaker would be the control part. In Uruguay we do not have much experience in this stage of PPP contracts. We have very isolated experiences in what is control and monitoring. Both in the Law and in the regulatory framework, although there are guidelines, which were later strengthened with best practice guides, (...) I believe that there is still a long way to go."

The control function is relatively weaker than the others, given the experience of the public sector. The reliability of the control function, can be related to the experience of the public sector, but also dependant on legislation.

6.3.2.3 Line 1 of Metro of Bogota

- The Link between Polity/Bureaucracy and Contractual Functions

Two participants mentioned how bureaucracy was affecting the coordination function:

"Personally, I think the coordination part (coordination function of the contract) is going to be complex. In Bogotá, the issue of working with other entities is very complex. Metro is a very new company, compared to others that are 40 years old."

"As I told you, concession contracts have been made mainly outside the cities, for highways. This is one of the first times it has been done in an urban setting. Usually, the type of contract is turnkey. Here (...), there are still coordination issues to learn and establish. (...) The agents who

are involved are not used to this type of contract. The way they act is very rigid, it is standard of what they have done all their lives. (...) Along the way it will be necessary to adjust certain interactions with entities."

The previous participants indicate that the coordination function of the contract is especially difficult given the number of public actors and agents involved in the project, and their experience with this kind of project. They confirm that the reliability of this function can be related to formal rules, specifically bureaucracy, particularly considering the experience of the public actors involved.

This is especially relevant for the relationship between risk factors and contractual hazards mentioned in the previous section. It is only logical to assume that problems in the coordination of activities between different public actors involved may generate problems to manage, for example, third-party opportunism. It may also be relevant to deal with controversies that may arise from different ways of understanding the contract.

Besides, bureaucracy was also related to the way the control function works, and the following two quotes were eloquent:

"In terms of control, it is more complex. The contract should think about everything that can happen and what is important to control. We do not know now, until experience tells us, we do not know where is going to lack control to align the incentives."

"And in control, a super positive fact is that we have PMO, as a support given that we are a young company. The fact that there are people who have participated in metro projects also allows us to control how we want to do it."

These participants illustrate that the control function is more difficult given the complexity of the project. For example, clauses related to property rights, scope of service and performance guarantee are going to be more difficult to develop in the contract. Under their view, the reliability of this function can be related to the experience of bureaucrats.

Again, this is important for the relationship between risk factors and contractual hazards mentioned in the previous section. For example, it is reasonable to assume that problems in the development of clauses related to the scope of service could generate standard opportunism. The contractor will most probably be worried about the benefits he may obtain from this interaction, and, if the contract gives the space to so, he will do the minimum necessary to maximize its return.

Finally, bureaucracy was also related to the adaptation function works in this project. The following quote shows how a participant visualised the previous link:

"I feel that in terms of adaptation, the contract is quite flexible. The source is the concession contract experience. It is flexible because it has different mechanisms to resolve conflicts, such as being the friendly composer, ways of changing technical specifications. It has a clear, transparent, risk allocation. In terms of adaptation, I believe that the contract is flexible to see the expected problems, changes and conflicts."

According to this participant, the adaptation function is well resolved. It is related, for example, to price adjustments clauses or unexpected physical conditions clauses or force majeure clauses. The reliability of the adaptation function, in his view, is given by the experience of the public sector when developing those clauses. The participant also mentions the control function, and conflict resolution clauses, which can be also related to the bureaucracy in place, as stated in the previous section.

This is also important for the relationship between risk factors and contractual hazards mentioned in the previous section. For example, it is reasonable to assume that problems in the development of clauses related to price adjustments could generate standard opportunism. The contractor will most probably be worried about the benefits he may obtain from this interaction and, if this contractual function is not correctly handled, it could probably take advantage.

- The Link between Legislation and Contractual Functions

Legislation may affect the potential efficiency of the contract, by enabling contracting and framing the context to assist in contract enforcement. Specifically, it may do so by changing the way the coordination function works, which deals with the need to coordinate interdependent tasks between the different parties which may have to be carried out separately or jointly.

Two participants showed how legislation was affecting the coordination function in this project:

"Yes, this makes me think about the property issue, because this issue is complex. We have tried to start the issue last year, but expropriation here is a long overdue issue. In the contract, it was clear that there is going to be a strip that is going to be delivered, but all the issues related to that, with a very tight schedule, can be complicated. Legislation makes the possibility of obtaining the properties slow, and that means that the state must assume them."

"I believe that Colombia has been character as a country with many laws. Everything is over-regulated, everything has a certain bureaucracy, much of the concern of people who work in the public sector is that they want to help but there is always the risk that they will end up in a

disciplinary investigation. This has caused much of the risk allocation to go to the private sector, due to the risk of making technical decisions."

The first one of the previous participants explains that legislation is related to the success of the coordination function, especially those clauses related to roles and responsibilities. According to this participant, legislation may hinder the possibilities of dealing with some social risks like the impossibility of obtaining land and access rights. The second participant, moreover, explains that over-regulation is related to more risk transfer, transferring some roles that should not be transferred to the counterpart, which could eventually generate more technical risks.

This is, again, important for the relationship between risk factors and contractual hazards mentioned in the previous section. Problems with the coordination function of the contract, as a consequence of inadequate legislation, may generate an increase of technical and social risks, which are related to standard opportunistic behaviour and third-party opportunism.

Furthermore, the following three quotes are persuasive in terms of how legislation was affecting the way the control function works:

"For example, regarding legislation, we had some cases, in the environmental strand, where we did not have enough normative information that would give us the tools to prevent risks of an environmental impact by the project in its different stages, especially in construction and operation."

"It is a novelty to work on a concession contract. We had always worked with technical specifications, with a technical offer. Let's say that, in that way, we were able to have a different degree of control. Here, by giving flexibility to the contract, although we try to reduce it to the maximum, well, there is still a risk."

"We are super regulated. But politicians can ask us what they want in the terms they want for petty purposes. They are not even thinking about protecting the public resource or anything like that. And we are in the middle of a political campaign, because unfortunately the term of the Mayor's Office is very short compared to the project's schedule. Some want to get it out quickly before leaving and others want to prevent it from leaving. And there are no mechanisms to regulate them."

The first of the previous participants explain that formal rules, specifically legislation, are related to the success of the control function, and may impact on environmental risks. The second one defends that the lack of legislation may hinder the possibilities of dealing with political risks, such as lack of political support, and political interference.

If we take as true that environmental and political risks may generate third-party opportunism, we can also say that legislation may be the source of this problem. Legislation may not help to minimise standard opportunistic behaviour and third-party opportunism by means of a developed control function of the contract.

Finally, the following quote enlightens how legislation may affect the potential efficiency of the contract by changing the way the adaptation function works:

"There is a distaste that sometimes remains. I am not a lawyer, of course, but sometimes I get the feeling that there is an attitude in the legal framework in terms that if something happens, then the sanctions or what is going to happen will finally have to be assumed by the public company (Metro of Bogotá), instead of another party that may be responsible. It is also a feeling from other projects in the country, there remains a feeling of: who is the law for?

Interviewer: Are you talking about the content of the adaptation clauses?

Yes, exactly. That's how it is. That is the feeling. That the private sector is favoured instead of the public sector."

According to this participant, the adaptation function is not well resolved, given that it is probable that the public sector will have to assume the costs in unexpected contexts. The reliability of the adaptation function, for example, for price adjustments or unexpected physical conditions, is related, according to this participant, to the legislation, which favours the private sector. Legislation, therefore, according to his view, may not help the public sector with the management of standard opportunistic behaviour.

- The Link between the Judiciary and Contractual Functions

The following participants were eloquent on how the judiciary may affect the way the coordination function works:

"Let me think ... in Colombia you can honestly stop a project, or if a judge says that it does not stop, it stops on the other hand, with another lawsuit. That is why there are risks that only the contractor can assume, because the rules that exist do not allow us otherwise. That happens to us. They have put us guardianships, resolutions, lawsuits, for environmental issues that slows down the process. A judge without knowledge blocks the project. That is very complicated here. They give these issues to judges who have no idea what they are talking about (...) They are judges who come up with arguments that they looked for in Google."

"We have a risk. Although we have taken the time necessary for the project to mature, we did set a very serious limit and that is that the change of Government in the city could mean the death of the project after 3 years of work. That imposed schedule limits that are not always the most fortunate, because they lead to decisions at a given moment that sacrifice aspects that they should not sacrifice."

Formal rules, specifically the judiciary, can be related to the success of all functions. However, it may particularly change the reliability of the coordination function. It may change the way the contract is developed in terms of roles and responsibilities, as the first of the previous participants explain, and it can also modify clauses related to calendar or program of actions to be developed.

If the judiciary does not have the needed degree of specialisation and judges may stop or delay without reasonable arguments, they may increase the potential pressure which can be exerted by the politicians and the media. With a judiciary without specialisation, more political and social risks can be in place. The judiciary may promote third-party opportunism.

Besides, the following participant was clear regarding how the judiciary was affecting the control function:

"They (these projects) should be shielded and isolated from the political component and the media component. (...) Here it would seem that sometimes we are coming and going considering what politicians and the media say. The media, unfortunately, in my opinion, in this country, works for pay. If they are paid to say something, they say it, without investigation, without rigor. That leads us to have to give a series of explanations about a number of atrocities and lies that take us away from the true point. And that to avoid lawsuits or judges that could stop the project."

The control function is related to clauses to deal with property rights, confidentiality, service scope and performance guarantee, and conflict resolution, among others. The judiciary, in this case, may stop the project in response to unreasonable demands from third-parties. Ergo, an erratic or inexpert judiciary may promote third-party opportunism.

Finally, the following quote clarifies how the judiciary affects the adaptation function in this project:

"As for the adaptation, I lack information about the force majeure clauses and all that. But there are the three friendly composers, a mechanism by which we don't have to go to court to agree on how to get this out. You can get back on the road, without going to legal proceedings that what they do is put this in a refrigerator, in a freezer, and it is not known how long it lasts. So, in a way, although I don't have all the knowledge about the area, the fact that these mechanisms are there as the friendly composer, allows us to comply."

The adaptation function includes contractual clauses, for example, referring to price adjustments, value engineering clauses, clauses with procedures to address unexpected physical conditions and force majeure clauses, among others. The previous participant shows that they are frequently a source of conflict and that the judiciary does not deal with this in an efficient way. He says that this is well resolved as conflict resolution clauses (which belong to the control function) are included. However, the fact that the judiciary is not able to deal with relevant issues in an efficient way may generate an advantage for the party that has more information regarding a specific matter. It may be a source of potential standard opportunistic behaviour.

6.3.2.4 Summary of Key Findings

Section 6.3.2 shows how the link between formal rules in place (bureaucracy, legislation and the judiciary) and the efficacy in the use of the different contractual functions (coordination, control and adaptation) is actually working in the three selected projects. It shows that the reliability of the functions can be related to particular formal rules. Therefore, formal rules can be relevant to deal with the transaction costs of developing the MTPs analysed.

In general, participants showed that the "rules of the game" may not always help to reduce transaction costs. The cases show that bureaucracy, legislation and the judiciary may not help decision-makers. Instead, the different contractual functions are not always helpful to deal with the risks and hazards, related to the MTPs studied, given those formal rules. Consequently, in their view, transaction costs could be better economised with different formal "rules of the game".

Based on a NIE view, the probable reason behind the previous statement is that formal rules transcend the MTPs sphere, as the same rules are used for different sectors and projects, and other economic and social matters. Theoretically, they can be economising transaction costs for the society as whole, for the different transactions that are being developed, but this is not the problem addressed in this thesis. This section illustrates how the formal institutional environment at the investment phase, in the selected cases, may not be functional to economising the transaction costs related to each one of the MTPs studied. This is thoroughly discussed in section 7.3 with a cross-case view of this topic.

6.3.3 Role of the Planning and Appraisal Process for Transaction Cost Economising

The fourth and final subsidiary question presented in Section 3.1.3 was: How do governmental decision-makers perceive that an 'open-systems' approach to MTP planning and appraisal would impact on the transaction costs, given the formal institutional environment in place? Building from the said theoretical framework and the methodology, this section analyses the qualitative data obtained from the semi-structured interviews related to the third theoretical proposition offered alongside this thesis. Results are presented in a case-by-case basis, as in the previous sections, and are then used to elaborate a discussion with a cross-case view in Chapter 7.

The three selected cases were planned and appraised using a closed-systems approach to planning, with a hard thought system. Project objectives were fixed in early stages by a technical team, imposing the scientification and depoliticization of the problem. Technical teams initially acted as a sole decision-maker with abstract aims that were expected to be fulfilled by the development of the project. A control-oriented phased approach was used, inferring the management of structured phases of a project life cycle one after another. This section (6.3.3.) shows that participants have proposed several reasons behind the selection of this approach to decision-making. However, basically all of them are related to some sort of risk management process.

The case-by case results presented in this section are divided in the following: the role of political and social risks; and planning and appraisal for risk management. In the three cases, when participants were asked about the reasons behind the selection of a "closed-systems" approach to decision-making at the planning and appraisal stages, they raised political and social risks as the most relevant issue. After that, they were directly asked about the planning and appraisal approach as a tool to manage contractual and construction risks, and they elaborated on how this theoretical proposition was actually working in the selected cases.

6.3.3.1 Ferroanel Railway São Paulo, Brazil

- The Role of Political and Social Risks

Firstly, political and social risks were at the top of the list when considering the reasonability of using a "closed-systems" approach to planning and appraisal in FNSP. The following participants are eloquent regarding this subject:

"I believe that this (a "closed-systems" approach) is adopted by several factors. Especially, I think that there is a political factor, due to which the project should start before 4 or 5 years. As soon as a term ends, priorities change."

In Brazil you have a vast territory, several interests, you do not have a single thought. You have different approaches. This diversity makes it very difficult for you to sit everyone down, talk, and then make an agreed decision. This would take a long, long time. The Ferroanel case is a very good example. You have a Federal Government and the state of São Paulo, with different incentives and interests. Ferroanel would be useful for everyone; however, it could be slower (with an "open-systems" approach). Even if everything starts well, it can change quickly.

The first of the previous participants alleged that a "closed-systems" approach can be adopted to deal with political risks. Moreover, according to the second of the previous participants, given its extension, Brazil has political stakeholders with very different interests. In his view, it is difficult to put everyone to work and reach an agreed solution. In this context, a "closed-systems" approach to planning can be perceived to mitigate political risks such as: government discontinuity, opposition or political interference, lack of political support, delays in obtaining approvals and permits, among others. This is particularly relevant given that the political dimension of risk was considered as the most relevant risk dimension for the project's construction, as illustrated by the quantitative strand of this research.

Furthermore, the following participant also related the "closed-systems" approach to planning to the social dimension of risks. The following quotes clarify this issue:

"It is not that it takes time. The communities lack organisational and technical capacity. They do not see the project as a common good. They analyse the specific impact for them."

"I believe that communities, environmentalists, would have the possibility of delaying the work if you open the planning. If you open it too much, you will have problems."

Participants explained that communities lack organisational and technical capabilities and they are not seen as a good partner to plan a megaproject. These interviewees believed that a "closed-systems" approach to planning is helpful to mitigate social risks such as: protests and interference by residents, claims by third-parties, legal actions of the affected community, among others. Again, this is relevant given that the social dimension of risk was the second dimension in order of importance in this project, given the results obtained by the quantitative strand.

Regarding the previous subjects, the following quote supports the general intuition behind this issue:

"I think it is a delicate subject. In other countries, a megaproject is not carried out at a fixed cost. They say it will cost approximately an amount X. From there, the project is developed, all the necessary steps are taken and incorporated into the project. Here, you have to start with a fixed

amount and that brings problems, great insecurities. To ensure that the project develops, few changes need to be made."

The previous participant clarifies the problem. It can be perceived that a "closed-systems" approach to planning is a practical approach to ensure that only few changes are made to the project.

- Planning and Appraisal for Risk Management

The following participants are eloquent and consistent with the general messages obtained in the interviews regarding the possibility of using an "open-systems" approach:

"The benefit of including the community is debatable. If you leave it in the hands of the community, you will not approve anything. The politician can then stop the project."

According to this participant, the megaproject could be stopped if different social actors are included. The community could find political support if its requests are not considered. Moreover, this participant believes that the community's requests would not be beneficial and it would slow the execution.

On this subject, previous sections of this thesis showed that political and social risks are very much related to third-party opportunism at the contracting and execution stage. The line of reasoning that this NIE approach to the problem provides is that a "closed-systems" approach may help to deal with this particular contractual hazard as well. Moreover, this may be happening, at least to some extent, given that contractual functions cannot reduce this contractual hazard at the contracting and execution stages. Previous sections also show that formal rules in place (bureaucracy, legislation and the judiciary) can affect the potential efficacy of using those functions. Specifically, the existing formal rules could actually increase third-party opportunism.

The following participants contribute to illustrate that formal rules may not help to generate an "open-systems" approach.

Particularly regarding polity and bureaucracy, this interviewee was eloquent:

"As the public sector does not have a general vision for the country, as we do not have an organisation specialised in general planning, with accumulated knowledge, with technology, with teams, with sophisticated methodologies for this, what does the Government do? The Federal Government, the State Government, commission the private sector to carry out projects of public interest. But the private sector has no public interest, it has a private perspective."

According to this participant, Brazil does not have an institution specialised in long-term planning, with the necessary know-how, technology, human resources, and sophisticated methodologies. Therefore, it usually asks the private sector to deal with projects which are related to public interest. This is counterproductive to generate an "open-systems" approach to planning.

Besides, the next participant mentioned the importance of legislation:

"I believe that communities, environmentalists, would have the possibility of delaying the work if you open the planning. If you open it too much, you will have problems. And why? Because of legislation and culture. Although this improves the technical proposal, in the end it is better to do closed planning."

In his view, in order to generate an "open-systems" approach, it is relevant to have a correct bureaucracy, but also a legislation that enables the process.

The following participant, in turn, assessed the problem of the judiciary:

"In the first instances you will always receive a negative (response from the judiciary) (...) In the second and third instances, there will be a greater balance."

"Then there is also another important issue, an aggravating factor in recent years, which is the issue of the judicial decision. Brazilian justice is usually very slow in its decisions. So, this generates insecurities."

According to the previous statement, an "open-systems" approach is not possible given that there are no formal rules that make this feasible. Regarding this issue, the absence of a judiciary prepared to deal with the technical challenges that this approach would generate is particularly important.

In summary, according to participants, formal rules may not promote the adoption of an "open-systems" approach in the context of political opposition and social volatility. According to their view, it would incentivize third-party opportunism given the lack of experience of bureaucrats, the absence of legislation to develop initial planning and pre-investment public consultations, and the lack of an experienced and trustworthy judiciary to deal with problems that may arise.

This pre-investment formal institutional context can be projected into the contracting phase. The formal rules at the planning stage are consistent with those related to the development of the contract and are not useful to limit potential third-party opportunism. Given those formal rules, contractual functions may not be as effective as they should to deal with the previous contractual hazard. As a consequence, since the planning and appraisal stages, decision-makers may prefer a "closed-systems" approach as a risk management tool, in order to deal with risks from the

planning stage, but also for the contracting stage of the project, when the contract is finally formalised to start with execution.

6.3.3.2 Central Railway Project of Uruguay

- The Role of Political and Social Risks

In this project, although the technical risk factors were at the top of the construction risks, as illustrated in section 6.1, according to participants, social and political risks are the most important to determine the use of a "closed-systems" approach to planning. In this case, this is not inconsistent, given that the construction risk assessment using fuzzy logic showed that the social dimension of risk was the second in order of importance.

Interviewees showed that the social and political risks were at the top of the list when considering the reasonability of using a "closed-systems" approach to planning. The following two quotes are transparent in this sense:

"It (the "closed-systems" approach) is useful to manage risks, especially those related to politicians and the affected society."

"I'm not saying that doing it this way is a way to prevent people from participating. Yes, it prevents them from blocking it (the project). Claims were always attended, but it is not planned in an open way so that it is more manageable and requested times are respected."

These participants believe that a "closed-systems" approach to planning may be helpful to mitigate social risks such as: protests and interference by residents, claims by third-parties, legal actions of the affected community, among others. Again, this is relevant since the social dimension of risk was the second dimension in order of importance in this project, given the results obtained by the quantitative strand.

The following quotes support the general intuition regarding the previous subjects:

"When the decision is collective, broader, open, it is more likely that it will not come out. When it is closed, it is dichotomous, either it comes out or it doesn't come out because I (Governmental decision-maker) want it or I don't want it."

"I believe that the fear of opening the planning is that you begin to lose control; communication management is difficult. It (the project) may become a lot of things that you do not want, or later it is a snowball."

The previous participants clarify the problem. It may be perceived that a "closed-systems" approach to planning is a useful approach. In their view, it can help to manage misinformation as well.

- Planning and Appraisal for Risk Management

Regarding the option of using an "open-systems" approach to decision-making at the planning and appraisal stages, the following participants are coherent with the previous messages:

"Knowing the idiosyncrasy of Uruguayans -as in soccer- if you open the discussion, everyone will have an opinion. They are all engineers, architects, and they have opinions, and it may generate delays. (...) You have to respond to claims; I'm not saying they don't contribute, but it would be unmanageable. There are many people who do not have this spirit of contributing."

Participants perceive that an "open-systems" approach to planning would directly stop the project. Basically, this consideration is related to political and social risks and the following quote makes this clear:

"The project was not initially presented to all the actors because there are forces that are against every project, which may generate complications and make it fail. (...) there has been experience of other projects that have not materialised, (...) I get the feeling that using this "open-systems" approach is seen as something risky."

Previous sections of this chapter showed how political and social risks can be related to contractual hazards, particularly third-party opportunism. Using a NIE perspective, the "closed-systems" approach could help to deal with this particular contractual hazard when executing this project. Part of the explanation is that contractual functions (control, coordination and adaptation) cannot reduce this contractual hazard. Formal rules in place may affect the potential efficacy of those functions.

The following participants help to clarify the previous statement. Regarding polity and bureaucracy, this quote is illustrative:

"There are two variables. Lack of time and the fact that political authorities were not advised on the importance of maintaining more intense contact with the social actors involved in such an important project. I think time was perhaps a minor variable because a specific team could have been put in place to do that, go to get feedback (...) In the design stage of the layout there were three people. Later, two more came with the consultant. This needed a much larger team. A very good job was done from the national surveying division, which carries out the expropriations.

But they began in November 2017 with the expropriation stage, hiring a psychologist. A good job was done in that regard. But it would have been necessary to have done a previous work to show this."

As explained, time was relevant, but the participant is also making explicit that the problem was the lack of human resources to work on this, the bureaucracy available. The planning phase was developed basically by politicians that did not know how to communicate this correctly, and the appraisal was developed with lack of human resources.

Moreover, the following interviewee refers to the bureaucracy as well:

"There is a technocracy, formed many years ago, like this. The bureaucratic technician, who has decision-making power, is used to being right. Sometimes it is said 'people don't know what they want.'"

The next participant mentioned the importance of legislation:

"There has been a great lack of dialogue between the current Executive and the opposition regarding this project. It should have been a State policy. But of course, there may be politicians who would block things if you open that field. There should be an institutional framework to avoid this from happening. Better legislation..."

In his view, there is a need for better legislation in order to promote the dialogue between politicians from different parties. This way, megaprojects would be developed as State public policies, and not politically associated with political parties.

The following participant assessed the problem of the judiciary:

"I Imagine the different organisations would have to agree for there to be such a formal rule. It cannot be imposed. You need to draw up a law. That should be discussed in parliament (...). They would have to create a supra body on this issue, with a judiciary that knows and has authority (...) You have to generate all that ... And here we don't have that."

According to this statement, an "open-systems" approach would need a supra institution in charge of planning. There should be legislation, and a judiciary that has the correct know-how. None of these are available in Uruguay and, therefore, in his view, it is not reasonable to develop an "open-systems" approach to planning.

Similarly, considering the previous case, formal rules may disincentivize the use of an "open-systems" approach to decision-making at the planning and appraisal stage in this MTP, given the

potential social and political opposition. If used, it could incentivize third-party opportunism, due to the characteristics of the legislation, bureaucracy and judiciary in place.

As in the previous case, the formal institutional environment at the pre-investment stage can be projected into the contracting phase. The formal rules at the planning stage are consistent with those related to the development of the contract and are not useful to limit potential third-party opportunism. As already explained, contractual functions, related to those formal rules are not as effective as they should to deal with third-party opportunism. Ergo, since the planning and appraisal stage, decision-makers may prefer a "closed-systems" approach as a risk management tool to deal with risks that may appear along the project lifecycle.

6.3.3.3 Line 1 of Metro of Bogota

- The Role of Political and Social Risks

Firstly, political risks were at the top of the list when considering the reasonability of using a "closed-systems" approach to planning and appraisal in this project as well. The following participants are eloquent regarding this subject:

"Since its inception, this project has been associated with political-social pressures. The transition from the technical option to the elevated train was difficult because there was some support for the subway; because it was not understood why the changes were necessary. Since the change took place, the defence of the project, with the community, from the political point of view, was always in the background. A project that begins like this has effects on its maturation. The project should be able to mature and have the support of all; that would greatly facilitate the subsequent steps. (…) Here, this was not done because of political reasons. The Mayor could not open the project because it was being held back from a political point of view. It would have been overthrown."

"The Metro became a political issue from day one. They made it a political issue. Citizens have been cheated. Metro (the planning of) has been around since 1942 in Bogotá, so society no longer believes decision-makers. And, obviously, if there were more public intervention, as the issue is so polarised, I think we would still be at a discussion level."

Clearly, a "closed-systems" approach to planning is perceived by some participants, to contribute to mitigate the political risks of "subsequent steps". At the contracting stage, this is related to construction risks: government discontinuity, opposition or political interference, lack of political support, delays in obtaining approvals and permits, among others. This is particularly relevant

given that the political dimension of risk was perceived as the most relevant risk dimension for this project's construction, as illustrated by the quantitative strand of this research.

Furthermore, the following participants also relate the "closed-systems" approach to planning to the social dimension of risks. The following quotes clarify this issue:

"When a "closed-systems" approach is carried out, some risks are reduced, not all. But with an open approach to planning you can find madness. Stakeholders, some of them, have no knowledge."

"There are associations, there are unions, there are very solid stakeholders, which can generate popular actions, where they say that they do not agree with the project because of A, B, C. It can be of a technical or political nature, and a project can be stopped."

These participants believe that a "closed-systems" approach to planning is helpful to mitigate construction risks related to the social dimension, such as: protests and interference by residents, claims by third-parties, legal actions of the affected community, among others. Again, this is relevant given that the social dimension of risk was the second dimension in order of importance in this project, given the results obtained by the quantitative strand of the proposed methodology.

The following quotes support the general intuition regarding the previous subjects:

"It is a practical way (the "closed-systems" approach), considering the benefits that the proposed technical solution can have. When you talk about a "closed-systems" approach to planning, you apply it since the conceptual design of the project."

"Yes, a "closed-systems" approach to planning helps to manage the risk of misinformation."

The previous participants clarify the problem. It may be perceived that a "closed-systems" approach to decision-making at the planning and appraisal stages is practical. In their view, it may help to manage misinformation along the project.

- Planning and Appraisal for Risk Management

The following interviewees are consistent with the messages obtained in previous cases regarding the feasibility of using an "open-systems" approach:

"I believe in a "closed-systems" approach to planning. Democratic planning does not work, because it is very difficult to make sure the different actors agree; each one is going to defend

their particular interests and not the joint interest (...) If we had followed a democratic process here, no project could have been done."

"It is a small group that makes the decision, with a multi-criteria evaluation, with all its components, but it is not integrated with others. From our perspective, we feel it would not have turned out other way; we have been with the project for so many years, dozens of years, trying to get everyone to agree. It is not so positive to be so democratic because you do not end up developing projects in the city."

Participants perceive that an "open-systems" approach to planning would directly stop the project. They are not clear regarding at what stage would this happen but it is evident that the use of a "closed-systems" approach to planning can be related to political and social risks. The following participant makes this clear:

"I believe that everything that has to do with the technical issues, in my view, it is perfectly planned, documented and arranged. But that socio-political pressure can stop the project, it can put the stick in the wheel. That's the way I see it. (...) Being very open, although I stand for rights and equity, I also think that there must be a point at which the country must execute and there should not be more talking."

It is evident that political and social construction risks can be one of the reasons behind the use of a "closed-systems" approach to planning at the structuring phase.

Again, these risks are related to third-party opportunism and the "closed-systems" approach at the planning and appraisal stages can help to deal with this particular contractual hazard, which basically occurs after the contract is signed. The control, coordination and adaptation functions may not effectively deal with the abovementioned contractual hazard, given that bureaucracy, legislation and judiciary are not fit for that purpose.

The following participants help to clarify that formal rules may not help to adopt an "open-systems" approach.

Regarding polity and bureaucracy, this participant was eloquent:

"From my point of view, we do not adopt this (an "open-systems" approach) because of the capacity of the teams. It would take very large teams to do that. Secondly, the decisions here are more political and organisational, and not taken at the social level. If you include people, if you give everyone space and light, this will never be closed."

According to this statement, an "open-systems" approach to planning requires human resources capable of developing it, and they did not have it in this case. This lack of human resources is

consistent with the lack of experience of the bureaucracy to deal with this type of projects, which may affect the use of contractual functions to deal with third-party opportunism. Besides, an "open-systems" approach to planning could have stopped the project given the lack of agreement between the different agents involved.

The next participant mentioned the importance of the legislation:

"There is a regulation in Colombia that requires prior consultations. However, this stage was not mandatory in this case because it applies to rural roads, outside the urban environment."

In order to generate an "open-systems" approach, it is relevant to have a correct bureaucracy but also a legislation that enables the process, which should be related to what will happen at the contracting stage.

Finally, the following participant assessed the problem of the judiciary:

"Yes, prior consultations do exist in our legislation, but not for all types of projects. However, almost always those consultations end up being more a political discussion than a technical one. What they do is paralyze the project because there is no such due diligence of the judiciary afterwards. Let's say that they (the stakeholders) can even reach an agreement, and agree on the table. Then that same one who agreed will go and sue and throw back everything agreed. I believe that what is missing is what one could call 'more judicial stability' in these types of decisions."

According to the previous participant, an "open-systems" approach is not possible given that there are no formal rules that make this feasible. Regarding this issue, the absence of a judiciary prepared to deal with this in the next steps, after the "open-systems" approach has been developed, is particularly important.

The participants of this project also confirmed that they lack formal rules to develop an "open-systems" approach, considering the current state of bureaucracy, legislation and the judiciary. As well as in the two previous cases, the pre-investment formal rules of the game may affect the contracting phase. Formal rules may not be useful to limit potential third-party opportunism and contractual functions can be ineffective. Consequently, since the beginning of the project lifecycle, decision-makers may prefer a "closed-systems" approach as a construction and contractual risk management tool.

6.3.3.4 Summary of Key Findings

Section 6.2 showed that the nature of MTPs implies a very complex set of risks, particularly related to the political, social and technical dimensions. Besides, Section 6.3.1 illustrated how decision-makers believe that those risks can be related to unusually elevated contractual hazards. These higher contractual hazards mean that MTPs have more transaction costs when developing a typical construction contract.

Moreover, Section 6.3.2 showed how formal rules of the game may be perceived as inadequate by the decision-makers and that the said rules may not help them to reduce the transaction costs mentioned in the previous paragraph. On the contrary, bureaucracy, legislation and the judiciary, as they are currently in place, could entail more transaction costs as contractual functions are more difficult to use. In particular, it is safe to say that political and social risks, related to third-party opportunism, may increase transaction costs.

In this context, Section 6.3.3 showed that in an already probable scenario of high transaction costs related to construction risks, contractual hazards and inadequate formal rules (at least for MPT development), decision-makers may believe that they can economise transaction costs by using a "closed-systems" approach to planning, as risks are minimised. Furthermore, formal rules at the pre-investment stage may not promote an "open-systems" approach to planning. This is reasonable, in their view, as an "open-systems" approach to planning could generate more transaction costs. This issue is thoroughly discussed in the next chapter.

7 Discussion

7.1 Chapter Overview

The overall aim of this research was to examine the nature of the relationship between the selection of the MTP planning and appraisal approach and the complex set of transaction costs that that this type of projects imply. In particular, it analysed if the formal institutional environment surrounding planning, appraisal, contracting and implementing megaprojects, can be contributing to the selection of a "closed-systems" approach to decision-making at the planning and appraisal stages.

In order to do so, it used a multiple-case study to explore how construction risks are translated into contractual hazards, how formal rules affect contractual functions, and how these contractual hazards can be handled by using a "closed-systems" approach to decision-making at the planning and appraisal stages, given the formal institutional environment surrounding MTP development. The following subsections discuss cross-case results regarding each one of these steps.

7.2 The Link Between Construction Risks and Contractual Hazards

Given the general objective mentioned above, the first research objective of this document was to study how construction risk factors could be related to contractual hazards in the multiple-case study. A thorough list of construction risks was included in Table 1 of Section 2.3.4, the list of contractual hazards considered was presented in Section 2.5.4, and the link between risk factors and contractual hazards was theoretically introduced in sections 2.6.3 and 4.2.1. The pattern matching analysis was developed in terms of which risk factors are connected to which contractual hazards. In the paragraphs below, this link is explored in light of cross-case results.

7.2.1 Political and Social Risks as sources of Third-Party Opportunism

The three MTPs included in this research process presented very different situations regarding political risks. It was the most important risk dimension in the case of Metro Line 1 of Bogotá (L1MB), and the most relevant risk factors within this dimension were: government discontinuity, delays in obtaining approvals and permits, and opposition and political interference. Secondly, it was the less important risk dimension in the case of the Central Railway Project of Uruguay (CRPU), but one of the former risk factors was between the top 10: delays in obtaining approvals and permits. Finally, the political dimension was also the most relevant risk dimension in the case of Ferroanel Norte of São Paulo (FNSP), and the most relevant risk factors in this case were: lack

of political support/political indecision, lack of transparency and corruption, and government discontinuity and opposition.

This is in line what it was presented at the literature review, when megaprojects were characterised as political projects in section 2.2.2. MTPs are normally used to influence electoral contests, and opposition or lack of political support may be generated as a result of carrying them out. Technical/rational arguments in favour or against these projects are usually constructed as a consequence of their complexity (see section 2.2.5). In particular, directional complexity, defined as the disagreement on the paths to achieve the objectives of the MTP, or the objectives themselves, can be the source of the constructed technical argument that generates political risks. Moreover, the organic nature of MTPs, the fact that they co-evolve with their context and undergo a transformation in their objectives, is also in the source of political threats.

In the three cases, interviewed participants identified a link between political risks and third-party opportunism. In L1MB, changing political objectives, as a result of the city elections that were expected in the short-term, were considered to increase the potential political interference when executing the project. In CRPU, the relationship between social and political agents was expected to generate political resistance at the construction stage. In FNSP, changes in political points of views, given the potential changes in the context, were related to potential political indecision, which was expected to generate difficulties for the development of the project.

The link between political risks and third-party opportunism was initially reasonable given the selected theoretical background. Third-party opportunism is related to public contract scrutiny, considering that the essence of public contracting is its publicity. This type of opportunism may be exercised by politicians, or other stakeholders. In the three cases, the mentioned link was perceived as independent of the context. Political circumstances in each case had singularities. However, no significant link between political risks and the other contractual hazards (standard opportunistic behaviour and governmental opportunism) was mentioned by participants. The pattern in this case was evident.

As for social risks, in the three cases, interviewees assessed that this dimension was in second place, in order of importance. Moreover, the social risk factors that they specially considered in each case were much more similar. The most important social risks in L1MB were: involvement of many decision-making bodies, and protests and interference by residents. The same two were the most relevant in the case of CRPU. The involvement of many decision-making bodies was also considered in FNSP, but participants also included “compensations higher than expected”.

This is also related to MTPs’ special characteristics explained in the literature review, especially in section 2.2.3. The interconnection between stakeholders with different and conflicting interests

around the project is the source of the social risks considered. The difficulty to establish the boundaries between the different groups involved, which may generate a spiral of intervention, connecting the social dimension of risk with the political dimension explained before, is of particular importance. Moreover, there is a social complexity which is related to the broad group of participating actors, who need to work with each other and communicate in order to develop the project.

The link between this risk dimension and the same contractual hazard was noticed in the three cases. A pattern was also found in terms of the link between the social dimension of risk and third-party opportunism. Potential protests and interference were reasonably related to potential challenges to the probity of the contract in L1MB. In CRPU, new demands that affected the technical development of the project were generated due to social noise. In FNSP, the involvement of many decision-making bodies increased the possibility of interference by third-parties, especially politicians.

This link was also consistent with what was explained in sections 2.6.3 and 4.2.1. This type of opportunism may be exercised by different stakeholders as they may achieve political and economic benefits. Social risks lay the ground for the existence of this contractual hazard. Besides, no substantial comments were made by the participants regarding a potential link between social risks and governmental opportunism or those risks and standard opportunistic behaviour.

7.2.2 Technical/Economic/Environmental Risks as sources of Standard Opportunism

The three selected megaprojects give variability to this study as well in terms of technical risks. Considering the five dimensions, the technical one was the third most important in L1MB, the most important in the CRPU, and the fourth most important in FNSP. For L1MB, the most relevant technical risk factors were: special conditions on the site and inaccurate estimates of project costs. In CRPU, the most important were: changes in project scope requirements, inaccurate estimates of project costs, and other changes in the engineering design of the project. Finally, in FNSP the most significant technical risks were: technical difficulties in making changes to the affected utilities, changes in technology or in industry standards, and changes in project scope requirements.

Evidently, this risk dimension is related to the typical technical complexity of MTPs alluded in Section 2.2.5. These projects normally present a design challenge, linked to a number of tasks to be developed in an intricate spatial and temporal framework. Moreover, this is also related to an

infrequent strategic environment presented by MTPs as global projects (Section 2.2.7), which include different value chains and complex interfaces between the public and private sector.

Although there is variability in terms of the technical risk factors assessed as most important by participants, a link between risks from this nature and standard opportunistic behaviour could be extracted from the conversations in the three cases. In L1MB, there was a perceived link between the good level of experience of the public company in charge and a minimised generation of information asymmetries. The same link was observed in CRPU, although in a different direction. The lack of an appropriate team to deal with the complexity of the project and the urgency at the pre-investment phase could have generated information asymmetries. Finally, in the same line of reasoning, there was a perceived bet made by decision-makers in FNSP, an acceptance of information asymmetries given the need to advance to the contracting stage without complete pre-investment studies.

This pattern is consistent with the presented theoretical lens. Standard opportunistic behaviour may occur because there may be asymmetric information between the parties involved in the construction contract. Asymmetric information refers to any situation where one party to a transaction has greater material knowledge than the other party. If the public party has little experience, or needs to advance fast and does not develop consistent pre-investment studies before contracting, it is reasonable to expect more information asymmetries and, therefore, standard opportunistic behaviour.

The three projects were complex in technical terms but, again, there were particularities in each case. Nevertheless, the same link was present in the three cases. No link was apparent between technical risks and governmental opportunism, nor third-party opportunism.

On the other hand, the economic dimension of risk proved to be one of the less important in the three selected cases. It ranked as the fourth risk dimension for the case of L1MB, and the third risk dimension in the other two cases, CRPU and FNSP. In both L1MB and CRPU the exchange rate was among the most relevant economic risks. In FNSP, the participant assessed economic recession and changes in material costs as the most relevant ones.

Once again, this risk dimension was related to one specific contractual hazard. In this case, the interviewees linked this risk with the potential existence of information asymmetries. In L1MB, risk management was expected to be well treated given the solid team that worked on the contract. In CRPU, it was mentioned that the level of information regarding economic variables could be potentially translated in standard opportunistic behaviour. That is why the contract was developed as detailed as possible regarding these matters. In FNSP, information asymmetries were related

to the contractor characteristics. This is associated with the typical moral hazard of potential contractors, which can lie in order to obtain the construction contract.

This link, between economic risks and standard opportunistic behaviour, was consistently revealed in the three cases. This was not the case for this kind of risks and governmental opportunism, or third-party opportunism. Economic risks were usually related to some kind of asymmetric information at the moment of contracting.

Finally, environmental risks were considered the less important in general terms; the fifth risk dimension in the case of L1MB, the fourth in the case of CRPU, and also the fifth in the case of FNSP. Heavy rain was the most relevant risk factor in the framework of this risk dimension in the three cases.

Standard opportunistic behaviour was the contractual hazard that was mentioned in the two cases where a link between this risk dimension and contractual hazards was visualised. In L1MB, the potential risk was related to the level of information that the parties had before the contract. Besides, the level of these risks was associated with to the level of detail of the contract when dealing with them, intimately related to the level of information as well.

7.3 The Link Between Formal Rules and Contractual Functions

The second research objective of this document was to study how contractual functions could be related to formal rules in the multiple-case study (see Sections 1.5.3 and 3.1.2). This was expected to help to understand how contractual hazards can be handled using the construction contract, considering the formal rules of the game: bureaucracy, legislation and the judiciary. “How” this link was working, in terms of which formal rules affect which contractual functions, was explored.

7.3.1 Formal Rules and the Contractual Control Function

Bureaucracy was related to the control function in the three cases. This function ensures that the activities carried out by the counterparts are not pursuing separate and undesired objectives. In the three cases (FNSP, CRPU, and L1MB), it was explicit that the complexity of the project alleged by participants, requires experienced bureaucrats to develop a consistent control function in the contract. This was basically stated considering technical issues for CRPU and L1MB, and legal issues in the case of FNSP. The three cases illustrated how the reliability of this function is

related to the bureaucracy in place, in order to deal with standard opportunistic behaviour and third-party opportunism.

Moreover, the three cases showed that legislation is also relevant for developing the control function. In L1MB, both the lack of regulation and overregulation, regarding different aspects, can generate a difficulty to develop a consistent control function to deal with risks of diverse dimensions. In CRPU, the use of the current legislation for megaprojects is incipient and, therefore, challenges around it are expected, especially regarding the control function. In FNSP, again, the link was associated to the possibility of interpreting legislation in different ways, which could affect the development of the control function. Once again, this is related to how decision-makers in the three cases can deal with contractual hazards and the resulting transaction costs of developing the contract.

Moreover, the cases unveil that the judiciary may affect the use of the control function, which is also related to clauses to deal with property rights, confidentiality, service scope and performance guarantee, and conflict resolution, among others. A judiciary with specific knowledge is needed to assess the differences that may arise. However, if it does not have enough experience the project may be unnecessarily delayed. As shown by the multiple-case study, the pertinence and potential success of the control function may be related to the experience of the judiciary. An inadequate judiciary implies more transaction costs ex-ante to deal with issues that will arise ex-post.

7.3.2 Formal Rules and the Contractual Coordination Function

Firstly, bureaucracy was related to the coordination function in the three cases. This function deals with the need to coordinate interdependent tasks between the different parties, which may have to be carried out separately or jointly. In the case of L1MB, its reliability in dealing with contractual hazards was related to the experience of the public sector; to the alignment of incentives and interests of bureaucrats of different public actors in the case of CRPU; and to the information generated at the initial steps, considering bureaucrats knowledge and experience, in the case of FNSP. The three cases revealed that the coordination function, impacted by bureaucracy, can be relevant to deal with both standard opportunistic behaviour and third-party opportunism.

Besides, legislation was also related to the coordination function. In L1MB, it was perceived that legislation hinders some activities that are needed to establish an optimum schedule, and may generate a sub-optimum risk transfer at the contract. In CRPU, a similar link was suggested and, as well as in the L1MB case, this was related especially to social risks. In FNSP, different possible interpretations of the legislations may generate difficulties when dealing with the typical

complexities around megaprojects. The three cases show that inadequate legislation may generate problems to develop a correct coordination function at the contract, which may increase standard opportunistic behaviour and third-party opportunism, and therefore the transaction costs of developing the contract.

On the other hand, the link between the judiciary and the coordination function was only revealed in the narratives of the participants of L1MB and FNSP. Some experience of the judiciary delaying the expected development of the contract were repeated in L1MB. The same was mentioned for FNSP and, in both cases, specific problems related to environmental, political and social risks were identified. When developing the contract, decision-makers need to contemplate potential coordination problems which may affect schedule. Difficulties to use this function may arise, as well as problems to deal with contractual hazards, specifically third-party opportunism.

7.3.3 Formal Rules and the Contractual Adaptation Function

Finally, bureaucracy was also related to the adaptation function in L1MB and CRPU, but no mention of this link was found in the participants' narrative for FNSP. This function deals with need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. Once again, in both cases, the reliability of this function is related to the experience of the public sector. The two cases presented different scenarios, as L1MB shows a context where participants considered that the bureaucracy had enough experience, and CRPU did not. In both cases, this was specifically related to standard opportunistic behaviour.

Lastly, L1MB and FNSP revealed a link between legislation and the adaptation function, which deals with the need to face the inevitable incompleteness of the contract, due to unforeseen changes in the context. Participants alleged that the inclination of legislation, in favour of one or another party in the contract, or the level of specificity of the legislation, regarding price adjustments or unexpected physical conditions or force majeure, may change how the adaptation function actually works, which may generate standard opportunistic behaviour.

7.4 The Role of the Planning and Appraisal Process for Risk Management

7.4.1 Introduction

The three cases analysed used a "closed-systems" approach to decision-making, with a hard thought system, at the planning and appraisal stages. Project objectives were fixed in early stages by technical teams, imposing the scientification and depoliticization of the problem. A technical

group, with political power, initially acted as a sole decision-maker with abstract aims that should be fulfilled by the development of the project. A control-oriented phased approach was used, inferring the management of structured phases of a project life cycle one after another. A public consultation process was sometimes developed, only once the relevant features of the project were already decided.

According to what was stated in section 2.4, this planning and appraisal approach hinders the delivery of the widest possible range of positive transformational benefits that megaprojects are able to bring in terms of economic, social, environmental, and territorial outcomes, both in the short run and in the long term. This traditional approach with a focus on the solution is not suited to megaprojects, where problems addressed are often ill-structured (and interdisciplinary), complex (several variables are involved) and dynamic (environment and factors change over time).

However, the three selected cases have shown that there may be rational arguments to justify its use. The view of several participants is that the "closed-systems" approach to decision-making, when planning and appraising the project, can be useful to reduce the transaction costs of developing the contract, which are specifically related to political and social construction risks, and the contractual hazard of third-party opportunism.

7.4.2 The Challenge: Political and Social Risks

In the case of L1MB, participants claimed that political pressure was exerted since the project's inception. Some of them alleged that a "closed-systems" approach to decision-making prevented political risk escalation and, therefore, reduced transaction costs related to developing the MTP. Moreover, various interviewees stated a "closed-systems" approach was useful to prevent stakeholders from stopping the project with popular actions due to their lack of knowledge.

In CRPU, a participant explicitly alleged that the "closed-systems "approach was useful to deal with the affected society and, eventually, with politicians. Another one, specifically said that it would prevent them from blocking the project. By using this approach, a potential snowball of criticism is perceived to be stopped from the root. According to these participants' view, the "closed-systems" approach gives certainty, and the project is actually developed if the Government decides to go ahead, minimising the transaction costs of developing the MTP.

Participants claimed that political risks were relevant in FNSP as well, given that priorities regularly change. Moreover, it was alleged that the vast territory of Brazil generates an unmanageable set of heterogeneous political interests. Regarding social risks, once again it was

considered that the stakeholders lack the organisational and technical capacity to discuss about the project. The "closed-systems" approach to decision-making was perceived, in this context, useful to prevent unnecessary delays and, therefore, to reduce the transaction costs of developing it.

The theoretical argument behind the use of an "open-systems" approach to decision-making when planning and appraising MTPs, with a soft thought system, is that it favours more comprehensive and integrated ways of planning and appraising infrastructure megaprojects. It does so by promoting a reduction in data demands, focusing on simplicity and transparency aimed at clarifying the terms of conflict and accepting uncertainty, keeping options open, all while focusing on the actual criteria used by the relevant stakeholders. It is more consistent given megaprojects characteristics.

Nevertheless, this research illustrated that decision-makers may believe that this approach to planning could increase transaction costs. In L1MB, it was mentioned that a more democratic process in the project planning and appraisal would eventually hinder the progress of the project if it is not done professionally. In CRPU, once again, the initial presentation of the project to all actors would generate complications; it was perceived as risky. In FNSP, an "open-systems" approach was understood by some participants to delay the necessary approvals needed in order to advance. Their perception was that the megaproject could be eventually delayed, or even blocked, at any stage, if different social actors are included since the first steps. They perceived that an "open-systems" approach could even generate more misinformation than a "closed-systems approach" if it is not done correctly. This is clearly debatable from a theoretical point of view, but several participants provided a consistent message in the three cases: a more "open-systems" approach to decision-making when planning could increase the transaction costs related to MTPs.

7.4.3 Inadequacy of Bureaucracy, Legislation and the Judiciary

This thesis has illustrated a potential link between political and social construction risks and third-party opportunism at the contracting stage. This is relevant given that transaction costs are generated surrounding the contract that the public party needs to develop with the private party. It is here asserted that a "closed-systems" approach at the planning and appraisal could be perceived, by decision-makers, as a useful approach to help to deal with the transaction costs related to this particular contractual hazard.

This is happening, at least to a certain extent, given that the contractual functions (control, coordination and adaptation) are ineffective in order to deal with this contractual hazard. Previous

sections showed that formal rules in place (bureaucracy, legislation and the judiciary) may be affecting the potential efficacy of using those functions. Those formal rules do not always help to minimise transaction costs related to third-party opportunism. As a consequence, formal rules can be, at least partially, responsible for the "closed-systems" approach to planning and appraisal used from the beginning of the project. This was confirmed in the three cases.

Moreover, formal rules at the planning and appraisal stage may not favour an "open-systems" approach to decision-making at the pre-investment phase. It is not absolutely clear if formal rules could be the cause or the consequence of the problem. It could be the cause in the sense that it does not provide the formal institutional background to develop a more "open-systems" approach to planning and appraisal. However, it could be also a consequence, given that decision-makers prefer to sustain this status quo in order to deal with the mentioned contractual hazards in a more effective way, with less transaction costs.

Regarding bureaucracy, participants explained that there is a lack of human resources, in quantity and quality, in order to deal with an "open-systems" approach to planning. Interviewees mentioned the "capacity" of the teams, that "larger teams" are needed to do this, with a different "organisation" with "accumulated knowledge". As stated in the previous section, this is consistent with the fact that bureaucracy limits the way contractual functions may work. Bureaucracy constrains the applicability of the coordination, control and adaptation functions of the contract, which are expected to deal with third-party opportunism. A "closed-systems" approach can be, therefore, doubly justified. It may help to deal with the perceived incompetence of the public sector to adopt an "open-systems" approach at the pre-investment phase, and it may be perceived as a good strategy to minimise third-party opportunism, which will inevitably appear after the contract is signed, given megaprojects' characteristics and the lack of experience of the bureaucracy in place.

Secondly, legislation was also mentioned in the three cases. Participants stated that no legislation obliges to use an "open-systems" approach in Colombia. In Uruguay, the lack of institutional framework -of "better legislation"- prevents this to occur as well. In Brazil, legislation was one of the explanations behind the fact that problems would arise in case an "open-systems" approach to planning is used. Once again, this is coherent with legislation limiting the way contractual functions work. Current legislation may hamper the applicability of the coordination, control and adaptation functions of the contract, which are expected to deal with third-party opportunism. A "closed-systems" approach can be, therefore, doubly justified as well. It may help to deal with social risks, for which no legislation exists, or is not clear enough, and it may be perceived as a good strategy to reduce potential third-party opportunism which is enlarged by the lack of the said legislation.

Thirdly, the judiciary was also relevant. The lack of a correct due diligence from the judiciary in Colombia, in case problems are materialised, hinders the possibility of using an "open-systems" approach. In Uruguay, in parallel, it was claimed that the judiciary lacks the knowledge to affront the challenge behind the use of an "open-systems" approach to planning. Finally, in FNSP, the judiciary generates insecurities given how slow it actually works when dealing with issues that arise in complex projects. Once again, this is consistent with the judiciary limiting the way contractual functions work. The judiciary can debilitate the applicability of the coordination, control and adaptation functions of the contract, which are expected to deal with third-party opportunism. A "closed-system" approach can be also doubly justified. It may help to deal with social and political risks for which the judiciary does not have experience, and it may be perceived as a good strategy to reduce potential third-party opportunism which is enlarged by the lack of the said sound judiciary.

In this context, it seems safe to say that there could be a strategic choice from decision-makers, which may prefer to sustain the status quo related to the "closed-systems" approach. It is here confirmed that there could be a perception that the said approach may be helpful to reduce transaction costs. However, as stated elsewhere in this thesis, it is important to acknowledge that there may be other institutional forces playing, such as the social interpretation installed in the social and political arena, by which project efficiency and economic efficiency are prioritised over sustainability, equity, regional development, political pay-off, and other equally considerable criteria.

In the semi-structured interviews conducted, participants consistently mentioned a cultural background as well, which favours the behaviour of decision-makers. In fact, it can be stated that the cultural context surrounding the different stakeholders could be also motivating the use of a "closed-systems" approach in order to reduce transaction costs.

7.4.4 The Role of the Cultural Context

Evidently, as theoretically explained in Section 2.5, institutions can be defined as elements that give meaning and organisation to whatever social interaction, political process, or economic activity is being developed. One of the pillars of institutions (see Scott, 2012) is the cultural-cognitive element, which was also consistently mentioned in the interviews. It is related to symbols (including words, signs, and gestures) that shape the meaning of objects and activities.

The regulative element thoroughly studied in this thesis was also associated with the cultural context of the planning and appraisal process in the multiple-case study. Several participants

linked the regulative context to the culture of very different actors: politicians, bureaucrats, society, NGOs and the private sector, among others.

Political culture was related to a constricted view of the public policy problem behind megaprojects, considering it an ideological, not rational, explanation behind the societal challenges that the megaproject is expected to solve. This is very much related to the positions that are assumed by the politicians, without considering technical explanations, and transmitted to the society. In this context, rules are used by politicians in the matter that most suits them, although the cultural interpretations considered could be questionable.

Besides, an unconscious way of doing by bureaucrats was thought to obstruct the development of megaprojects. As megaprojects are usually different than typical infrastructure projects, as stated in Section 2.2, the bureaucratic way of doing is not prepared to respond to the different needs.

Moreover, societal cultural values were also identified as a problem to develop the MTPs analysed. Specifically, participants considered the sensibility of the society regarding the destruction of the biological environment, or the position selected by their political leaders, or even the change in their spatial context, and they preferred to maintain it in the way they are used to. In the same way, the organised society was also mentioned. In particular, their corporate and narrow view of the problems can help to escalate problems that may arise.

The cultural background of the private sector was also raised. Examples were included regarding the different cultures of the participants of the consortia related to the development of the project. In some cases, the private contractor is formed by companies of different cultures and this generates challenges in the internal communication. Consequently, the communication between the private and public parties of the contracts is complexified.

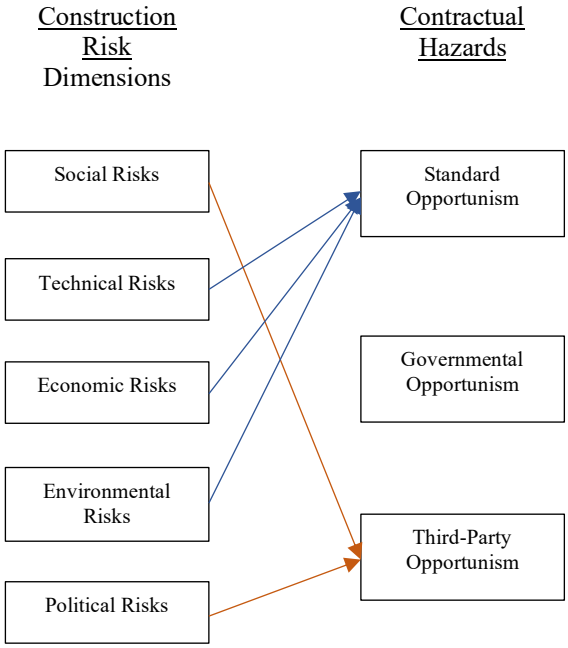
Therefore, there are norms and values that are cognitively, culturally and structurally embedded in the decision-making of the affected stakeholders. They are not necessarily of instrumental value, but there is social appropriateness and legitimacy around them.

The issue here illustrated is that the mentioned cultural context of the different stakeholders motivates the use of a “closed-systems” approach as well. There is more than the rational view proposed by NIE, which was thoroughly studied in this thesis. The cultural norms and symbols were considered by participants as a problem for the development of megaprojects. From a NIE view, in this context, an “open-systems” approach would eventually generate even more transaction costs. It could eventually even make the contracting and execution phases more difficult, and this is again related to the formal rules.

7.4.5 The Rationality for a "Closed-Systems" Approach to Planning and Appraisal

The relationship between construction risks and contractual hazards holds across cases in the multiple-case study presented in this thesis. The following figure illustrates this:

Figure 21 – Link Between Construction Risks and Contractual Hazards

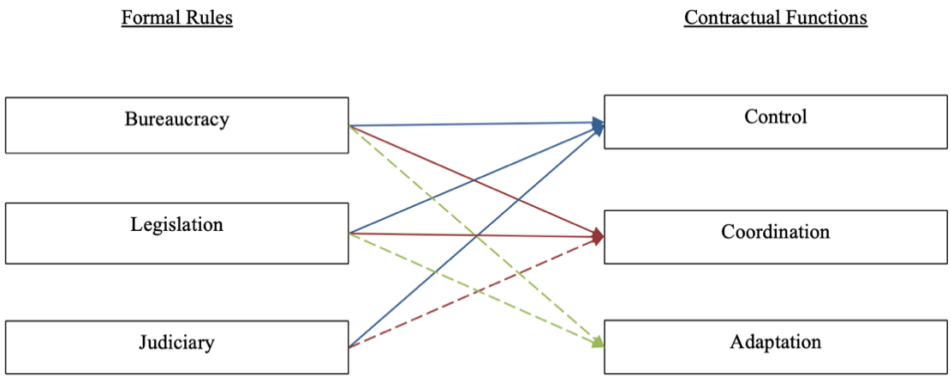


The links between construction risk dimensions and contractual hazards were consistent in MTPs developed in different contexts, given that the three megaprojects studied were being developed in different Latin American countries, in different regions, and in the framework of different institutional settings.

Moreover, the three cases were at different stages. The L1MB case was studied at the moment that the public party was contracting; the CRPU project was already contracted when the study was developed; and, finally, FNSP was at the pre-contracting stage, but most of the technical environmental and social pre-investment studies had been already developed.

The same occurs with the link between the potential use of contractual functions and formal rules of the game. The impact of the formal rules was very clear in the control function, clear in the coordination function, and weaker in the adaptation function. The following figure illustrates this:

Figure 22 – Link Between Formal Rules and Contractual Functions



Against this background, it is safe to say that the formal rules when contracting and executing the MTPs studied can be making contractual functions generally ineffective to deal with contractual hazards. Therefore, formal rules may not be helping to economise transaction costs, and could even raise them.

The theory proposed and examined in this document is based on the following argument, which addresses the internal validity and logical coherence of the emergent theoretical replication. Megaprojects are intrinsically risky in political and social terms. These risks are translated into contractual hazards and, therefore, transaction costs. These transaction costs are being economised using a "closed-systems" approach to decision-making when planning and appraisal, given the formal rules of the game in place and the cultural context related to the different stakeholders.

It is here elucidated that it is at least difficult, but conceivably impossible, to demand a change in the status quo from a "closed-systems" approach to an "open-systems" approach to decision-making at the planning and appraisal stages of MTPs, if the formal rules of the game (bureaucracy, legislation, and the judiciary) are not aligned to do so. The multiple-case study presented shows that the formal institutional environment at the planning, appraisal, contracting and execution stages can be discouraging the use of a more "open-systems" approach to the planning and appraisal of such projects in LatAm.

As a natural experiment, this multiple-case study did not intend to show that this is actually happening in LatAm. That would be possible with a statistical generalisation. Nevertheless, it did illustrate that it can be happening, as this is perceived as true by several participants in the selected cases. The analytical generalisation presented in this thesis empirically shows that the contribution of the formal institutional environment should not be ruled out when trying to explain why a "closed-systems" approach to planning and appraisal is sustained in LatAm.

7.4.6 The Way Forward

The most pressing challenge addressed by this thesis was that the "closed-systems" approach hinders the delivery of the widest possible range of positive transformational benefits that megaprojects are able to bring in terms of economic, social, environmental, and territorial outcomes, both in the short run and in the long term. This traditional approach with a focus on the solution is not suited to MTPs, where problems addressed are ill-structured (and interdisciplinary), complex (several variables are involved) and dynamic (environment and factors change over time).

In order to promote an "open-systems" approach to decision-making when planning and appraising MTPs, it would be helpful to adapt the legislation, bureaucracy and the judiciary at the pre-investment stage and at the investment stage.

Formal Rules at the Pre-Investment Stage

At the pre-investment stage, LatAm countries would benefit from the development of legislation and bureaucracy to institutionalise an "open-systems" approach to planning and appraisal. It would be judicious to modify the phase-stage gate approach demanded by National Investment Planning Systems (SNIPs), and normally used by project developers.

On that subject, there is a policy alternative that several countries outside the region are using, which could be replicated, at least to some extent, in this region. Other countries such as Australia, Canada, UK and New Zealand, have created dedicated centres of infrastructure expertise that produce independently-assessed lists of infrastructures, based on some kind of audit of infrastructure needs or infrastructure assessments. These centres are usually referred to as Infrastructure-Bodies (I-Bodies).

These organisations are thought to enjoy broad public support because, among other reasons, they can institutionalize this "open-systems" approach to decision-making when planning megaprojects, by including multiple stakeholders in the process. They can help to build a social understanding around the project, in the context of a broad idea behind the country or region to be pursued by the society as a whole. They can help to crack the typical phase-stage gate approach by introducing an iterative decision-making process when incorporating multiple perspectives in the context of alternative scenarios. These I-Bodies are a fertile environment to develop and use country-tailored PSMs, such as those presented in section 2.4.4. There are several examples of this type of "open-systems" approaches to planning and appraisal in the mentioned countries.

In Australia, for example, both national and state formal rules mandate a multi-stage appraisal process that includes Problem Definition and Option Identification and Analysis. In the context of Infrastructure Australia, project proponents must "identify a comprehensive longlist of options" and apply a "robust options analysis" to filter this to a shortlist (Infrastructure Australia, n.d.). Moreover, the Australian Transport Assessment and Planning (ATAP) guidelines instruct planners to engage widely with government agencies, community groups and industry to identify challenges before considering solutions (ATAP, n.d.). These guidelines also recommend incorporating a scenario analysis to identify future drivers for change and develop best and worst-case scenarios. Community engagement is considered crucial to develop trust in the early stages, and identify, prevent and solve problems on an ongoing basis.

Besides, the Treasury Board of Canada's Business Case Guide, another good example, explicitly states that the development of a business case should be a collaborative effort involving internal and external stakeholders, and all parties should agree on the overall need and the actual requirements to address the objectives (Treasury Board of Canada Secretariat, n.d.). In this context, planners are expected to develop a long list of possible options, perform screening using "deal breakers", and essential criteria should be used to evaluate the viable option in depth. Furthermore, risk assessment is expected for each viable option and a framework to capture and balance the interest of stakeholders are being advocated (Impact Assessment Agency of Canada, n.d.)

Likewise, UK's Green Book requires a strategic case and explicitly states that before the quantitative part of a MCDA, the problem needs to be thoroughly explored using a range of qualitative techniques. In this context, the UK government's Analysis Function includes the following methodologies in its guidelines: SSM, SCA and SODA. It is here explained that it can be useful for stakeholders to explore the problem together and techniques such as "laddering" (iteratively asking how and why) are recommended to uncover fundamental options and objectives. Workshops should be facilitated to build consensus (UK, Civil Service – Analysis Function, n.d.). Furthermore, scenario planning is also part of the Department for Transport (DfT) Uncertainty Toolkit (UK Government – TAG Unit, n.d.).

Similarly, another practical example on this subject is New Zeeland. The NZ Treasury and NZ Transport Agency have made Investment Logic Mapping (ILM) a cornerstone of the pre-investment process. Through ILM workshops, an agreement should be reached on the core problems driving the need for investment, the benefits expected, the strategic responses and the solution options available (NZTA, n.d.). This serves as a structured engagement for resolving conflict. The use of an independent facilitator, trained to draw out differing viewpoints, ensures

neutrality and trust. Dilemmas among stakeholders are confronted in the ILM session and worked through evidence and discussion.

Therefore, different PSMs are currently being used in different countries and could be considered in the context of Latin American MTPs. SODA type methodologies could be used to agree on a possible portfolio of actions, which can include the development of specific MTPs. Besides, SSM could be considered to assess the cultural acceptability of a particular MTPs, in line with the different views about the roots of the public policy problem which the project is intending to address. SCA could help to reach commitment among the stakeholders of a project, and a progress package with a decision calendar can be developed based on partial commitments and contingency plans. These methodologies should be iterative, in line with an "open-systems" approach to decision-making, without losing technical utility, for which a robustness analysis can be performed by these organisations. Moreover, the evident dilemmas that arise from the development of these PSMs could be modelled using drama theory in the context of the infrastructure policy which the I-Bodies are expected to develop.

Furthermore, at appraisal, it would be desirable to use formal tools in order to link MTPs to the planning objectives, without losing the iterative process. It would be desirable that the mentioned I-Bodies support and control pre-feasibility studies, feasibility studies, negotiation and procurement, to take advantage of the expertise of their expert human resources. However, in addition to the typical economic efficiency analysis, other methodologies should be considered when appraising MTPs, in line with their special characteristics. For example, a Social Network Analysis (SNA) can be developed for stakeholder characterisation. Instead of focusing the attention on stakeholders' attributes, this methodology seeks to define and analyse the relationships between pairs of stakeholders in a given network (see Yang, 2014). SNA avoids the typical simplification of the problem implied by the traditional static analysis focused on the individual classification of stakeholders.

Project appraisal can be strengthened as well, with the help of these organisations, by considering dynamic capabilities frameworks at the pre-investment stage, as proposed by Gann, Davies y Dodgson (2017). For example, specific frameworks can be used to calibrate uncertainty, learn from other projects and industries, and seek, test, and select new combinations of ideas, technologies, and practices. Ultimately, all the previous three qualities aim to create options that are available for different future scenarios (Flyvbjerg, 2014; Gann et al., 2017; Lovallo and Kahneman, 2003).

In order to effectively promote an "open-systems" approach to decision-making at the planning and appraisal stages, the *legislation* should specify the functions of these I-Bodies in the previous direction, framing planning and appraisal. Moreover, these *bureaucratic* organisations should be

technically sound, and human resources would need to be correctly equipped with the capabilities needed to promote this "open-systems" approach. The results presented in this thesis shed light on the relevance of both the legislation and bureaucracy in order to achieve the expected results.

However, this thesis also shows that formal rules should be also changed in order to reduce the future transaction costs of including stakeholders' different interpretations and interests at the pre-investment stage. If this is not done, decision-makers could be incentivised to sustain the status quo given that the stakeholders' participation could elevate political and social risks of the project at implementation, as previously illustrated, and increase the contractual hazard of third-party opportunism.

In order to avoid this, legislation should be changed as well so that stakeholders have the opportunity of formally accepting or rejecting the MTP at the pre-investment stage. If they reject it, they need to have the opportunity to challenge the decision in the relevant courts before project implementation starts. If they do not reject it, having had the chance at the pre-investment stage, they should be impeded to do so at the investment stage, in order to minimise the mentioned contractual hazard and transaction costs. Evidently, the judiciary should be independent and technical sound as well to make this potential change in legislation feasible and useful.

Considering the previous reasoning, a change in formal rules in terms of legislation, bureaucracy and the judiciary at the MTPs pre-investment phase could generate a better set of incentives so as to promote an "open-systems" approach when planning and appraising these projects.

Formal Rules at the Investment Stage

At the investment stage, formal rules could be changed as well so that contractual functions can effectively minimise contractual hazards, including third-party opportunism.

Firstly, it would be crucial to identify a technically sound public party to deal with the different contractual functions of a MTP development contract. Regarding the control function, experience in contract writing and interpretation in the public sector is needed, particularly to state how property rights will be affected, and to specify a correct scope of service of the contractor. If this is not the case, it may promote third-party opportunism from external actors, especially if they find a flawed contractual arrangement which is perceived to affect the future public service provided. Moreover, negotiation and conflict resolution knowledge and experience of the public agent involved may minimise unneeded disagreements between the parties of the contract, and it could also minimise third-party opportunism as it can prevent conflict escalation. Regarding the coordination function, knowledge and experience in the management of the different public actors

involved in a MTP may align interests and minimise problems related to the project's schedule. Evidently, there is an increased risk of political and social unrest when projects are delayed. Finally, on the adaptation function, bureaucrats in charge of a MTP contract need to be prepared to deal with unforeseen changes in the social, economic and political context, using the adaptation clauses available. If that is not the case, they may be promoting third-party opportunism as well.

Therefore, having knowledgeable and experience teams in the public sector for the implementation of MTPs makes the difference. If this is not the case, a higher potential third-party opportunism can be perceived by decision-makers. In that context, they would do everything they can to minimise it, including opting for a "closed-systems" approach to decision-making at the planning and appraisal stages, in order to reduce the information shared with the stakeholders since the beginning of the project.

In addition, legislation can also be considered and adapted to minimise contractual hazards, including third-party opportunism. On the control function, minimising the ambiguity about the different contractual options for the delivery of MTPs is crucial to avoid potential mistakes on the selection of the contractual option. Political and social risks, and third-party opportunism, rise if mistakes on this subject are perceived. Regarding the coordination function, legislation must be particularly clear on the environmental and social management responsibilities in the public sector. Laws and regulations must be as well-defined as possible, considering good practices and lessons learned from other countries, adapted to each context, especially for obtaining land and access rights. It is important to avoid duplication and overlapping of responsibilities in the public sector, which could lead to project delays, cost overruns and, eventually, political and social risks. Finally, laws and regulations should be as specific as possible in terms of what constitutes a change in context, in order to adopt a credible adaptation function in the contract involved.

Therefore, a well-crafted legislation, which specifies the different delivery methods for MTPs is also vital. Moreover, it should also allocate responsibilities in the public sector avoiding misinterpretations, especially in environmental and social terms, being specific in terms of roles, responsibilities and adaptation measures. These two conditions are essential to minimise third-party opportunism and to discourage the use of a "closed-systems" approach to decision-making from the outset of a megaproject, as a tool to minimise information sharing and transaction cost economising.

Finally, in third-place, the judiciary can also affect the way that the contractual functions can be used to minimise third-party opportunism. On the subject of the control function, it may slow the project if the judicial process is inadequate or if judges are not prepared to deal with the contractual complexities related to how property rights are allocated in a contract. Regarding coordination, an unjustified intervention of the judiciary may increase project delays, as it changes

the project schedule, or escalates project discontent if there is an ineffective communication regarding the MTP. This is very much related to the degree of specialisation of the judges in, for example, environmental and social issues related to megaprojects. An unprepared judiciary can increase the potential pressure which can be exerted by the politicians and the media.

Therefore, a judiciary which is specialised in complex projects will always be desirable and would prevent third-party opportunism. If a weak judiciary is perceived by decision-makers, they will be incentivised to use a "closed-systems" approach to decision-making at the pre-investment phase in order to control the flow of information and minimize social and political risks.

The Role of International Organizations

International Organizations (IOs) and Multilateral Development Banks (MDBs), could play a central role to promote an "open-systems" approach when planning and appraising MTPs. This research has been developed in the context of the researcher's work as a consultant for the IDB, but the recommendations here presented may be useful also for other institutions which are working at the region, such as the International Monetary Fund (IMF), World Bank (WB), the Development Bank of Latin America (CAF), and FONPLATA.

Firstly, "good practices" usually recommended to countries should be updated to consider a change in the pre-investment formal rules as explained above. Of particular importance it would be to promote the use of an iterative decision-making process when planning this specific type of projects. Currently, the planning and appraisal process advocated by IOs and MDBs, to the countries that they are working with, do not incorporate the need to methodically integrate alternative perspectives when planning MTPs, to construct a portfolio of potential actions for different contexts, and to evaluate the acceptability of the projects, in the context of a sound stakeholder characterisation considering methodologies such as PSMs.

Regarding appraisal, MDBs' typical internal approval procedures for loans and guarantees mirrors the phase-stage gate approach used by countries. Actually, a "closed-systems" approach is used to determine the participation of the bank in a specific project. For example, although an economic cost-benefit analysis is normally requested, there is no usual request for PSMs to allow for changes in the context. The replication of the bureaucratic process required to appraise a project in MDBs reinforces the use of a "closed-systems" approach at the pre-investment phase by the countries they serve.

Finally, when working on loans and technical cooperations related to MTPs, institutional strengthening components are usually related to bolstering the bureaucratic capabilities of the public owner of the project. This thesis has shown that other formal rules related to legislation and the judiciary should be specially considered as well, because they will help to determine how a project will be planned and appraised as well, with potential impacts on outputs and outcomes.

8 Conclusions and Final Reflections

8.1 Responses to the Research Questions

8.1.1 Research Subsidiary Questions

A mixed method research design, combining quantitative and qualitative research methods, was used in this thesis to answer to the questions proposed in Chapter 3. A multiple-case study approach was adopted to make an in-depth analysis of MTPs in different countries and sub-regions of Latin America, and, therefore, in very different institutional contexts.

The first research subsidiary question proposed in Section 3.1.3, which was answered with the multiple-case study for each of the cases included, was: *what is the perceived contribution of the different construction risk factors to the overall likelihood that MTPs obtain the results that governmental decision-makers expect?*

In order to answer this question, this thesis applied Fuzzy Set Theory in the risk assessment of the three selected cases. It did so as this methodological approach can consider the imprecision and vagueness of construction risk factors that are usually ill-defined in nature. The results confirmed that risk factors from the political, social and technical dimensions were absolutely relevant for the development of this kind of projects. Some ill-defined risks, considered among the 10 most important in these projects, were the following:

- Lack of political support/political indecision.
- Lack of transparency and corruption.
- Opposition and political interference.
- Protests and interference by residents.
- Involvement of many decision-making bodies.
- Lack of legislation or regulatory adaptation.
- Inappropriate design due to lack of technical capabilities.
- Insufficient capacities in construction work.

This thesis explained how the previous ill-defined risk factors can be related to the nature of MTPs. Among other characteristics, these projects are political, human-centred, global, complex and organic. As they are politized, and the decision-making process of political actors is developed considering the electoral contest and their intentions to remain in office, political risks are usually relevant. Moreover, given that MTPs are global and human-centred, and several interconnected stakeholders with conflicting interests are involved, political and social risks are even more relevant. Even more, as MTPs are complex, and multiple structural elements, from the technical and social arenas, are interacting and changing in the different phases of the project,

social and technical risks can be usually expected. Finally, as they are organic, and they co-evolve with their context, political, social and technical risks are naturally significant as well.

The second subsidiary question, which was answered with the multiple-case study for each of the cases included, and with a cross-case view, was: *how are these construction risk factors and dimensions perceived, by the governmental decision-makers included in the analysis, to be translated into contractual hazards?*

In order to answer this question, this thesis conducted semi-structured interviews to decision-makers related to the three selected projects. The analysis here presented confirmed the following pattern in the cases studied:

- Political and social risk factors can be related to third-party opportunism.
- Technical risk factors can be related to idiosyncratic opportunism.

Third-party opportunism and idiosyncratic opportunism are contractual hazards. The first one is related to the fact that political and social actors can obtain political and economic benefits if they challenge the probity and reasonability of the construction contract that is being developed between the public and private parties that participate in the MTP construction contract (which can involve other activities, such as design, finance, operation & maintenance). The second one is related to specific knowledge and bounded rationality, and, consequently, to information asymmetries between the contractual parties involved in the said contract.

Therefore, MTPs' characteristics are related to contractual hazards that need to be managed by the decision-makers along the life of the project. The management of those contractual hazards involve transaction costs. These are the costs related to finding the correct contractor, developing the terms of the contract, among others. According to the NIE view, decision-makers economise these transaction costs with the governance structure, given the formal rules of the game: bureaucracy, legislation and the judiciary. In fact, formal rules can be eventually changed if it is necessary to low-down those transaction costs.

Therefore, the third subsidiary question, which was answered with the multiple-case study for each of the cases included, and with a cross-case view, was: *how can those risk factors and hazards be managed using the construction contract, given the formal institutional background?*

The analysis here presented showed that contractual functions used to manage contractual hazards are basically ineffective in the MTPs reviewed.

Contractual functions are: safeguard or control function, coordination function, and adaptation function. Contractual clauses related to these functions are used to ensure activities carried out by

the parties pursue common objectives, to coordinate interdependent tasks and to face the inevitable incompleteness of the project. Basically, they are used to deal with contractual hazards, but they imply the said transaction costs. In fact, it is here illustrated how decision-makers can perceive that the formal institutional environment, or formal "rules of the game", may affect the effectiveness of those clauses. They may perceive that the bureaucracy, legislation and the judiciary in place can negatively affect contractual functions and generate elevated transaction costs.

In this context, and based on a NIE view, it was safe to theoretically propose that decision-makers could be keen to use every mechanism available to minimise those transaction costs. This is why, the final subsidiary question, also answered with the multiple-case study for each of the cases included and with a cross-case view, was: *how do governmental decision-makers perceive that an 'open-systems' approach to megaproject planning and appraisal would impact in the contractual hazards, given the formal institutional environment in place?*

This is the core question of the thesis. The author understands that one of the most relevant challenges when planning and appraising megaprojects is the planning and appraisal approach used by decision-makers. It was here theoretically argued, and assumed (check Section 2.4), that an "open-systems" approach, with a soft thought system, should be used in order to deliver the widest possible range of positive transformational benefits that MTPs are able to bring. However, a "closed-systems" approach is used in Latin America and it was here theoretically proposed that this could be related to a transaction economising attitude adopted by decision-makers since the beginning of the project.

With the multiple-case study developed, this thesis showed how decision-makers may perceive that a "closed-systems" approach, with a hard thought system, can be helpful to economise transaction costs, given the formal rules of the game in place. This was particularly related to the social and political risks associated with the projects analysed. In fact, decision-makers interviewed perceive an "open-systems" approach would eventually increase those transaction costs, and even paralyze the projects' development, and this was intimately related to the bureaucracy, legislation and the judiciary in place.

8.1.2 Main Overarching Question

The main overarching question of this research process was: *Could the formal institutional environment adversely impact the employment of a more "open-systems" approach to decision-making at the planning and appraisal stages of LatAm MTPs?*

Indeed, it could. The NIE theoretical perspective used in this thesis helped to illustrate how formal rules related to bureaucracy, legislation and judiciary can discourage the use of a more open systems approach to the planning and appraisal of MTPs, as they may elevate transaction costs. They can do so, at least, by these two channels:

- Formal rules at the planning and appraisal stages may discourage an "open-systems" approach as they could elevate political and social risks of projects
- Formal rules at the contracting and execution stages may elevate transaction costs as they may have a negative impact on the effectiveness of using contractual functions, which are needed to deal with contractual hazards.

As a natural experiment, the multiple-case study proposed did not intend to show that this is always happening in the region. That would be possible to demonstrate with another methodological approach, more quantitative in nature, with the view of producing a statistical generalisation. Nevertheless, this thesis did prove that the two mentioned channels can be happening, as this is perceived as true by several participants in the selected cases. The analytical generalisation presented empirically showed that the contribution of the formal institutional environment should not be ruled out when trying to explain why a "closed-systems" approach to planning and appraisal is sustained in LatAm. The previous channels must be considered.

8.2 Contributions of the Research

MTPs are large-scale complex investments typically involving multiple stakeholders. These projects possess certain generic features that distinguish them from other scales of transport development, and they are perceived as critical to the success of major urban, metropolitan, regional and/or national and transnational development.

An "open-systems" approach to decision-making at the planning and appraisal stages of MTPs has been advocated by several academics and practitioners in the past decades as it favours simplicity and transparency, aimed at clarifying the terms of conflict and accepting uncertainty, keeping options open, all while focusing on the success criteria used by the relevant stakeholders. However, in Latin America, a "closed-systems" approach, with a hard thought system, has been consistently used.

This research explained how to change the formal rules of the game in order to promote a more "open-systems" approach to planning and appraising megaprojects in the region. The research has used a New Institutional Economics perspective, which has not been used before, in order to

deeply understand the regulatory challenge behind this planning issue, and make solid policy recommendations.

Firstly, at the pre-investment stage of MTP development, bureaucracy, legislation and the judiciary should be prepared to generate incentives for social and political actors to participate in the process, while discouraging them to challenge the probity of the contract that will be developed regarding the said MTP. Formal rules that mandate participation at the pre-investment stage -while prohibiting it at the investment stage- would be beneficial, as they could promote an "open-systems" approach while minimising transaction costs related to third-party opportunism.

Secondly, at the execution stage, formal rules should be changed in order to promote the effectiveness of the contractual functions used in complex projects. In particular, more experienced bureaucrats and judges are needed to minimize conflict escalation and, therefore, third-party opportunism as well. Moreover, precise and simpler legislation could give clarity (discouraging potential differences in interpretation), especially in environmental and social terms, being specific in terms of roles, responsibilities and adaptation measures.

Changes in the formal rules of the game, in this direction, would help to promote an "open-systems" approach, with a soft thought system, at the planning and appraisal stages of MTP development.

8.3 Limitations of the Research

This research has used a NIE approach to thoroughly analyse the regulative element of the institutional context behind the use of a "closed-systems" approach to planning and appraising three MTPs in Latin America. In this context, it has several limitations.

Although it determines the direction of the changes that the formal rules of the game need to suffer to promote an "open-systems" approach to planning, it does not determine the detail and feasibility of those changes. It did not study these issues as these are very much context-dependent and a more comprehensive and detailed analysis of each one of the country's institutional environments is needed in order to do so.

Moreover, given the said objective, this thesis did not deal with the normative and cultural-cognitive elements of the institutional environment, which may affect and be affected by the regulative "formal" rules analysed. Evidently, there are other institutional forces, apart from the formal rules of the game, of more "informal" nature, that were not evaluated. This limitation is acknowledged in several parts of this thesis. As a consequence, although the policy recommendations presented would possibly promote an "open-systems" approach to decision-

making at the planning and appraisal stages of MTP development, it is not reasonable to state that they would guarantee the application of the said approach. In the opinion of the author, a detailed analysis of these other institutional elements, related to the cultural and normative institutional environment, could help even more to understand the complexity of the planning challenge here considered, and to propose more holistic policy recommendations.

8.4 Concluding Remarks and Recommendations for Further Research

MTPs are indeed needed in Latin America. Several countries and regions have developed and are pursuing this kind of projects longing for the sustainability and economic development of the region. However, these endeavours have had, and are experiencing, several challenges, much of them related to the planning and appraisal approach used in the initial stages of project development. It was here assumed, and explained in detail in section 2.4, that a more "open-systems" approach to decision-making when planning and appraising these projects is necessary.

This thesis has proved that decision-makers may perceive that bureaucracy, legislation and the judiciary, understood as the formal and regulative institutional environment surrounding such projects, could discourage the use of a more "open-systems" approach to planning and appraising MTPs. It has showed the direction of the adjustment of the said formal rules, both at the pre-investment and investment phases of MTP development, that could most certainly help to promote the needed change in the planning and appraisal approach.

However, formal rules are only one, but very important, institutional element that should be addressed for this to change and eventually deliver the widest possible range of positive transformational benefits that megaprojects are able to bring in terms of economic, social, environmental, and territorial outcomes, both in the short run and in the long term. Further research focused on an in-depth study of the normative and the cultural-cognitive elements of the institutional environment would help to dimension the challenge behind the policy change here studied in detail. It would help to set the political context and the cultural discourse that should complement the formal institutional adjustment, in order to effectively promote a transformation.

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APPENDIX A – Interview Guide

Topic 1: How are risk factors managed using the construction contract? How are risk factors related to contractual hazards?

Introducing Question

Interested parties in the construction contract have limited capacities to understand the complexity of variables that can affect the project, to foresee all the contextual conditions in the future, and, in addition, they may have the intention of obtaining individual benefits. In that context ...

How do you believe that construction risks (social, technical, economic, environmental and political) "were managed"[13] / "could be managed"[14] in the contract of your project?

Structuring Question 1 (Optional): Contracts have three main functions: coordination, control and adaptation. Coordination has to do with the fact that the private and the public have to coordinate on a lot of things that are happening. The control function exists because there may be opportunistic behavior on both sides and there must be clauses that can correct that. And adaptation serves for context changes. In your opinion, "are all"[1] / "could be all"[2] three handled in the same way? Do you think there are differences between the three considering the previous risks?

Structuring Question 2 (Optional): These construction risks are usually understood as related to contractual hazards, which are: the risk that the private sector can take advantage of having more technical information; the risk of the Government changing the rules of the game; and the risk of social-political third-parties coming to look for benefits. The question is: do you think any of those contractual hazards is higher than the others? Do you think they "were"[1] / "could be"[2] correctly handled in this megaproject?

Examples of Follow-up Questions (Optional): What do you mean by…? Yes…? *Examples of Probing Questions (Optional):* Could you tell me more about…? In what way do you find this or that risk "was"/"could be" better or worst managed…? Could you give me an example of that?

Specifying Questions (Optional): Were the different risk dimensions managed in different ways? In what ways would you "have managed" / "manage" this risk differently?

[13] If contract has already been signed
[14] If contract has not been signed yet

Direct questions (Optional): What about X dimension (social, technical, etc.) that you did not mention? Why did this not happen as expected?

Indirect Questions (Optional): Some people believe that…What do you think?

Interpreting Questions (Optional): Do you mean that…? Is it fair to say that you believe or you are suggesting that…? Do I understand this correctly, are you saying that…? Do you say that…?

Topic 2: How is contractual risk management related to the regulative context?

Introducing Question

In your opinion: do the current formal rules of the game (constitution, legislation, judiciary, bureaucracy, property rights, etc.) affect how construction risks "are" / "could be" translated into the contract?

Structuring Question

In your opinion: do the current informal rules of the game (culture, idiosyncrasy, etc.) affect how construction risks translate into the contract?

Examples of Follow-up Questions (Optional): What do you mean by…? Yes…?

Examples of Probing Questions (Optional): Could you tell me more about…? In what way do you find that the formal/informal rules help or makes difficult to manage X/Y/Z risks…?

Specifying Questions (Optional): How did that happened?

Direct questions (Optional): What about the culture of X stakeholder (society, government, private sector) that you did not mention? Would you have preferred to do this differently, but you could not do that considering the formal/informal rules? Was the contract adapted to the complexity of the project, or the formal/informal impeded this?

Indirect Questions (Optional): Some people believe that…There are some examples were…What do you think about that?

Interpreting Questions (Optional): Do you mean that…? Is it fair to say that you believe or you are suggesting that…? Do you believe that…?

Topic 3: Can contractual hazards be managed by selecting a planning approach?

Introducing Question

In your opinion, does the planning process in the initial stages of the project affect the necessary contractual management, given the construction risks?

Structuring Question (Optional): These construction risks usually evolve in contractual hazards: the risk that the private sector can take advantage of having more technical information; the risk of the Government changing the rules of the game; and the risk of social-political third-parties coming to look for benefits. The question is: do you think any of those contractual hazards is higher than the others? Do you think they were correctly handled in this megaproject?

Indirect Question - Let's think that there are two simple options in terms of planning. Firstly, there is a closed one that has to do with the analysis of alternatives being carried out in house, and then going out to convince the stakeholders about the project. On the other hand, there is an option of open planning, inviting the different stakeholders (social, technical, political) to reach a solution. The planning here seems to have been done more of the closed than open style. In your opinion: why is this type of planning done, more inclined to the closed-system approach?

Examples of Follow-up Questions (Optional): What do you mean by…? Yes…?

Examples of Probing Questions (Optional): Could you say more about…? In what way do you find…?

Specifying Questions (Optional): How did that happened?

Direct questions (Optional): Is this related to the formal or informal rules? Does the closed-system approach help to manage contractual and construction risks?

Indirect Questions (Optional): Some people believe that? What do you think?

Interpreting Questions (Optional): Do you mean that…? Is it fair to say that you believe or you are suggesting that…?

APPENDIX B – Questionnaire

Please tick [√] in any one rating that you feel appropriate for each item. (Refer to Table 1)

		LIKELIHOOD OF OCCURRENCE						
		AC	***VF***	***F***	***P***	***O***	***R***	***VR***
Risk Dimension	***Risk Factors Under Specific Dimensions***							
D1	***SOCIAL***							
	Impossibility of obtaining land and access rights							
	Compensations higher than expected							
	Protests and interference by residents							
	Claims by third-parties							
	Costs of contractual disputes with contractor							
	Threats to the safety of personnel or assets							
	Vandalism							
	Involvement of many decision-making bodies							
D2	***TECHINCAL***							
	ENGINEERING DESIGN							
	Inappropriate design due to lack of technical capabilities							
	Measurement errors on the site							
	Conflicting interfaces between work items							
	Special Conditions on the site							
	Insufficient site inspections							
	Changes in project scope requirements							
	Changes in technology or in industry use standards							
	Other changes in the engineering design of the project							
	Inaccurate estimates of project cost							
	CONSTRUCTION MANAGEMENT							
	Poor allocation of time and resources							
	Insufficient capacities in construction work							
	Fall in the supply chain							
	Poor quality of local materials							
	Bad suppliers							
	Obstacles to import							
	Distance between site and materials / suppliers							
	Bad contract enforcement							
	Budgetary and cash flow inconsistencies							
	Lack of human resources for the development of the works							
	Technical difficulties in making changes in affected utilities							
	SAFETY IN CONSTRUCTION							

	Insufficient protection of adjacent buildings and facilities							
	Insufficient worker safety							
	Inefficient protection regarding the surrounding environment							
	Inefficient traffic control and management							
D3	***ECONOMIC***							
	Changes in funding vehicles							
	Changes in the taxes							
	Multinational sanctions							
	General inflation							
	Wage inflation							
	Changes in material costs							
	Changes in the cost of energy							
	Exchange rate							
	Economic recession							
	Economic effects of an environmental catastrophe							
	Legislative or regulatory changes in financing							
D4	***ENVIRONMENTAL***							
	ENVIRONMENTAL RISKS DUE TO CONSTRUCTION							
	Underground water filtrations							
	Affectation of flora and fauna							
	UNFAVOURABLE WEATHER CONDITIONS							
	Heavy rain							
	Windstorms							
	Earthquake							
D5	***POLITICAL***							
	Political instability							
	Lack of political support / Political indecision							
	War or regional conflicts							
	Opposition or political interference							
	Government discontinuity							
	Changes in funding policy							
	Delays in obtaining approvals and permits							
	Lack of transparency and corruption							
	Protectionism							
	Lack of updating or regulatory adaptation							
	Other unexpected legislative or regulatory changes							

Please tick [√] in any one rating that you feel appropriate for each item. (Refer to Table 2)

		IMPACT OF RISK				
		VH	H	M	L	VL
Risk Dimension	**Risk Factors Under Specific Dimensions**					
D1	**SOCIAL**					
	Impossibility of obtaining land and access rights					
	Compensations higher than expected					
	Protests and interference by residents					
	Claims by third-parties					
	Costs of contractual disputes with contractor					
	Threats to the safety of personnel or assets					
	Vandalism					
	Involvement of many decision-making bodies					
D2	**TECHINCAL**					
	ENGINEERING DESIGN					
	Inappropriate design due to lack of technical capabilities					
	Measurement errors on the site					
	Conflicting interfaces between work items					
	Special Conditions on the site					
	Insufficient site inspections					
	Changes in project scope requirements					
	Changes in technology or in industry use standards					
	Other changes in the engineering design of the project					
	Inaccurate estimates of project cost					
	CONSTRUCTION MANAGEMENT					
	Poor allocation of time and resources					
	Insufficient capacities in construction work					
	Fall in the supply chain					
	Poor quality of local materials					
	Bad suppliers					
	Obstacles to import					
	Distance between site and materials / suppliers					
	Bad contract enforcement					
	Budgetary and cash flow inconsistencies					
	Lack of human resources for the development of the works					
	Technical difficulties in making changes in affected utilities					
	SAFETY IN CONSTRUCTION					
	Insufficient protection of adjacent buildings and facilities					
	Insufficient worker safety					

	Inefficient protection regarding the surrounding environment					
	Inefficient traffic control and management					
D3	***ECONOMIC***					
	Changes in funding vehicles					
	Changes in the taxes					
	Multinational sanctions					
	General inflation					
	Wage inflation					
	Changes in material costs					
	Changes in the cost of energy					
	Exchange rate					
	Economic recession					
	Economic effects of an environmental catastrophe					
	Legislative or regulatory changes in financing					
D4	***ENVIRONMENTAL***					
	ENVIRONMENTAL RISKS DUE TO CONSTRUCTION					
	Underground water filtrations					
	Affectation of flora and fauna					
	UNFAVOURABLE WEATHER CONDITIONS					
	Heavy rain					
	Windstorms					
	Earthquake					
D5	***POLITICAL***					
	Political instability					
	Lack of political support / Political indecision					
	War or regional conflicts					
	Opposition or political interference					
	Government discontinuity					
	Changes in funding policy					
	Delays in obtaining approvals and permits					
	Lack of transparency and corruption					
	Protectionism					
	Lack of updating or regulatory adaptation					
	Other unexpected legislative or regulatory changes					

APPENDIX C - Aggregated Fuzzy Preferences, computed fuzzy risk rating and corresponding 'crisp' score.

Table C1 – Ferroanel Norte São Paulo

	LIKELIHOOD				IMPACT				FUZZY RISK RATING				x	y	CRISP RATING	RANKING ORDER	RISK PERCENTAGE
RISK DIMENSIONS / Risk Factors																	
SOCIAL																	14,9%
Impossibility of obtaining land and access rights	0,30	0,39	0,46	0,55	0,31	0,40	0,50	0,60	0,09	0,16	0,23	0,33	0,20	0,40	0,45	25	3,74
Compensations higher than expected	0,53	0,63	0,68	0,78	0,33	0,43	0,53	0,63	0,17	0,27	0,35	0,48	0,32	0,40	0,51	6	
Protests and interference by residents	0,41	0,51	0,53	0,63	0,25	0,35	0,45	0,55	0,10	0,18	0,24	0,34	0,21	0,41	0,46	21	
Claims by third-parties	0,39	0,49	0,55	0,64	0,23	0,33	0,43	0,53	0,09	0,16	0,23	0,33	0,20	0,40	0,45	24	
Costs of contractual disputes with contractor	0,38	0,48	0,53	0,63	0,28	0,38	0,48	0,58	0,10	0,18	0,25	0,36	0,22	0,40	0,46	20	
Threats to the safety of personnel or assets	0,15	0,24	0,28	0,38	0,16	0,25	0,35	0,45	0,02	0,06	0,10	0,17	0,08	0,41	0,42	52	
Vandalism	0,30	0,39	0,43	0,53	0,16	0,25	0,35	0,45	0,05	0,10	0,15	0,24	0,13	0,41	0,43	48	
Involvement of many decision-making bodies	0,64	0,74	0,79	0,86	0,38	0,48	0,58	0,68	0,24	0,35	0,45	0,58	0,40	0,39	0,56	2	
TECHNICAL																	
ENGINEERING DESIGN																	16,2%
Inappropriate design due to lack of technical capabilities	0,20	0,29	0,34	0,44	0,28	0,38	0,48	0,58	0,06	0,11	0,16	0,25	0,14	0,41	0,43	45	4,07
Measurement errors on the site	0,16	0,25	0,30	0,40	0,25	0,35	0,45	0,55	0,04	0,09	0,14	0,22	0,12	0,41	0,43	49	
Conflicting interfaces between work items	0,28	0,36	0,41	0,51	0,33	0,43	0,53	0,63	0,09	0,15	0,22	0,32	0,19	0,41	0,45	27	
Special Conditions on the site	0,29	0,38	0,40	0,50	0,29	0,38	0,48	0,58	0,08	0,14	0,19	0,29	0,17	0,41	0,44	30	
Insufficient site inspections	0,23	0,31	0,39	0,49	0,38	0,48	0,58	0,68	0,08	0,15	0,22	0,33	0,19	0,40	0,45	28	
Changes in project scope requirements	0,34	0,44	0,49	0,59	0,38	0,48	0,58	0,68	0,13	0,21	0,28	0,40	0,25	0,40	0,47	17	
Changes in technology or in industry use standards	0,35	0,45	0,51	0,61	0,38	0,48	0,58	0,68	0,13	0,21	0,29	0,41	0,26	0,40	0,48	15	
Other changes in the engineering design of the project	0,24	0,34	0,40	0,50	0,31	0,40	0,50	0,60	0,07	0,14	0,20	0,30	0,17	0,41	0,44	33	
Inaccurate estimates of project cost	0,34	0,44	0,49	0,59	0,38	0,48	0,58	0,68	0,13	0,21	0,28	0,40	0,25	0,40	0,47	16	
CONSTRUCTION MANAGEMENT																	19,4%
Poor allocation of time and resources	0,25	0,35	0,39	0,49	0,30	0,40	0,50	0,60	0,08	0,14	0,19	0,29	0,17	0,41	0,44	31	4,87
Insufficient capacities in construction work	0,25	0,35	0,39	0,49	0,30	0,40	0,50	0,60	0,08	0,14	0,19	0,29	0,17	0,41	0,44	31	
Fall in the supply chain	0,25	0,35	0,39	0,49	0,37	0,47	0,57	0,67	0,09	0,17	0,22	0,33	0,20	0,41	0,45	23	
Bad contract enforcement	0,24	0,34	0,36	0,46	0,30	0,40	0,50	0,60	0,07	0,14	0,18	0,28	0,16	0,41	0,44	34	
Budgetary and cash flow inconsistencies	0,25	0,35	0,39	0,49	0,43	0,53	0,63	0,73	0,11	0,18	0,24	0,35	0,22	0,41	0,46	19	
Lack of human resources for the development of the works	0,18	0,26	0,29	0,39	0,33	0,43	0,53	0,63	0,06	0,11	0,15	0,24	0,14	0,41	0,43	41	
Technical difficulties in making changes in affected utilities	0,35	0,45	0,48	0,58	0,40	0,50	0,60	0,70	0,14	0,23	0,29	0,40	0,26	0,40	0,48	12	
Insufficient protection of adjacent buildings and facilities	0,18	0,28	0,31	0,41	0,20	0,30	0,40	0,50	0,04	0,08	0,13	0,21	0,11	0,41	0,43	50	
Insufficient worker safety	0,11	0,20	0,24	0,34	0,28	0,38	0,48	0,58	0,03	0,08	0,11	0,19	0,10	0,41	0,42	51	
Inefficient protection regarding the surrounding environment	0,18	0,28	0,35	0,45	0,33	0,43	0,53	0,63	0,06	0,12	0,18	0,28	0,16	0,41	0,44	38	
Inefficient traffic control and management	0,18	0,28	0,31	0,41	0,30	0,40	0,50	0,60	0,05	0,11	0,16	0,25	0,14	0,41	0,43	44	

ECONOMIC																	20,0%
Changes in funding vehicles	0,29	0,39	0,43	0,53	0,48	0,58	0,68	0,78	0,14	0,22	0,29	0,41	0,26	0,40	0,48	14	5,04
Changes in the taxes	0,23	0,31	0,35	0,45	0,38	0,48	0,58	0,68	0,08	0,15	0,20	0,30	0,18	0,41	0,45	29	
Multinational sanctions	0,08	0,14	0,19	0,29	0,31	0,40	0,50	0,60	0,02	0,06	0,09	0,17	0,08	0,41	0,42	53	
General inflation	0,19	0,29	0,34	0,44	0,25	0,35	0,45	0,55	0,05	0,10	0,15	0,24	0,13	0,41	0,43	47	
Wage inflation	0,25	0,35	0,39	0,49	0,28	0,38	0,48	0,58	0,07	0,13	0,18	0,28	0,16	0,41	0,44	35	
Changes in material costs	0,31	0,41	0,48	0,58	0,50	0,60	0,70	0,80	0,16	0,25	0,33	0,46	0,30	0,40	0,50	7	
Changes in the cost of energy	0,30	0,40	0,45	0,55	0,40	0,50	0,60	0,70	0,12	0,20	0,27	0,39	0,24	0,40	0,47	18	
Exchange rate	0,35	0,45	0,48	0,58	0,40	0,50	0,60	0,70	0,14	0,23	0,29	0,40	0,26	0,40	0,48	12	
Economic recession	0,34	0,44	0,49	0,59	0,53	0,63	0,73	0,83	0,18	0,27	0,35	0,48	0,32	0,40	0,51	4	
Economic effects of an environmental catastrophe	0,14	0,20	0,28	0,38	0,40	0,50	0,60	0,70	0,06	0,10	0,17	0,26	0,14	0,41	0,43	46	
Legislative or regulatory changes in financing	0,16	0,25	0,30	0,40	0,35	0,45	0,55	0,65	0,06	0,11	0,17	0,26	0,15	0,41	0,43	39	
ENVIRONMENTAL																	
ENVIRONMENTAL RISKS DUE TO CONSTRUCTION																	8,9%
Underground water filtrations	0,28	0,38	0,40	0,50	0,23	0,33	0,43	0,53	0,06	0,12	0,17	0,26	0,15	0,41	0,44	37	2,23
Affectation of flora and fauna	0,35	0,45	0,51	0,60	0,25	0,35	0,45	0,55	0,09	0,16	0,23	0,33	0,20	0,40	0,45	26	
UNFAVOURABLE WEATHER CONDITIONS																	
Heavy rain	0,45	0,55	0,60	0,69	0,33	0,43	0,53	0,63	0,15	0,23	0,32	0,43	0,28	0,40	0,49	8	
Windstorms	0,29	0,38	0,40	0,50	0,24	0,33	0,43	0,53	0,07	0,12	0,17	0,26	0,15	0,41	0,44	36	
Earthquake	0,01	0,03	0,11	0,21	0,36	0,43	0,53	0,63	0,00	0,01	0,06	0,13	0,05	0,41	0,42	55	
POLITICAL																	20,7%
Political instability	0,15	0,25	0,30	0,40	0,35	0,45	0,55	0,65	0,05	0,11	0,17	0,26	0,14	0,41	0,43	40	5,21
Lack of political support / Political indecision	0,49	0,59	0,64	0,74	0,50	0,60	0,70	0,80	0,24	0,35	0,45	0,59	0,41	0,39	0,56	1	
War or regional conflicts	0,08	0,10	0,19	0,29	0,33	0,40	0,50	0,60	0,02	0,04	0,09	0,17	0,08	0,41	0,42	54	
Opposition or political interference	0,34	0,44	0,49	0,58	0,43	0,53	0,63	0,73	0,14	0,23	0,30	0,42	0,27	0,40	0,48	10	
Government discontinuity	0,36	0,46	0,50	0,60	0,41	0,50	0,60	0,70	0,15	0,23	0,30	0,42	0,27	0,40	0,49	9	
Changes in funding policy	0,36	0,46	0,54	0,64	0,48	0,58	0,68	0,78	0,17	0,27	0,36	0,49	0,32	0,39	0,51	5	
Delays in obtaining approvals and permits	0,31	0,41	0,48	0,58	0,45	0,55	0,65	0,75	0,14	0,23	0,31	0,43	0,27	0,40	0,48	11	
Lack of transparency and corruption	0,38	0,48	0,53	0,63	0,48	0,58	0,68	0,78	0,18	0,27	0,35	0,48	0,32	0,40	0,51	3	
Protectionism	0,31	0,41	0,44	0,54	0,33	0,43	0,53	0,63	0,10	0,18	0,23	0,34	0,21	0,41	0,46	22	
Lack of updating or regulatory adaptation	0,24	0,34	0,40	0,50	0,23	0,33	0,43	0,53	0,05	0,11	0,17	0,26	0,15	0,41	0,43	42	
Other unexpected legislative or regulatory changes	0,24	0,34	0,40	0,50	0,23	0,33	0,43	0,53	0,05	0,11	0,17	0,26	0,15	0,41	0,43	42	
TOTAL															25,16		

Table C2 – Central Railway Project Uruguay

	LIKELIHOOD				IMPACT				FUZZY RISK RATING				x	y	CRISP RATING	RANKING ORDER	RISK PERCENTAGE
RISK DIMENSIONS / Risk Factors																	
SOCIAL																	14,7%
Impossibility of obtaining land and access rights	0,13	0,18	0,26	0,36	0,58	0,68	0,78	0,88	0,07	0,12	0,20	0,32	0,17	0,40	0,44	28	3,57
Compensations higher than expected	0,36	0,46	0,50	0,60	0,25	0,35	0,45	0,55	0,09	0,16	0,23	0,33	0,20	0,41	0,45	18	
Protests and interference by residents	0,38	0,48	0,53	0,61	0,28	0,38	0,48	0,58	0,10	0,18	0,25	0,35	0,22	0,40	0,46	9	
Claims by third-parties	0,31	0,41	0,48	0,56	0,21	0,30	0,40	0,50	0,07	0,12	0,19	0,28	0,16	0,41	0,44	27	
Costs of contractual disputes with contractor	0,34	0,44	0,49	0,59	0,30	0,40	0,50	0,60	0,10	0,18	0,24	0,35	0,22	0,40	0,46	10	
Threats to the safety of personnel or assets	0,08	0,15	0,18	0,28	0,31	0,40	0,50	0,60	0,02	0,06	0,09	0,17	0,08	0,41	0,42	49	
Vandalism	0,19	0,28	0,35	0,45	0,16	0,25	0,35	0,45	0,03	0,07	0,12	0,20	0,10	0,41	0,42	46	
Involvement of many decision-making bodies	0,53	0,63	0,64	0,73	0,25	0,35	0,45	0,55	0,13	0,22	0,29	0,40	0,26	0,40	0,48	2	
TECHNICAL																	
ENGINEERING DESIGN																	16,8%
Inappropriate design due to lack of technical capabilities	0,23	0,33	0,34	0,44	0,48	0,58	0,68	0,78	0,11	0,19	0,23	0,34	0,21	0,41	0,46	7	4,08
Measurement errors on the site	0,21	0,30	0,36	0,46	0,38	0,48	0,58	0,68	0,08	0,14	0,21	0,31	0,18	0,41	0,44	22	
Conflicting interfaces between work items	0,34	0,44	0,45	0,55	0,28	0,38	0,48	0,58	0,09	0,16	0,21	0,32	0,19	0,41	0,45	17	
Special Conditions on the site	0,21	0,31	0,35	0,45	0,38	0,48	0,58	0,68	0,08	0,15	0,20	0,30	0,18	0,41	0,45	20	
Insufficient site inspections	0,18	0,26	0,33	0,43	0,40	0,50	0,60	0,70	0,07	0,13	0,20	0,30	0,17	0,41	0,44	24	
Changes in project scope requirements	0,39	0,49	0,55	0,64	0,35	0,45	0,55	0,65	0,14	0,22	0,30	0,41	0,27	0,40	0,48	1	
Other changes in the engineering design of the project	0,40	0,50	0,58	0,66	0,28	0,38	0,48	0,58	0,11	0,19	0,27	0,38	0,24	0,40	0,46	5	
Changes in technology or in industry use standards	0,15	0,25	0,30	0,40	0,21	0,30	0,40	0,50	0,03	0,08	0,12	0,20	0,10	0,41	0,42	45	
Inaccurate estimates of project cost	0,31	0,40	0,45	0,54	0,38	0,48	0,58	0,68	0,12	0,19	0,26	0,36	0,23	0,40	0,47	4	
CONSTRUCTION MANAGEMENT																	20,4%
Poor allocation of time and resources	0,21	0,31	0,35	0,45	0,45	0,55	0,65	0,75	0,10	0,17	0,23	0,34	0,21	0,41	0,46	13	4,93
Insufficient capacities in construction work	0,23	0,33	0,38	0,48	0,46	0,55	0,65	0,75	0,10	0,18	0,24	0,36	0,22	0,40	0,46	8	
Fall in the supply chain	0,25	0,35	0,39	0,49	0,37	0,47	0,57	0,67	0,09	0,17	0,22	0,33	0,20	0,41	0,45	14	
Bad contract enforcement	0,21	0,31	0,35	0,45	0,38	0,48	0,58	0,68	0,08	0,15	0,20	0,30	0,18	0,41	0,45	20	
Budgetary and cash flow inconsistencies	0,14	0,24	0,28	0,38	0,50	0,60	0,70	0,80	0,07	0,14	0,19	0,30	0,17	0,41	0,44	23	
Lack of human resources for the development of the works	0,24	0,34	0,40	0,50	0,45	0,55	0,65	0,75	0,11	0,19	0,26	0,38	0,23	0,40	0,46	6	
Technical difficulties in making changes in affected utilities	0,28	0,38	0,44	0,54	0,36	0,46	0,56	0,66	0,10	0,17	0,24	0,35	0,21	0,40	0,46	12	
Insufficient protection of adjacent buildings and facilities	0,18	0,28	0,31	0,41	0,50	0,60	0,70	0,80	0,09	0,17	0,22	0,33	0,20	0,41	0,45	16	
Insufficient worker safety	0,09	0,16	0,20	0,30	0,55	0,65	0,75	0,85	0,05	0,11	0,15	0,26	0,14	0,41	0,43	33	
Inefficient protection regarding the surrounding environment	0,13	0,23	0,25	0,35	0,38	0,48	0,58	0,68	0,05	0,11	0,14	0,24	0,13	0,41	0,43	34	
Inefficient traffic control and management	0,21	0,31	0,35	0,45	0,33	0,43	0,53	0,63	0,07	0,13	0,18	0,28	0,16	0,41	0,44	25	
ECONOMIC																	19,7%
Changes in funding vehicles	0,10	0,19	0,21	0,31	0,50	0,60	0,70	0,80	0,05	0,11	0,15	0,25	0,14	0,41	0,43	32	4,76
Changes in the taxes	0,08	0,15	0,18	0,28	0,43	0,53	0,63	0,73	0,03	0,08	0,11	0,20	0,10	0,41	0,42	43	
Multinational sanctions	0,05	0,10	0,15	0,25	0,43	0,53	0,63	0,73	0,02	0,05	0,09	0,18	0,08	0,41	0,42	50	
General inflation	0,13	0,21	0,26	0,36	0,38	0,48	0,58	0,68	0,05	0,10	0,15	0,24	0,13	0,41	0,43	37	
Wage inflation	0,13	0,23	0,25	0,35	0,38	0,48	0,58	0,68	0,05	0,11	0,14	0,24	0,13	0,41	0,43	34	

Changes in material costs	0,20	0,30	0,33	0,43	0,40	0,50	0,60	0,70	0,08	0,15	0,20	0,30	0,18	0,41	0,45	19	
Changes in the cost of energy	0,13	0,23	0,25	0,35	0,35	0,45	0,55	0,65	0,04	0,10	0,14	0,23	0,12	0,41	0,43	38	
Exchange rate	0,29	0,39	0,43	0,51	0,33	0,43	0,53	0,63	0,09	0,16	0,22	0,32	0,20	0,41	0,45	15	
Economic recession	0,16	0,26	0,33	0,43	0,35	0,45	0,55	0,65	0,06	0,12	0,18	0,28	0,15	0,41	0,44	30	
Economic effects of an environmental catastrophe	0,11	0,16	0,24	0,34	0,43	0,53	0,63	0,73	0,05	0,09	0,15	0,24	0,13	0,41	0,43	41	
Legislative or regulatory changes in financing	0,10	0,18	0,23	0,33	0,43	0,53	0,63	0,73	0,04	0,09	0,14	0,24	0,12	0,41	0,43	40	
ENVIRONMENTAL																	
ENVIRONMENTAL RISKS DUE TO CONSTRUCTION																	8,9%
Underground water filtrations	0,16	0,26	0,29	0,39	0,33	0,43	0,53	0,63	0,05	0,11	0,15	0,24	0,14	0,41	0,43	31	2,16
Affectation of flora and fauna	0,06	0,11	0,18	0,28	0,25	0,35	0,45	0,55	0,02	0,04	0,08	0,15	0,07	0,41	0,42	51	
UNFAVOURABLE WEATHER CONDITIONS																	
Heavy rain	0,31	0,41	0,44	0,54	0,34	0,43	0,53	0,63	0,11	0,18	0,23	0,34	0,21	0,41	0,46	11	
Windstorms	0,24	0,33	0,38	0,48	0,29	0,38	0,48	0,58	0,07	0,12	0,18	0,27	0,16	0,41	0,44	29	
Earthquake	0,00	0,00	0,10	0,20	0,63	0,73	0,83	0,93	0,00	0,00	0,08	0,19	0,06	0,41	0,41	55	
POLITICAL																	19,5%
Political instability	0,03	0,05	0,13	0,23	0,45	0,55	0,65	0,75	0,01	0,03	0,08	0,17	0,07	0,41	0,42	53	4,71
Lack of political support / Political indecision	0,13	0,20	0,28	0,38	0,40	0,50	0,60	0,70	0,05	0,10	0,17	0,26	0,14	0,41	0,43	36	
War or regional conflicts	0,03	0,04	0,14	0,24	0,55	0,65	0,75	0,85	0,01	0,02	0,10	0,20	0,08	0,41	0,41	54	
Opposition or political interference	0,16	0,25	0,30	0,40	0,43	0,53	0,63	0,73	0,07	0,13	0,19	0,29	0,17	0,41	0,44	26	
Government discontinuity	0,09	0,13	0,20	0,30	0,39	0,48	0,56	0,65	0,03	0,06	0,11	0,20	0,10	0,41	0,42	48	
Changes in funding policy	0,09	0,15	0,21	0,31	0,43	0,53	0,63	0,73	0,04	0,08	0,13	0,23	0,11	0,41	0,43	42	
Delays in obtaining approvals and permits	0,29	0,38	0,39	0,48	0,45	0,55	0,65	0,75	0,13	0,21	0,25	0,36	0,23	0,41	0,47	3	
Lack of transparency and corruption	0,03	0,05	0,13	0,23	0,55	0,65	0,75	0,85	0,01	0,03	0,09	0,19	0,08	0,41	0,42	52	
Protectionism	0,06	0,13	0,16	0,26	0,43	0,53	0,63	0,73	0,03	0,07	0,10	0,19	0,09	0,41	0,42	47	
Lack of updating or regulatory adaptation	0,11	0,21	0,23	0,33	0,38	0,48	0,58	0,68	0,04	0,10	0,13	0,22	0,12	0,41	0,43	39	
Other unexpected legislative or regulatory changes	0,13	0,20	0,28	0,38	0,29	0,38	0,48	0,58	0,04	0,08	0,13	0,22	0,11	0,41	0,42	44	
TOTAL															24,20		

Table C3 – Metro Line 1, Bogotá, Colombia

	LIKELIHOOD				IMPACT				FUZZY RISK RATING				x	y	CRISP RATING	RANKING ORDER	RISK PERCENTAGE
RISK DIMENSIONS / Risk Factors																	
SOCIAL																	4,01
Impossibility of obtaining land and access rights	0,27	0,35	0,44	0,55	0,54	0,64	0,75	0,85	0,15	0,23	0,33	0,47	0,29	0,39	0,49	20	15,1%
Compensations higher than expected	0,40	0,50	0,56	0,67	0,41	0,51	0,62	0,73	0,16	0,25	0,35	0,49	0,31	0,39	0,50	16	
Protests and interference by residents	0,53	0,64	0,67	0,78	0,42	0,53	0,64	0,75	0,22	0,34	0,43	0,58	0,39	0,39	0,55	6	
Claims by third-parties	0,47	0,58	0,65	0,75	0,35	0,45	0,56	0,67	0,16	0,26	0,36	0,51	0,32	0,39	0,51	14	
Costs of contractual disputes with contractor	0,45	0,56	0,61	0,72	0,40	0,51	0,62	0,73	0,18	0,29	0,38	0,52	0,34	0,39	0,52	9	
Threats to the safety of personnel or assets	0,21	0,31	0,37	0,48	0,22	0,31	0,42	0,53	0,05	0,10	0,16	0,25	0,13	0,41	0,43	52	
Vandalism	0,28	0,38	0,44	0,55	0,28	0,38	0,49	0,60	0,08	0,15	0,21	0,33	0,19	0,40	0,45	44	
Involvement of many decision-making bodies	0,61	0,72	0,75	0,85	0,38	0,49	0,60	0,71	0,23	0,35	0,45	0,60	0,41	0,39	0,56	4	

TECHNICAL																	
ENGINEERING DESIGN																	4,42
Inappropriate design due to lack of technical capabilities	0,17	0,25	0,32	0,43	0,69	0,80	0,91	1,02	0,12	0,20	0,29	0,44	0,26	0,40	0,47	29	16,7%
Measurement errors on the site	0,20	0,30	0,35	0,46	0,64	0,75	0,85	0,96	0,13	0,22	0,30	0,45	0,27	0,40	0,48	27	
Conflicting interfaces between work items	0,31	0,40	0,45	0,55	0,53	0,64	0,75	0,85	0,16	0,25	0,33	0,47	0,30	0,40	0,50	17	
Special Conditions on the site	0,43	0,54	0,58	0,68	0,49	0,60	0,71	0,82	0,21	0,32	0,41	0,56	0,37	0,39	0,54	7	
Insufficient site inspections	0,25	0,35	0,42	0,53	0,47	0,58	0,69	0,80	0,12	0,20	0,29	0,42	0,25	0,40	0,47	31	
Changes in project scope requirements	0,25	0,35	0,42	0,53	0,55	0,66	0,77	0,88	0,14	0,23	0,32	0,46	0,28	0,39	0,49	22	
Changes in technology or in industry use standards	0,22	0,32	0,39	0,50	0,60	0,71	0,82	0,93	0,13	0,23	0,32	0,46	0,28	0,39	0,48	26	
Other changes in the engineering design of the project	0,19	0,28	0,35	0,45	0,44	0,55	0,65	0,76	0,08	0,15	0,23	0,35	0,20	0,40	0,45	42	
Inaccurate estimates of project cost	0,30	0,39	0,45	0,56	0,67	0,78	0,89	1,00	0,20	0,31	0,40	0,56	0,36	0,39	0,53	8	
CONSTRUCTION MANAGEMENT																	5,13
Poor allocation of time and resources	0,23	0,34	0,37	0,48	0,58	0,69	0,80	0,91	0,13	0,23	0,30	0,44	0,27	0,40	0,4844	25	19,3%
Insufficient capacities in construction work	0,19	0,30	0,33	0,44	0,53	0,64	0,75	0,85	0,10	0,19	0,24	0,37	0,22	0,40	0,46	35	
Fall in the supply chain	0,20	0,28	0,34	0,44	0,40	0,50	0,60	0,70	0,08	0,14	0,21	0,31	0,18	0,41	0,44	45	
Bad contract enforcement	0,25	0,35	0,38	0,49	0,55	0,65	0,76	0,87	0,14	0,23	0,29	0,43	0,27	0,40	0,4845	24	
Budgetary and cash flow inconsistencies	0,16	0,25	0,32	0,43	0,55	0,65	0,76	0,87	0,09	0,17	0,24	0,37	0,21	0,40	0,45	39	
Lack of human resources for the development of the works	0,20	0,30	0,35	0,46	0,47	0,58	0,69	0,80	0,09	0,17	0,24	0,37	0,22	0,40	0,46	37	
Technical difficulties in making changes in affected utilities	0,26	0,36	0,40	0,51	0,55	0,65	0,76	0,87	0,14	0,24	0,31	0,44	0,28	0,40	0,49	19	
Insufficient protection of adjacent buildings and facilities	0,17	0,26	0,31	0,42	0,42	0,53	0,64	0,75	0,07	0,14	0,20	0,31	0,18	0,41	0,44	47	
Insufficient worker safety	0,15	0,24	0,28	0,39	0,53	0,64	0,75	0,85	0,08	0,15	0,21	0,33	0,19	0,41	0,45	43	
Inefficient protection regarding the surrounding environment	0,21	0,30	0,33	0,44	0,45	0,56	0,67	0,78	0,10	0,17	0,22	0,34	0,20	0,41	0,45	40	
Inefficient traffic control and management	0,33	0,42	0,45	0,56	0,53	0,64	0,75	0,85	0,17	0,27	0,34	0,48	0,31	0,40	0,51	15	
ECONOMIC																	5,24
Changes in funding vehicles	0,21	0,29	0,34	0,45	0,49	0,60	0,71	0,82	0,10	0,17	0,24	0,36	0,22	0,40	0,46	36	19,8%
Changes in the taxes	0,31	0,41	0,46	0,56	0,42	0,53	0,64	0,75	0,13	0,22	0,30	0,42	0,26	0,40	0,48	28	
Multinational sanctions	0,12	0,22	0,25	0,35	0,47	0,58	0,69	0,80	0,06	0,13	0,17	0,28	0,16	0,41	0,44	49	
General inflation	0,32	0,43	0,47	0,58	0,45	0,55	0,65	0,76	0,14	0,23	0,31	0,44	0,28	0,40	0,4870	21	
Wage inflation	0,22	0,31	0,35	0,45	0,41	0,51	0,62	0,73	0,09	0,16	0,21	0,33	0,19	0,41	0,45	41	
Changes in material costs	0,35	0,45	0,53	0,64	0,44	0,55	0,65	0,76	0,15	0,25	0,35	0,49	0,30	0,39	0,4971	18	
Changes in the cost of energy	0,27	0,38	0,44	0,55	0,40	0,51	0,62	0,73	0,11	0,19	0,27	0,40	0,24	0,40	0,47	33	
Exchange rate	0,45	0,56	0,64	0,74	0,53	0,64	0,75	0,85	0,24	0,36	0,47	0,63	0,42	0,38	0,57	3	
Economic recession	0,24	0,35	0,45	0,55	0,55	0,65	0,76	0,87	0,13	0,23	0,34	0,48	0,29	0,39	0,49	23	
Economic effects of an environmental catastrophe	0,18	0,28	0,32	0,43	0,60	0,71	0,82	0,93	0,11	0,20	0,26	0,40	0,24	0,40	0,47	32	
Legislative or regulatory changes in financing	0,12	0,21	0,25	0,36	0,53	0,64	0,75	0,85	0,06	0,13	0,19	0,31	0,17	0,41	0,44	48	
AMBIENTALES																	2,18
Underground water filtrations	0,17	0,28	0,32	0,43	0,41	0,51	0,62	0,73	0,07	0,14	0,20	0,31	0,18	0,41	0,44	46	8,2%
Affectation of flora and fauna	0,05	0,06	0,15	0,26	0,28	0,36	0,47	0,58	0,01	0,02	0,07	0,15	0,06	0,41	0,42	55	
Heavy rain	0,30	0,40	0,47	0,58	0,40	0,51	0,62	0,73	0,12	0,20	0,29	0,42	0,26	0,40	0,47	30	
Windstorms	0,07	0,14	0,19	0,30	0,28	0,36	0,47	0,58	0,02	0,05	0,09	0,17	0,08	0,41	0,42	54	
Earthquake	0,07	0,14	0,19	0,30	0,56	0,67	0,78	0,89	0,04	0,09	0,15	0,27	0,13	0,41	0,43	53	
POLITICAL																	5,55

Political instability	0,31	0,41	0,46	0,57	0,55	0,65	0,76	0,87	0,17	0,27	0,35	0,50	0,32	0,40	0,51	13	21%
Lack of political support / Political indecision	0,37	0,46	0,52	0,63	0,47	0,58	0,69	0,80	0,18	0,27	0,36	0,50	0,32	0,40	0,51	12	
War or regional conflicts	0,15	0,23	0,26	0,37	0,35	0,44	0,55	0,65	0,05	0,10	0,14	0,24	0,13	0,41	0,43	51	
Opposition or political interference	0,44	0,55	0,60	0,70	0,54	0,64	0,75	0,85	0,23	0,35	0,45	0,60	0,40	0,39	0,56	5	
Government discontinuity	0,51	0,62	0,69	0,78	0,50	0,60	0,71	0,82	0,25	0,37	0,49	0,64	0,44	0,38	0,58	1	
Changes in funding policy	0,25	0,33	0,38	0,49	0,48	0,58	0,69	0,80	0,12	0,19	0,26	0,39	0,24	0,40	0,47	34	
Delays in obtaining approvals and permits	0,40	0,50	0,56	0,67	0,62	0,73	0,84	0,95	0,25	0,36	0,47	0,64	0,43	0,39	0,57	2	
Lack of transparency and corruption	0,30	0,40	0,45	0,55	0,58	0,69	0,80	0,91	0,17	0,28	0,36	0,50	0,32	0,40	0,51	11	
Protectionism	0,16	0,25	0,30	0,41	0,36	0,47	0,58	0,69	0,06	0,12	0,17	0,28	0,15	0,41	0,44	50	
Lack of updating or regulatory adaptation	0,35	0,45	0,51	0,61	0,51	0,62	0,73	0,84	0,18	0,28	0,37	0,51	0,33	0,39	0,51	10	
Other unexpected legislative or regulatory changes	0,24	0,34	0,40	0,51	0,40	0,51	0,62	0,73	0,09	0,17	0,25	0,37	0,22	0,40	0,46	38	
TOTAL															26,52		