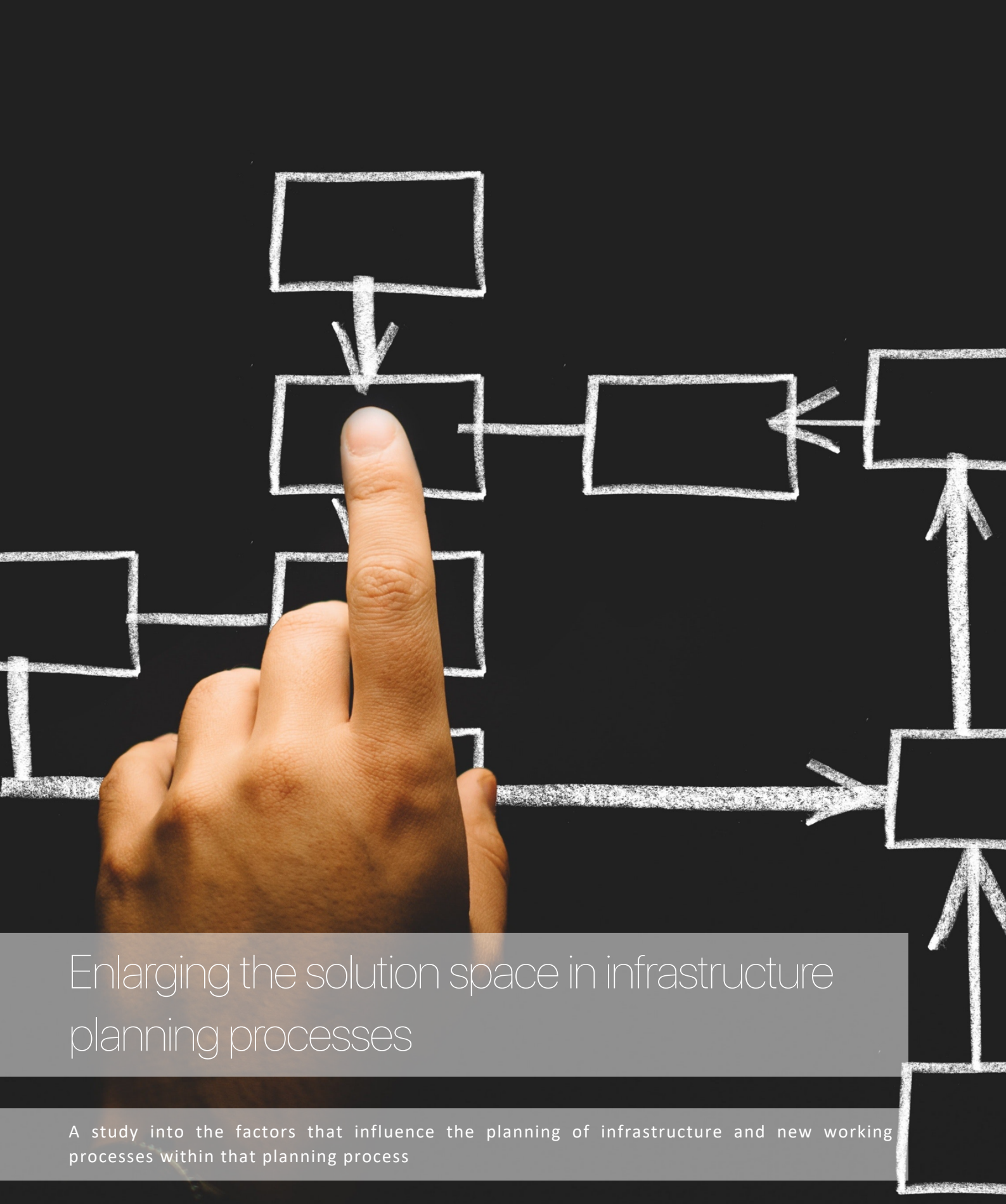

Enlarging the solution space in infrastructure planning processes

A study into the factors that influence the planning of infrastructure and new working processes within that planning process

TU Delft

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Summary

This thesis provides insight into how the design approach, also known as 'Design Thinking' could be implemented in infrastructure planning processes. This is done with the objective to prevent premature convergence, which means, too early choosing for a solution by which other valuable alternatives are 'killed off.' By preventing premature convergence, the level of integration of the infrastructure solution will improve.

The reason for studying how premature convergence could be prevented originates by several challenges that European governments should deal with the coming years. These challenges are originated by changes in the climate, technological development and changes in the desires of citizens. Preventing premature convergence and providing more integration in infrastructure planning processes means that the solution space – the room to develop solutions – should be as large as possible in the infrastructure planning process.

In the literature research, the factors have studied that influence the solution space. This is presented in an analytical model of which a copy is included in Figure 1. In this figure, the factors can be seen as well as their mutual relation, in which a 'plus' means a directly proportional relation and a 'minus' an inversely proportional relation.

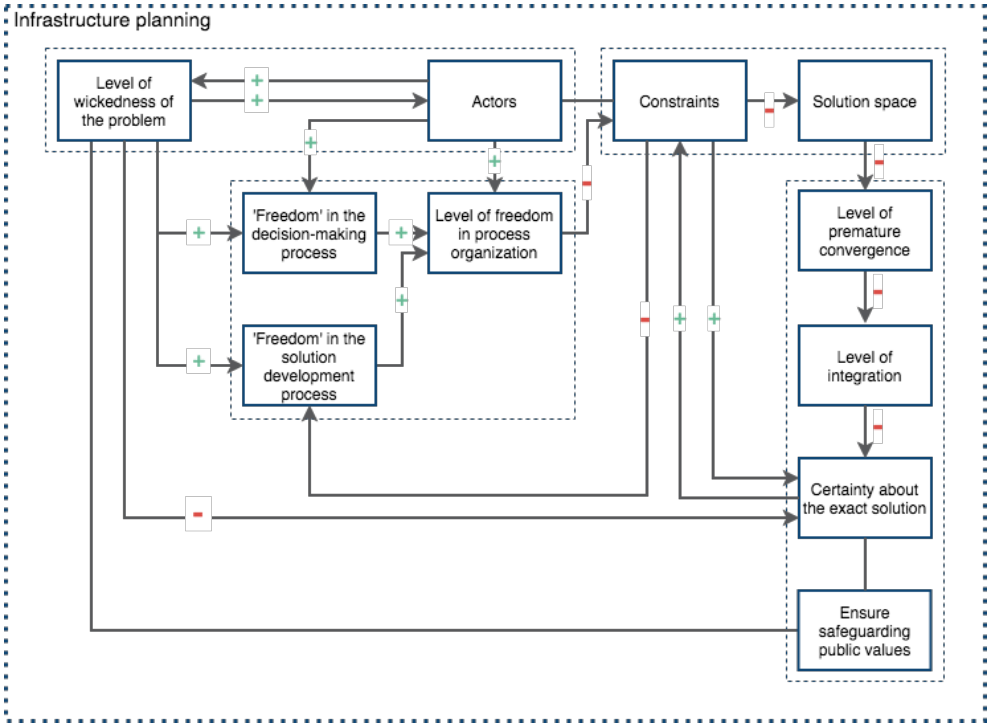

Figure 1 Copy of Figure 10 Analytical model, based on the literature research (own figure)

In the infrastructure planning context, the problem that causes the need to plan infrastructure is wicked by nature. Furthermore, there are many actors involved due to the size of infrastructure systems. Therefore, a free organisation of the infrastructure planning process is needed. This leads to adopting the networked decision-making model and the design approach in the solution development process. This all is influenced by constraints, which determines the size of the solution space.

The analytical model has been researched empirically in the national Dutch infrastructure planning process. In this process, also known as the 'MIRT procedure' has been searched for the factors that currently cause premature convergence and therefore lower levels of integration.

It has been found that in the current national infrastructure planning process of the Netherlands the wickedness of infrastructure planning problems is overlooked. Secondly, the number of actors is generally kept as low as possible, although this would not necessarily lead to more constraints. Furthermore, there is found that the organisation of the MIRT procedure is very strict. It is thus allowing little freedom in the process, which is also implying that there are many constraints in the MIRT procedure.

Answering the main question

After researching the MIRT procedure, the main question can be answered: *How can the solution space be enlarged in the infrastructure planning process of the Netherlands?*

In order to enlarge the solution space in the MIRT procedure, many constraints should be thought through on their actual purpose. It is argued that many of the constraints are caused by an unnecessary idea of ensuring legal certainty to citizens by providing certainty about the exact solution. Which is not necessarily true, since public values, of which legal certainty is one, could be provided through other mechanisms as well. These mechanisms are in line with the proposed networked decision-making process.

This answer leads to the following recommendations:

1. Change the organisation of the infrastructure fund
2. Improve the research to problems, and their deeper cause
3. Reduce the overall strictness of the MIRT procedure
4. Reduce the lead time of the MIRT procedure
5. Create an 'escape' if the cause of the problem is out of the infrastructure scope
6. Implement the design approach

Using the model in other countries

The analytical model and the proposed organisation of the process could be used in other countries as well. However, there are legal, administrative and cultural characteristics that should be considered. These characteristics are the legal and administrative family in which a country could be placed. And, secondly, the cultural dimensions, of which the 'power distance,' 'uncertainty avoidance,' and 'long-term orientation' are the main dimensions to consider.

Finally, one of the main points in the discussion is that the proposed decision-making process and the solution development process are probably not only useful in the infrastructure context but might probably be translated to other policy areas. This could be researched further in future

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9 pictures are included of buildings that inspired me:

Preface

Dear reader,

This thesis reflects the work I have been doing for the last couple of months. Not only does it reflect that, but it also reflects the work I have been doing in my entire study career. The primary driver behind this thesis is my ambition to make things that satisfy people, organisations and society as a whole. Because of my background, I limited myself to researching the field of infrastructure. However, a couple of times I came into fascinating discussions with people, with whom I could philosophise about leaving this scope and making crossovers between various specialisms and fields. The primary lesson from this thesis is to search for what people desire. Touching upon that creates fascinating discussions and make people think about their life choices.

The ones that know me well recognise that building has always been a central part of my life, starting already when I was very young. Therefore, by studying Civil Engineering at Delft University of Technology, a dream came true. During my bachelor's study career, I discovered that I like doing the technological part. However, I noticed that I preferred, even more, to think about the organisational aspects. The reason for that did I already explain, my ambition to create things that fit properly in society. This is, in my opinion, the major challenge in every project and is, as already explained, the primary driver behind this graduation thesis as well. This is also the primary motive to choose for studying the master Construction Management and Engineering, which is about organising (building) projects and behaving within the construction industry that still becomes more dynamic and complex.

In the last two years, I was not only busy with studying, but I tried to contribute to the 'project', known as Suit-case, as well. It started as a learning project for us and a way to discover if we were capable of helping organisations with their organisational questions. Nowadays we are well on the way to become a consultancy firm with tremendous and challenging projects in which we are able to help our customers to reflect on their working practices and to stimulate them to think differently. It has been a great journey so far, and I hope we can keep going. I am grateful to my partners, Bern, Marc and Tomas, whit whom I have started Suit-case. You have taught me a lot, keep reflecting on me and try to stimulate me to improve day by day.

Besides this I have to express my gratitude to my friends, my family, Mom and Dad, who motivated, stimulated and helped me throughout my life. My brother and sisters who helped me training my real-life discussion skills, but moreover have always been interested. Moreover, finally, I have to say that I am very grateful to my girlfriend, Iris, who has been far away but yet so close. You gave me much motivation, helped me in the process and did the very detailed readings, which all helped me through.

Kind regards,

D.R. (Daan) de Wit

1 Introduction

1.1 Subject

Currently, there are a lot of trends and developments in society that have a significant influence on human behaviour, their mobility and how transportation networks are used. For example, technological innovations in mobility modalities such as a Hyperloop (Delft Hyperloop, 2018) or autonomous driving cars (Heineke, Kampshoff, Mkrtchyan, & Shao, 2017). Other developments are the ongoing growth of the world population (United Nations, 2017), which increases the demands on all kinds of resources. Also, the ongoing trend of 'urbanisation' (United Nations, 2018), meaning that more people are going to live in urban areas instead of rural areas. Finally, more and more knowledge is gained about the influence of transport and mobility on the climate (Lockwood, 2010; Oreskes, 2004).

These trends and developments are causing challenges for governments including at the policy area of infrastructure and infrastructure planning. In the article of Massey (2017) the following key policy challenges in Europe that should be solved by European governments in the coming years, which are recognised by many others as well (Roggema, Kabat, & van den Dobbelsteen, 2012; Szulczewska, Giedych, & Maksymiuk, 2017; P. J. Williams & Williams, 2016):

- *"Creating really sustainable urban development."*
- *"Shaping cohesive urban, spatial and infrastructure governance."*
- *"Facilitate employment and new work patterns."*
- *"Defending the heritage of cities and cultures."*
- *"Dealing with multi-cultural societies and migration."*

1.2 Problem analysis

No integration in infrastructure planning

Within Europe, governments work by creating law based policy which regulates society, known as a policy process (Seaden & Manseau, 2001; van Heffen & Klok, 2000). Various studies recognise that those European policy processes are not prepared to deal with future challenges related to urban, spatial and infrastructure planning, that are containing many aspects (Razaghi & Finger, 2018; Romero-Lankao, 2012; Winter & Szczepanek, 2008; Yearworth, 2016). The reason for this can be found in the organisation of infrastructure planning, which is not able to incorporate the many aspects, due to a lack of focus on integration (Busscher, Arts, & Tillema, 2014). By integration is meant that various aspects are combined into a solution through coordination, communication and control (Baccarini, 1996; P. W. G. Morris, 2013).

The sectoral organisation and singular focussed

Opposite to the desired integration in infrastructure planning is the current, but recognised as undesired, focus on delivering sectoral, single modality infrastructure solutions (Arts, Hanekamp, Linssen, & Snippe, 2016; Brady, Davies, & Gann, 2005; Ferretti, 2016; Heeres, Tillema, & Arts, 2016; Te Brömmelstroet & Bertolini, 2010; Wang, Monzon, Ciommo, & Kaplan, 2014). The reason for this focus is the sectoral organisation of infrastructure planning (Busscher et al., 2014; Busscher, Tillema, & Arts, 2013; Heeres, van Dijk, Arts, & Tillema, 2017). One of the governments in Europe that aimed to tackle this problem is the government of the Netherlands, who provided a new set

of rules for the national planning process with the aim to achieve integration and to overcome the sectoral organisation (IBO Werkgroep Flexibiliteit in de infrastructurele planning, 2016; Ministerie van Infrastructuur en Milieu, 2016b). However, later research on the implementation and execution of these rules concluded that the level of integration and overcoming the sectoral organisation is still unsatisfactory (Leppink, 2017).

Solution certainty

One could ask why there is a focus on creating sectoral, single modality solutions. The answer can be found in *"the belief that there is one perfect solution"* (Hertogh & Westerveld, 2010, p. 245). This is caused by the desire to have certainty about the exact solution, which is more straightforward when there is a sectoral and singular solution (Flyvbjerg et al., 2018; Haskins, 2009; Nicholas & Steyn, 2017).

Safeguarding public values

The reason for desiring having certainty about the exact solution is originated by the anxiety of governments to endanger public values. Which in their opinion is in danger when there is no certainty about the exact solution (Crosby, Bloomberg, & Bryson, 2014; Janssen, Graaf, Smit, & Voordijk, 2016; Koppenjan, Charles, & Ryan, 2010).

Figure 2 presents a schematic overview of the problem analysis.

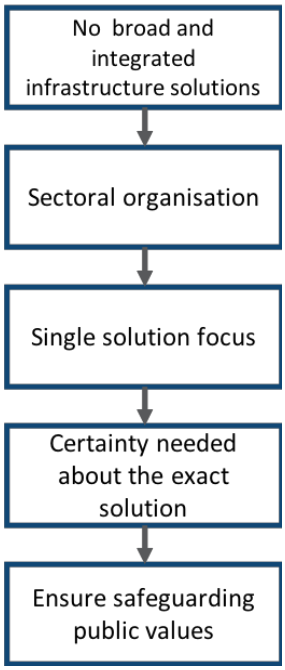

Figure 2 Problem analysis overview (own figure)

1.3 Objective

The search for improving integration in infrastructure planning is caused by the challenges as explained in paragraph 1.1. The need to improve integration in infrastructure planning is acknowledged by many other studies as well (Arts et al., 2016; Heeres et al., 2017; Hermans, Volker, & Eisma, 2014; Hjelmbrekke, Klakegg, & Lohne, 2017; Withanaarachchi & Setunge, 2014). Thus, integration, in this context, should focus on incorporating the trends and developments that cannot be coupled directly to infrastructure planning (Heeres & Arts, 2017; Hertogh & Westerveld, 2010; Newman, 2015; Razaghi & Finger, 2018). According to Hertogh & Westerveld (2010) one should aim for preventing 'premature convergence.' Meaning that *"a solution is chosen early in the process, thereby 'killing off' the many other options present at that point in time."* (Hertogh & Westerveld, 2010, p. 242). In other words, the space to create and develop solutions should be enlarged during the infrastructure planning process (Bakker & de Kleijn, 2014; Samset, 2014; Samset & Volden, 2016).

Therefore, the objective of this graduation thesis is to prevent premature convergence and to study how the solution space can be enlarged in infrastructure planning processes. This to create improved solutions that are more suitable in dealing with the trends and developments present in society.

1.4 Research questions

The main question of this graduation thesis is:

How can the solution space be enlarged in the infrastructure planning policy process in the Netherlands?

The research questions of this graduation thesis are

1. *How is infrastructure planning described in literature?*
2. *How can a solution space be enlarged according to literature?*
3. *How is the current solution development process within the infrastructure planning process of the Netherlands organised?*
4. *Which factors are influencing the solution development and selection in the current infrastructure planning process of the Netherlands?*
5. *What are the differences between the current solution development process within the infrastructure planning process of the Netherlands and the theoretical solution development process?*
6. *What are the main considerations when implementing the findings of this thesis in other European infrastructure planning processes?*

1.5 Scope

1.5.1 Infrastructure planning

The focus in this graduation thesis is on infrastructure planning, although one could argue that there are many more trends and developments in society, besides the ones stated in paragraph 1.1. This is, in fact, an arbitrary choice, although, one could argue as well that at some point there should be started at some field. A more important reason to focus on infrastructure planning is because a recent report about climate change stated that the economic sectors of transport, buildings and transport within the sector of electricity and heat production together are responsible for over 30% of greenhouse gasses, that, according to the same study are contributing to climate change (IPCC, 2014; Zeitschrift, Link, Dienst, & Eth, 2014). Thus, there is a need for other (types of) solutions. The third reason is that according to another study the real gross value added per hour worked in the (infrastructure) construction sector significantly stays behind with other economic sectors. The construction sector gross value added per hour worked has only grown with 20%, whereas the entire real gross value added per hour worked by the entire economy has grown with over 60% since 1995 (McKinsey Global Institute, 2017). Thus, there is an urgent need to improve the working principles in the construction sector. This all starts with planning, of which infrastructure planning is a large part.

1.5.2 Focus on the Netherlands

In this thesis is focussed on the infrastructure planning policy process within the Netherlands. The reason for this is that the current infrastructure planning policy process in the Netherlands often taken as an example for other countries (Hobma & Jong, 2016) due to the high international ranking of the infrastructure (Schlattau, 2015; World Economic Forum, 2017). Because of this 'leading role', it might be possible that presenting how the solution space can be enlarged in the Dutch infrastructure planning policy process might be inspiring for other countries as well.

1.5.3 Focus on governments

The focus on governments is because they are in the Netherlands responsible for the organisation of the planning policy process for infrastructure (Gann, 1997; Rijkswaterstaat, 2010; van Heffen & Klok, 2000). In this thesis is focussed on the organisation and planning of mobility and infrastructure. These consist of large networks and systems that are often essential for countries to funtion properly (Reimer, Getimis, & Blotevogel, 2014). Therefore, the organisation and planning of mobility and infrastructure is almost always done by governments of countries (Reimer et al., 2014). Although it is imaginable that the organisation and planning of mobility and infrastructure is done by private and commercial organisations (Leiringer, 2006), the focus of this thesis is on public and governmental organisations. The reason for keeping the focus on the public sector is because, as already stated previously, in most cases the planning of large mobility and infrastructure systems is done by governments.

1.5.4 Focus on MIRT

There are various public planning processes in the Netherlands which can be divided into 3 categories, planning processes on a national, regional and local level (Reimer et al., 2014). The focus of this thesis is on the current Dutch national infrastructure planning process, which is also known as the MIRT procedure (Ministerie van Infrastructuur en Milieu, 2016b). The reason for focussing on the national level rather than the regional or local level is because with focussing on this single planning process a significant share of the entire market volume is covered (Groot, Saitua, & Visser, 2016), which will be explained now.

The result of all infrastructure planning processes can be measured in the entire budget. This is the paid budget that is needed to execute all projects that are a result of all the infrastructure planning processes. The expected market volume until 2030 is about 244 billion euros of which at least 92 billion is spent through the national infrastructure planning processes, which is about 37%, the other 63% is spent through a variety of planning processes of which none is individually ‘responsible’ for this percentage (Groot et al., 2016). Thus, more than a third of the entire volume is planned through a single planning process, which justifies the attention for this single process.

1.6 Structure of the document

This thesis is structured as follows. In chapter 2 the theoretical framework is described on which this thesis is based. In chapter 3 the research methodology is described. In chapter 4 the current national Dutch infrastructure planning policy process is described. In chapter 5 the solution development process from the theoretical framework is compared with the solution development process found in the national Dutch infrastructure planning policy process. In chapter 6 a reflection is written on the theoretical framework by exploring characteristics of other European countries. In chapter 7 the conclusion is drawn that answers the main question of this thesis. In chapter 8 the discussion is presented. In chapter 9 the bibliography is presented.

2 Theoretical framework

This chapter presents the theoretical framework of this graduation thesis. The theoretical framework is based on scientific literature and will be used to create a background that supports the understanding of the subject of this thesis. The objective of this chapter is to present a conceptual model and to answer research question 1: *How is infrastructure planning described in literature.* And research question 2: *How can a solution space be enlarged according to literature.* These research questions follow from the two main concepts that are used in the main question: infrastructure planning and solution space.

2.1 The context of infrastructure planning

In the introduction is explained this thesis focusses on infrastructure planning. The reason for this focus can be found in the scope, see paragraph 1.5. In this paragraph will be explored how infrastructure planning is described in literature.

2.1.1 Exploring infrastructure planning

Traditionally, the organisation of infrastructures, as well as its regulation is done by governments (Reimer et al., 2014). The reason for being organised and regulated by governments is because infrastructure systems are extensive physical systems with a significant impact on societies and require significant capital investments (Kasper, 2015). In most countries, three organisational levels can be distinguished: a national, regional and local level (Biegelbauer, Lindloff, & Sager, 2017; Convertino & Valverde, 2013; Flyvbjerg, 2007).

Infrastructure planning is a process with the objective to regulate infrastructure systems. This is often regulated in an infrastructure plan. These infrastructure plans are mostly initiated by governments and created through a process and are generally known as policy plans (van Wee, Annema, & Banister, 2012).

2.1.2 The 'wickedness' of infrastructure planning

In the previous paragraph is explained that an infrastructure plan is generally known as a policy plan resulting from a process. In order to start a process, there should be a purpose to do so. In literature this reason is referred to as a policy problem (Bueren, Klijn, & Koppenjan, 2003; Rittel & Webber, 1973), thus related to the infrastructure context this can be called an infrastructure planning policy problem. And, although, it feels very logical to conclude that there is a policy problem which can be solved by creating a policy plan, it is not that simplistic.

The reason for this being difficult can be found in the nature of a policy problem: they are subject to a variety of objectives held by a range of interests of different people and organisations, which makes defining policy problems slightly more complex. A second reason for the difficulties with creating a policy plan is future uncertainty. The same literature that explains policy problems and provides the 2 reasons for the difficulties with creating policy plans classifies a policy problem as a 'wicked problem.' Wicked in this context means 'vicious,' 'tricky,' and 'aggressive' (Rittel & Webber, 1973; Westrik, 2002, p. 433; T. Williams & Samset, 2010).

In the article of Rittel and Webber (1973) 10 characteristics of a wicked problem are presented:

1. *"There is no definitive formulation of a wicked problem."*
2. *"Wicked problems have no stopping rule."*
3. *"Solutions to wicked problems are not true-or-false, but good-or-bad."*
4. *"There is no immediate and no ultimate test of a solution to a wicked problem."*
5. *"Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly."*
6. *"Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the solution."*
7. *"Every wicked problem is essentially unique."*
8. *"Every wicked problem can be considered to be a symptom of another problem."*
9. *"The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution".*
10. *"The planner has no right to be wrong."*

These characteristics indicate that there is not a particular 'starting moment' determinable at which the policy problem is formulated, see characteristic 8. Besides that, it is also not possible to define an 'end' in this process. However, this does not mean that no solution can be found. However, there cannot be spoken about 'the' solution, but rather about 'a' solution.

The multi-actor network

One of the reasons to classify policy problems as wicked is because of the variety of objectives and interests of different people and organisations. This variety of people and organisations is referred to as a multi-actor network and is characterised by (De Bruijn & ten Heuvelhof, 2012):

- a large variety between actors in the network;
- mutual dependencies between the actors;
- closedness to hierarchical signals;
- highly dynamic atmosphere

The relation between a wicked problem and a multi-actor network

The multi-actor network consists of many actors with different objectives and interests, being the cause of the existence of a wicked problem. The other way around it can be argued that once a wicked problem as such is recognised, it may attract even more actors because they are having an interest related to the wicked problem.

Because infrastructure planning is about the organisation of infrastructural systems that have a significant effect on society in which there are many actors, there is a large multi-actor network related to infrastructure planning.

2.2 The solution space in infrastructure planning and enlarging it

In the introduction of this thesis is explained that early in the process solutions are chosen resulting in 'killing off' other feasible solutions. Upon which is concluded that the solution space, the space

that allows for researching and developing other solutions should be made larger. Therefore, in this chapter the solution space will be explored in more detail and, secondly, there will be explored what should be done to enlarge the solution space.

2.2.1 A definition of a solution space

Before exploring how a solution space can be enlarged it is needed to understand what is meant by a 'solution space.' First, the mathematical explanation is presented because it provides a good visualisation of the definition of a solution space. The mathematical explanation helps to understand the term solution space. After understanding a solution space in a mathematical context, it is related to the planning context.

Definition of a solution space

The solution space is defined as the 'area' formed by the set of all feasible solutions and is limited by constraints (Branke, Deb, Miettinen, & Slowinski, 2008; Kang & Chen, 2016; Stacho, 2001; Wallenius et al., 2008). *"Constraints are requirements that limit the solution space beyond what is necessary for meeting the given functional and quality requirements"* (Pohl & Rupp, 2015, p. 8). Requirements are conditions or capabilities needed by a user to solve a problem or to achieve an objective (Pohl & Rupp, 2015).

This has been visualised in Figure 3, in which a solution space is visualised in a mathematical context. In this figure, the blue lines represent the functional and quality requirements. The green lines represent additional constraints that limit the solution space, which has been visualised as the grey area.

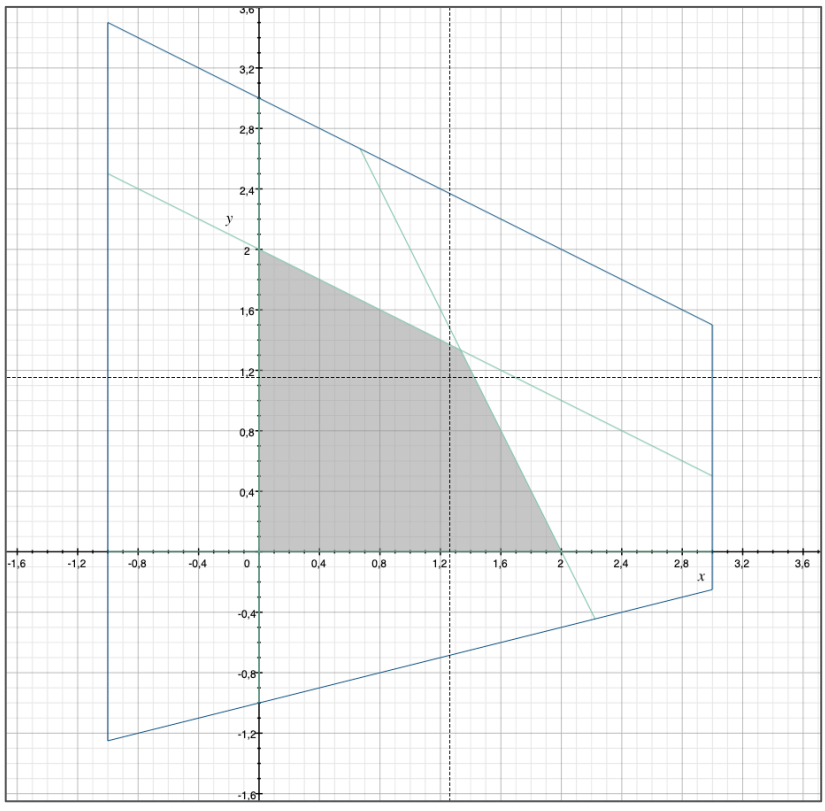

Figure 3 Visualisation of a solution space in a mathematical context (own figure)

In the context of planning policy processes, a solution space cannot be visualised as easily as in the mathematical context, because the constraints cannot always be expressed as mathematical equations and visualised accordingly. However, it can be understood that there are constraints and that these can be determined in the planning context. Research to these constraints revealed that there are 3 sources of constraints, each of which with its types, see Table 1 (Kamarudin, Ridgway, & Hassan, 2016; Leffingwell & Widrig, 1999).

Constraint source	***Types of constraint***
Design options/choices (mostly internal)	Technological
	Time
	Material
	Aesthetic
	Health
	Safety
Conditions imposed on the development process (mostly external)	Manufacturing
	Inspectability
	Sustainability
	Life-cycle
Standards and regulations (mostly external)	Economic
	Environmental
	Social
	Legality
	Ethical

Table 1 Sources and types of constraints (Kamarudin et al., 2016)

Measuring the enlargement of a solution space in the planning context

As stated in the problem statement the need for 'enlarging' a solution space follows from the unclarity about how various aspects in the planning process should be considered and integrated. In the mathematical context, it is easier to understand what it means to enlarge the solution space; it is moving the constraints outwards in order to geometrically add surface to the, in the example of Figure 3, grey area. Similar to the mathematical example, the solution space in the planning context can be enlarged by moving constraints. 'Outwards' cannot be taken literally in the planning context but should be seen as providing more freedom (Kilian, 2006; Wenngren, Ericson, & Holmqvist, 2014). Thus, the enlargement of a solution space can be measured according to the additional freedom given by moving a constraint. The desired functionality and quality requirements define the maximum size of the solution space.

Wicked problems and constraints

The solution space in the mathematical context can be understood and fixated easily, but this is not the case in the planning context. As described in paragraph 2.1.2, infrastructure planning policy problems are classified as wicked problems. In the article of Rittel and Webber (1973, p. 162) is stated that: *"Setting up and constraining a solution space is part of the wicked problem."* This

indicates that a solution space as such is recognised in the planning context and that it can be defined. Furthermore, it indicates that constraining a wicked problem does not change the wicked nature of the problem; it is only a way to allow for searching a solution. Others confirm this and explain that it is not an easy process, considering the other characteristics of a wicked problem (Farrell & Hooker, 2013; Rittel & Webber, 1973; Wenngren et al., 2014). The objective of this graduation thesis is to prevent premature convergence and to study how the solution space can be enlarged. This, however, does not mean that posing constraints is necessarily wrong, it is about the moment in the process when these are imposed.

The reason that constraining the solution space in the planning context is not an easy process can be found in the relation between the multi-actor network and the constraints. Due to the existence of a multi-actor network in which an infrastructure planning policy problem exists, there are many views and interests about the conditions that a solution should meet, thus about the constraints (Rittel & Webber, 1973; Samset, 2014).

Although actors impose constraints to the infrastructure planning policy problem, there is no relation between the size of the multi-actor network, i.e. the number of actors involved, and the number and level of freedom of the constraints (Broennum & Clausen, 2013). For example, it might be possible that there are actors in the multi-actor network that are constraining the solution space. If the multi-actor network expands, i.e. there are more actors involved, the new actors in the network may bring new points of view which allow for other actors to reconsider their constraints and even leave them. However, the other way around is possible as well. It might be possible that adding additional actors to the multi-actor network results in more constraints that further reduce the solution space.

2.3 Organising the process

It has been explained now that in the infrastructure planning context the cause desiring such a planning is a policy problem that has been classified as a wicked problem. Also, it has been explained that in order to enlarge the solution space in the infrastructure planning process constraints should give more freedom and 'moved outwards.' In this chapter will the role of the actors in the multi-actor network explored on the development of solutions. And, secondly, will be explored how solutions can be developed in the infrastructure planning context in such a way that the constraints are less limiting in the process.

2.3.1 Decision-making process

Actors in the multi-actor network are primarily involved because they are having an interest in the infrastructure plan, as explained in paragraph 2.1.1. Because of that interest, the actors try to influence the infrastructure plan by trying to influence the decisions leading to that plan (De Bruijn & ten Heuvelhof, 2012).

These processes are known as decision-making processes and can, according to de Bruin & ten Heuvelhof (2012) be divided into 2 types. Networked decision-making and hierarchical decision-making. Hierarchical decision-making is originated by the assumption that there is a single actor who can take decisions and impose these decisions on other actors (De Bruijn & ten Heuvelhof, 2012). However, this is not the situation in the infrastructure planning context in which multi-actor

networks exist. Due to the characteristics of such networks in which actors need each other to take decisions (mutual-dependencies), the decisions cannot be taken hierarchically, but are instead the result of an open and unstructured process (De Bruijn & ten Heuvelhof, 2012).

The networked decision-making process is visualised in Figure 4 and does have several characteristics (De Bruijn & ten Heuvelhof, 2012; de Bruijn & ten Heuvelhof, 1999). These are compared to the characteristics of hierarchical decision-making in Table 2.

Hierarchy	***Network***
Regular and sequential	Irregular and no clear sequence of activities
Phases	Rounds
Actors are stable	Actors join and withdraw and behave strategically
One arena, the process has a clear starting point and end point	Several arenas, no isolated starting point and end point
The content of the problem is stable	The content of the problem shifts
The incentive to regard problems as structured	The incentive to regard problems as unstructured
Consistency and predictability	Flexibility and unpredictability

Table 2 Comparing Hierarchical and networked decision-making (De Bruijn & ten Heuvelhof, 2012)

Although the decision-making process in a multi-actor network is unstructured and open, it is possible to visualise the decision-making process. In the article by Teisman (2000), Figure 4 is presented.

"The grey arrow is decision-making, the dots depict decision taken by the various actors, and the policy result stems from the interaction between decisions (building upon decisions of others, small black arrows, anticipation upon future decisions, white arrows, and covenanting results, white rectangles)." (Teisman, 2000, p. 945)

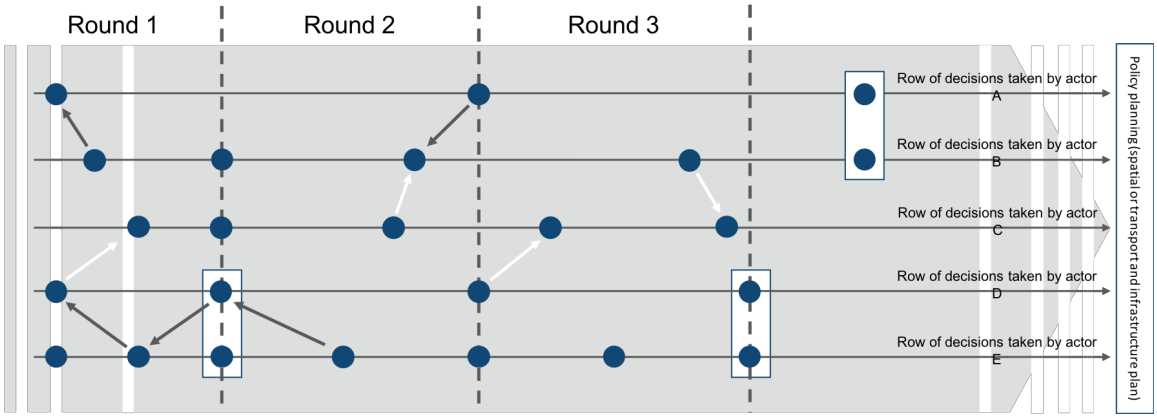

Figure 4 The concept of decision-making as a process, adapted from (Teisman, 2000)

This figure clarifies and underlines that policymaking in a particular field does not depend on a single actor who autonomously can take decisions. However, policy is created as a result of decisions taken by various actors through a process in which various rounds can be distinguished.

There are several guidelines – or rules – that apply on the decision-making process and that help in creating a suitable process (De Bruijn & ten Heuvelhof, 2012; de Bruijn, ten Heuvelhof, & In't Veld, 2010; de Bruijn & ten Heuvelhof, 2002):

1. *"Ensuring the actors participate in making the research transparent."*
    - Usually the research and analysis of 'the problem' is done by professionals, by letting actors participate in this they will create an improved understanding of the research and analysis.
2. *"Tolerate redundancy in the research."*
    - It should be accepted that there is more research done then necessarily required. This entirely depends on the views of actors on 'the problem,' other views sometimes need other research. Including more analysis proves that there could be conflicting views which is beneficial to attract different actors.
3. *"Give parties a repetitive opportunity of advancing their own interests."*
    - During the process, the situation can occur that there is a deadlock between 2 (or more) actors. In this situation, there should be room for the actors to adapt their interest in the situation. This can, for example, be done by reframing the problem or introducing a commonly agreed upon an expert who decides.
4. *"Create repetitive dependencies and a sense of urgency."*
    - In the process approach, it should be clear that a certain pace of decisions on the design is needed in order to book progress and keep the process attractive for the actors.
5. *"Make an indirect, loose coupling between the findings from the analysis, the making of the design and the implementation."*
    - If firm conclusions are drawn based upon the analysis done certain actors might withdraw from the process. Since it is not desired that actors withdraw and because the analysis could contain contradictory aspects, it is undesired to make too fast a too strong connection between analysis, design and implementation.
6. *"Give actors an exit option."*
    - There must always be an option to exit the process for the actors. However, this may not be too easy. Therefore 2 main rules apply: actors must give the process a fair chance and actors must explain and underpin if they leave.
7. *"Give actors the option to postpone commitments to decisions."*
    - Many decisions are made about the design that is created through the process. It must be possible for actors to come back to decisions although this could be experienced as frustrating by others. The reason for this is that actors might be feeling trapped in the process, which might make it unfavourable to commit to the process.

The presented guidelines, together with the explanation of the entire process, advocate for an open and free organisation of the decision-making process. It is already explained that in the infrastructure planning context there are many actors, which is complicating the decision-making process and is one of the reasons to classify infrastructure planning policy problems as wicked. To keep the planning process attractive for the stakeholders, it is needed, as already explained, to keep the process free and open.

2.3.2 Solution development process

Besides understanding how decisions should be taken in an infrastructure planning process, there should be understood how solutions can be developed. This should be done in such a way that the solution development process prevents premature convergence and thus contributes to incorporating trends and developments and a more integrated approach in infrastructure planning.

Problems, for which solutions should be generated, in the planning policy context are classified as wicked problems, see paragraph 2.1.2. There are general methods known that present an approach to developing solutions for wicked problems. Because these approaches to develop alternative solutions for wicked problems might be beneficial for generating policy alternatives in the planning context these approaches are explored. In the article by Roberts (2018) 6 different approaches to deal with wicked problems are presented together with the advantages and disadvantages of each approach. The 6 approaches are presented in an overview in Table 3 together with their most significant advantage and disadvantage. These approaches are explained in more detail after the table.

Approaches	***Advantage***	***Disadvantage***
Competitive	Certainly, a solution is chosen	Search for solutions keeps going on
Authority	Someone in charge	Can lead to not listening leaders
Rational-analytic	Clear path to a solution	Always ending at another wicked problem
Taming	Complexity is reduced	Simplifying a wicked problem is beyond reality
Collaborative	Support for solutions is created	Much time needed to create a collaborative environment
Design	Emphasises on learning, experimenting and creativity	Hard to transfer solution to other environments

Table 3 Overview of the 6 approaches listed by (Roberts, 2018) *(own table)*

Competitive approach

In the competitive approach are actors sponsored by governments who have to make policy to create their understanding of the wicked problem and to provide their potential solutions to deal with the wicked problem (Alford & Head, 2017). Finally, the government decides upon which solution to choose which results in winning and losing actors.

The advantage of the competitive approach is that winners and losers can be identified, and the winners get to decide which solutions are chosen and how solutions are precisely shaped.

The disadvantage of the competitive approach is that losers wait for their chance and come back to resume the game in order to win. This can keep the search for solutions going (Roberts, 2018).

Authority approach

In the authority approach, there is confidence in people on positions with power who have to determine the problems and develop solutions. Because of their leadership, they are entrusted to be our substitutes in the search for problems and solutions (Alford & Head, 2017).

The advantage of the authority approach is that only a few, or a single one, is taking care of the wicked problems and take responsibility for solving them. Because of that, problems only exist if the leader says they do.

The disadvantages of the authority approach are that the ones in charge can make mistakes and secondly, that it is easy for them not to listen to the problems of the ones who gave power (the followers). Furthermore, there is often a small group responsible for determining the problems (Roberts, 2018).

Rational-analytic approach

In the rational-analytic approach, the solution for wicked problems follows the advice and ideas of experts. Experts, in this case, can be from all different disciplines and can have a variety of backgrounds. The process followed in the rational-analytic approach is that it starts with fixing a problem, identifying the goal followed by setting criteria to measure the goal. Addressing solutions and measuring to which extend solutions meet the requirements, based on this information the most optimal solution is chosen (Pahl, Beitz, Feldhusen, & Grote, 2007).

The advantage of the rational-analytic approach is a clear path to solve a problem.

The disadvantage of the rational-analytic approach is the impossibility to solve a wicked problem entirely due to its nature. Therefore, by taking the rational-analytic approach one will always end at another wicked problem (Roberts, 2018).

Taming approach

In the taming approach, the problem is tried to bound which makes it less wicked. It can be seen as a more 'open' form of the rational-analytic approach that entirely fixes the problem. The determination of the problem is not only the responsibility of a small group of experts but a larger group of actors who are not necessarily all actors (Daviter, 2017). There are a couple of ways to tame a wicked problem; it can be done by splitting up the problem into smaller pieces; by simplifying the objectives; by restricting the solution space by reducing possible options and by excluding those who disagree with a solution (Roberts, 2018).

The advantage of the taming approach is that problems and solutions can be governed more easily. Secondly, uncertainty, complexity and ambiguity are reduced.

The disadvantage of the taming approach is that simplifying the wicked problem is beyond reality and the solved problem does not reflect the whole wicked problem. Secondly, the group of actors involved that determine the problem is still arbitrary and could not reflect everyone influenced.

Collaborative approach

In the collaborative approach, one is working together by negotiating about the problem and satisfactory solutions to the problem. Another possibility is that negotiation about self-held views and interests is not needed and that can be worked on a commonly agreed solution (Alford & Head, 2017; Daviter, 2017).

The advantage of the collaborative approach is that support is created amongst various actors who join the process.

The disadvantage of the collaborative approach is that large amounts of time are needed to created collaboration and commonly agreed upon objectives (Roberts, 2018).

Design approach

The design approach is about change in an unpredicted world. Design assists humans in reshaping the world by creating products, technologies, processes, policies and systems. Designing is done in collaboration. The design approach does not only aim to create a solution that fits best to the, perceived problem, but it also aims to create a solution that fits best in the process. In the design approach, one aims to avoid a 'premature selection' of the solution. Furthermore, the criteria of "good" and "bad" are themselves considered to be part of the problem (Daviter, 2017).

The advantage of the design approach is its emphasis on future, learning, experimenting, creativity and innovation rather than focusing on past issues.

The disadvantage of the design approach is that the result of the design approach might be a one-off, a unique result that cannot be transferred easily to other situations (Roberts, 2018).

The design approach as a preferred approach for the creation of solutions to wicked problems

In the articles of Roberts (2012, 2018) is pointed towards the design approach as being the preferred approach to create solutions to wicked problems. The same is also recognised by other scholars who even specify the design approach as a sufficient approach for planning policy in the infrastructure and spatial context (Elia & Margherita, 2018; Ferretti & Gandino, 2018; Ferretti, Pluchinotta, & Alexis, 2018; Heeres et al., 2017). These articles submit the following characteristics of the design approach for proposing the design approach as the preferred alternative to deal with wicked problems in the context of infrastructure and spatial planning policy:

- The design approach focusses on facilitating the creation of valuable solutions to problems with a multi-faceted nature while considering whole life cycles and focusing on integration (Joore & Brezet, 2015; Lawson & Dorst, 2009).
- The design approach provides methods that allow for different ways of thinking both rational-analytical and creative (Hekkert & van Dijk, 2011; Lawson & Dorst, 2009).
- The design approach methods are characterised by the search to novel ideas and support non-routine, irregular and ill-structured processes (Boujut & Léon, 2005; Dorst & Cross, 2001; Haupt, 2015; Wynn & Clarkson, 2018; Wynn & Eckert, 2017).

The characteristics of the design approach match to a great extent with the characteristics of an infrastructure planning policy process, see paragraph 2.1.2. As explained in that paragraph there is a variety of actors involved in the infrastructure planning policy process which contributes to the multi-faceted problem. The design approach jumps into that very well. Secondly, it is described that the design approach focusses on integration, which has been stated in the problem analysis as one of the major problems in the infrastructure planning policy process, see paragraph 1.2. The third listed characteristic of the design approach could contribute to the problem recognised in paragraph 1.2. as well, since it has been explained that new solutions should be able to incorporate recent trends and developments.

2.3.3 The design approach for enlarging the solution space

The design approach is further explored in this paragraph since it has been suggested to utilise this approach to create solutions to wicked problems. The design approach is also known as 'Design Thinking,' these terms are interchangeable (Dorst, 2011; Mintrom & Luetjens, 2016; Roberts, 2018).

This exploration of the design approach should lead to a structured method to develop alternative solutions for problems in the planning context.

In the previous paragraph is the design approach suggested to be a singular approach. However, there are many views regarding the design approach. These views are explored in order to improve the understanding of design. And, secondly, to improve the behaviour of the government who should facilitate and probably initiate the design approach. This should contribute to the application of the design approach in the policy process.

An attempt to explore different views on the design approach is made in the book of Lawson and Dorst (2009). The different points of view reflect different experiences that one could have with the design approach. However it is explicitly stated that the different views are complementary (Evbuomwan, Sivaloganathan, & Jebb, 1996). Almost the same points of view are also named in a study towards the definition of design by Ralph and Wand (2007) in which it is called 'weltanschauung'. An overview of the various points of view on the design approach is given in Table 4, which are explained then in more detail.

Design as:	***Characteristic***
problem-solving	Solution follows problem
learning	Testing a solution provides new insights into the problem
evolution	Formulation of problem and solution go straight on
creation of solutions to problems	Problem follows solution
integrating into a coherent whole	Integrating all knowledge into a single solution; can be seen as part of every other design views
fundamental human activity	Everything created by a human is a design

Table 4 Overview of various design views, based on (Lawson & Dorst, 2009) *(own table)*

Various worldviews on the design approach

The design approach as problem-solving (Hevner, March, Park, & Ram, 2004; Lawson & Dorst, 2009; Simon, 1996)

In the design approach as problem-solving the primary focus is on defining the problem. Followed by an analysis of the needs for the solution: the requirements. After which solutions are developed. This view emphasises that problems can be structured and are easily structured. Moreover, this view does not cooperate well in environments that are complex and ill-defined.

The design approach as learning (Lawson & Dorst, 2009; Polya, 1957)

In the design approach as learning is the focus on quickly testing solutions that might solve the problem. By doing this more information will be learned about the problem, this will help to improve the solution. In this process, knowledge is gained gradually on the problem and the best solution, which is also the focus of this view.

The design approach as evolution (Beck, 2000; Lawson & Dorst, 2009; March & Smith, 1995)

In the design approach as evolution, the development and evolvement of both the formulation of the problem and the solution go hand in hand, which is especially helpful in complex environments. This results in a search to find the best problem-solution pair.

The design approach as the creation of solutions to problems (Kessler, 2007; Lawson & Dorst, 2009)

In the design approach as the creation of solutions to problems, there is a free interpretation of the problem by the designer. This allows him to make decisions on his own and therefore the designer is part of the creativity. In this view, the focus is on the solution, not on learning about the problem as in the view designing as learning. Which is helpful in situations where the problem cannot easily be defined.

The design approach as integrating into a coherent whole (Lawson & Dorst, 2009)

In the design approach as integrating into a coherent whole, the focus is on creating a design in which everything is integrated into the design. This integration is on all the requirements, constraints, wishes and goals as given by the stakeholders. One could argue that this view is apparent in (almost) all design approaches.

The design approach as a fundamental human activity (Lawson & Dorst, 2009)

In the design approach as a fundamental human activity, Lawson and Dorst state that everyone can do some designing. This is based on their observations on new students who do not have any idea of the designing process and still can coop with a designing problem. However, they state that a better understanding of this process usually leads also to a better design.

The design approach in the policy context

In the policy context, problems exist that are classified as wicked problems which are not easily determined or formulated. Because of this the logical choice, to the extent that a choice should be made at all since design views are complementary, is to adopt the views:

- 'the design approach as evolution.'
- 'the design approach as the creation of solutions to problems.'
- 'the design approach as integrating into a coherent whole.'

This fits as well with the problem analysis of this thesis as described in paragraph 1.2, which started with the description of substantial trends and developments in society. These are linked to infrastructure planning. However, the problems following from these trends and developments are connected or even dependent on chosen solutions.

2.3.4 Framing as a method to enlarge the solution space

The term 'design approach' is already used a couple of times. However, it is still unclear what it entails. Therefore, it is explored here in more detail. In the works of Dorst et al (1992; 1997, 2011) is argued that the term 'design approach' – also referred to as 'Design Thinking' – is often misused by popular literature that combines many disparate and vague creative activities under the label of 'design thinking' (Dorst, 2011, p. 531). Dorst, together with various other authors explain that core of the design approach is 'framing' (Broennum & Clausen, 2013; Dorst, 2011; Ferretti & Gandino, 2018; Gassmann, 2006; Hertogh & Westerveld, 2010; Storvang & Clarke, 2014; Wenngren et al., 2014; Zerjav, 2015). In their view framing is a particular way of reasoning. Secondly, the same

authors state that framing is an all-encompassing method. Thirdly, the authors explain that by framing new insights can be developed that contribute to – or can even be seen as being at the base of – enlarging the solution space.

What is the concept of framing?

Framing is a method to search and develop new points of view on solutions. Secondly, framing is a method to create new contexts in which solutions can be placed (De Bruijn & ten Heuvelhof, 2012; Dorst, 2011; Elliott & Hayward, 1998). This results in the generation of multiple new alternatives for wicked problems (Dorst & Cross, 2001). It is even suggested that framing is crucial to achieving high-level solutions (Badke-Schaub, Frankenberger, & Birkhofer, 1998).

To fully understand the concept of framing as a method to develop alternative solutions for wicked problems, it is needed to understand the way of thinking used by humans when developing solutions. The human reasoning patterns can, according to Dorst (2011), be represented by the generic formula, as presented in Figure 5. Based on this generic formula, the reasoning pattern used in framing can be explained. In the book of Dorst (2015) the following example is used to explain the generic formula (Dorst, 2015, p. 32):

"This is very abstract, but as an example, we can look at the original problem situation of a complex case study like Kings Cross, the entertainment district in the City of Sydney, which has experienced continuous problems. The night-life attracts about 30.000 young people during the weekend nights. This is concentrated along a narrow 500-meter stretch of road. The problems that occur include drunkenness, fights, petty theft and minor drug-dealing. Over the years, the government has been trying to solve this problem by using these strong-arm tactics, mainly through increasing the police presence and installing CCTV cameras. Clubs have also been encouraged to hire their own security personnel. All this extra visible security has now made the entertainment district a pretty grim public environment, but although the number of arrests has increased, additional security measures do not seem to enhance public safety.

All the elements (what) in the example of Kings Cross (the police, the various groups of youngsters, the clubs, the physical characteristics of the public space) interact with each other in certain patterns (how) that define stable relationships, which in this case are leading to an undesired value, (outcome/solution), the problems of drunkenness and violence."

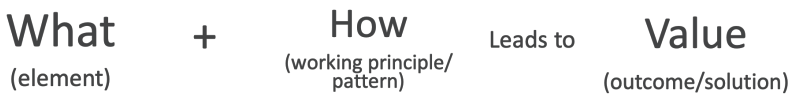

Figure 5 the creation of value (Dorst, 2011)

Having the generic formula clear that represents the relationship between 'What,' 'How,' and 'Value,' this formula can be used to understand the way of thinking in the design approach. This is explored since the design approach is introduced as the preferred approach to creating solutions to wicked problems.

From the explanation of wicked problems, see paragraph 2.1.2, can be derived that there is uncertainty about both elements (What) and the working principles (How). Since there has been defined that in a wicked problem there is no definitive formulated problem, nor there is "a well-described set of permissible operations that may be incorporated into the solution." This is presented in Figure 6.

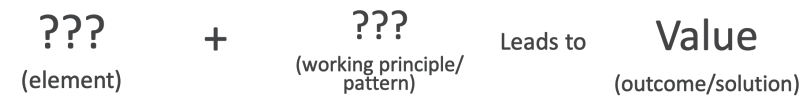

Figure 6 the problem of wicked problems (Dorst, 2011)

It is the challenge, as presented in Figure 6 to find elements that can work together in order to create the desired value. This can be done by randomly generating both elements and working principles and checking if there are combinations that accidentally matches. A smarter strategy would be to adopt a frame (Dorst, 2011). *"A 'frame' is the general implication that by applying a certain working principle a specific value is created"* (Dorst, 2011, p. 524). Thus, there should be thought backwards, starting with understanding the desired value, coupling it to a working principle by framing the problem in a certain way, as presented in Figure 7.

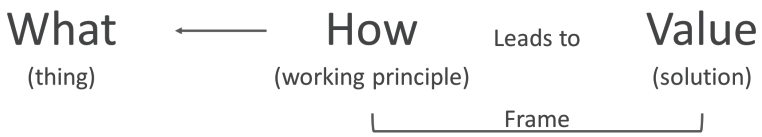

Figure 7 the concept of framing applied (Dorst, 2011)

The same example of Kings Cross is used in the book of Dorst (2015) to explain various parts of this formula in more detail. First, the use and idea of a 'frame' is explained in the following example (Dorst, 2015, p. 33):

"Designers from the Designing Out Crime center took on this project (the project of Kings Cross, as already used), and started with quickly reframing the issues that were presented to them by the local council as law-and-order problems and looking instead into how this area could be decriminalised. The designers reasoned that this approach could be a valid strategy because the people who get into trouble are overwhelmingly young people wanting to have a good time, not hardened criminals. The problems might arise from the fact that a crowd of 30.000 young people is coming to an area that has very little structure to it. The disorganisation of the area and its attractions creates a whole host of truly complex problems for the many parties involved. By using a metaphor (presented as 'frame' in the formula) to help us understand the issues, one could compare this situation to a large music festival (30.000 people on a festival terrain)."

The example above presents how the designers are using a frame to find a working principle. What follows is the search to various elements and the corresponding working principles that fit within the frame (Dorst, 2015, p. 34):

"In this entertainment quarter, the peak time of young people coming into the area is about 1 a.m., but the last train leaves at 1:20 am. Getting a taxi later in the night takes about two hours if the driver wants to pick up people there at all (taxis tend to avoid this neighbourhood). So once people are in the entertainment quarter, they are basically crammed into a single road until the trains start running again at six in the morning. Apart from the obvious improvement of providing more trains (element 1) the designers also proposed as a fall-back position a system of temporary signage on the pavement, to help partygoers reach a different train station that has buses running throughout the night (element 2). (the working principle here is to provide sufficient guidance out of the area).

Returning to the frame of a music festival, festival organisers would create chill-out spaces (element 3) and offer continuous attractions (element 4) to make sure that people will move around (working principle 2), so their experience does not completely depend on what takes place on a single large stage. As it happens, this entertainment district has a few big clubs that are the main attractions, but there is very little else to do. As a result, young people who have visited a club and go back out on the street might find that the queue for the next one is several hours long. If they decide not to join the queue, they are out in the street with nothing to do. The designers proposed that this problematic pattern of behaviour can be minimised by providing a texting service or a smartphone app (element 5) so that people can find out how long the wait for the next club is before leaving the first one (working principle 3). In addition, some of the laneways around the central street could be prepared as rest areas, with water fountains and a relaxed 'lounge' atmosphere away from the crowds (element 6). Another obvious thing one would provide for a music festival is enough public toilets. This particular entertainment quarter has only three, one of which is underused because it is located in a rather forbidding-looking police station. Consequently, there is a real problem with street urination. Of course, the designers proposed introducing a system of mobile toilet blocks (element 7). Over the years, the clubs had hired more and more security personnel and bouncers as part of the conventional approach to solving the alcohol-related crime and antisocial behaviour issues. The designers proposed a system of very visible young 'guides' in bright T-shirts (element 8), who help people find their way through the area and who are also approachable when help is needed (working principle 4). This proposal makes perfect sense: research has shown that people do not approach officials for help unless these officials are approachable for other, low-threshold question too. These bright and cheery Info people create a more caring social environment, a stark contrast to the huge private-security men in black who lurk, Death Eater-like in every corner. In fact, the introduction of these security personnel has, paradoxically, been a major contribution to the grim atmosphere of the area."

From the previous example can be seen that by using a frame various elements and working principles ('what' and 'how') can be used within the same frame. Each of the combinations contributes to the solution and the desired value that the solution should deliver. Another example of the combination between an element and working principle ('what' and 'how') is given here (Dorst, 2015, p. 49):

"Say that the outcome, or the 'value,' we want to achieve is an energy rush when coming to work in the morning. In straightforward, not wicked problems, we would also already know the 'how,' say that this is to be achieved through coffee. And we might even have a proposed method of brewing coffee (dripping, squeezing, using steam). So, we can start developing a 'what,' engineering

the machine to make the coffee for us. When both are unknown (as presented in the formula in Figure 7*), we would only know the goal (a quick rush of energy before work) but not know how to achieve it. Hence, if we go for coffee, we would still need to choose a brewing method, create a design for a machine, and then judge whether this would do the trick (Is it quick enough? Is it commercial? Is it environmentally OK?). If none of the coffee machines we can think of will satisfy the criteria, we might need to start considering other ways of creating the energy rush, for example doing a morning workout."*

The frame creating process

The creation of such frames consists of specific activities that should be done. These activities are presented in Figure 8. In this figure, the process of frame creation is presented as a linear approach. However, one should understand that in practice the frame creating process is not as linear as presented. The consecutive steps are followed generally but going forward, backward and jumping over steps is very common (Dorst, 2015). The information in the figure is directly based on the works of Dorst (2011, 2015), including the used terminology.

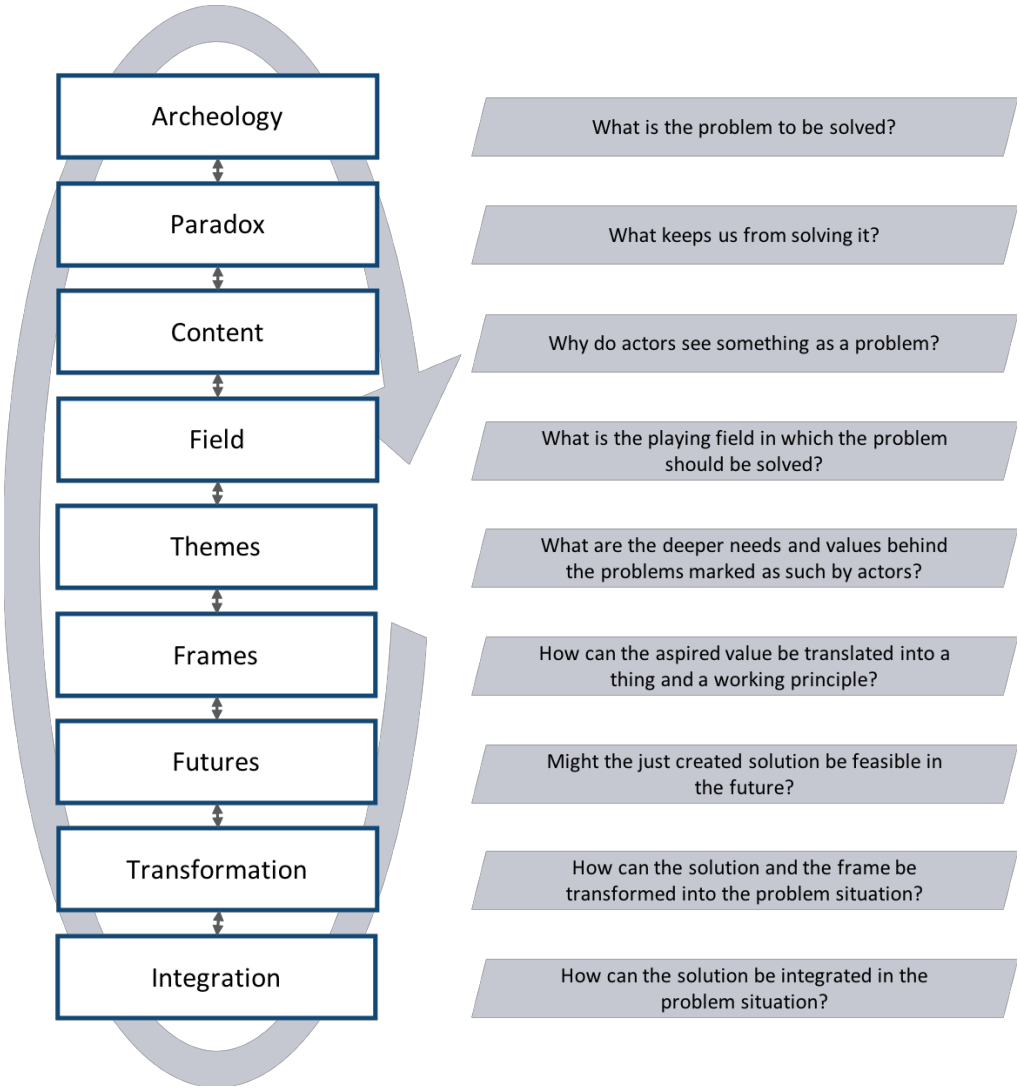

Figure 8 Frame creating process (Dorst, 2015)

Each of the steps is explained briefly (Dorst, 2015):

1. Archaeology — *an analysis about what seems to be the problem that should be solved.*
2. Paradox — an *investigation of the problem definition itself, the objective is to understand what keeps the problem owner from solving the problem.*
3. Context — *an exploration of the practices and the context of the actors involved, the interests and values of actors are explored here as well.*
4. Field — *creating a playing field, which can also be seen as creating a solution space, that provides room to develop solutions/designs and attract actors.*
5. Themes — *an analysis of the deeper needs and interests of the actors involved and clustering these into themes of needs and interests.*
6. Frames — *a translation of the common themes into frames by using analogies. "If a problem situation is approached as if it is … then …*
7. Futures — *forward thinking and analysing if a solution/design might be feasible in future.*
8. Transformation — *an evaluation of the feasible solutions/designs and the related frames. These are transformed in such a way that they fit the problem.*
9. Integration — *an integration of the solutions/designs into the problem context.*

In Figure 8 can be recognised that the framing method starts with getting an understanding of the problems that are tried to be solved. This understanding of the problems that exist should not be constrained. Furthermore, the framing method does not focus on fixating the problem, but it focusses on understanding and developing the problem. This is done by understanding what actors thrive, what their interests are and which values they find to be important (Dorst, 2011). By focussing on the aspired value, as explained earlier in this paragraph, actors realise what and why they find something valuable — leading to a re-formulation of constraints and a different perspective on the constraints, which leads to more freedom (Dorst, 2015).

In the detailed explanation of this model is described that there is a lot of interaction (Dorst, 2015). It starts with understanding the problem for which interaction is needed with actors. This is continued further during the framing method as can be seen explicitly in steps 4 and 8. In step 4 a playing field should be created that keep actors attracted because they are needed in step 8 to test solutions and eventually get feedback. All these moments of interaction play an important role in creating good solutions (Deuten & Rip, 2000).

2.4 Certainty about the solution

In the problem analysis, is explained that the reason for the desire of having certainty about the exact solution, which contributes to premature convergence and thus a small solution space, is the need to safeguard public values.

Public values are defined as the general interest, objectives, purposes and norms of societies (Crosby et al., 2014; de Bruijn & Dicke, 2006; Gestel, Koppenjan, Schrijver, Ven, & Veeneman, 2010). As explained in the introduction of this thesis, governments assume that in order to protect these values they need to have as much certainty as possible about the exact solution. However, research into literature reveals that this is not necessarily true (de Bruijn & Dicke, 2006; Gestel et al., 2010).

There are other ways acknowledged that allow for the protection of public values. In the article by de Bruijn & Dicke (2006), 3 strategies are proposed;

- Hierarchical: governments impose public values on actors
- Network: interaction takes place between actors about public values
- Market: competition takes place between actors on public values

In the problem analysis can be seen that governments are protecting public values by imposing them to the infrastructure planning system. However, this is not necessary according to de Bruijn & Dicke (2006). Public values can be protected as well by a network of actors. This can be seen as an addition to the networked decision-making process, as presented in paragraph 2.3.1. Important in this networked decision-making process is that governments while being one of the actors in the multi-actor network, establish fundamental rules in the decision-making process. This should be done while keeping the 7 guidelines in mind (de Bruijn & Dicke, 2006).

2.5 Conclusion

In this paragraph research question 1 and research question 2 will be answered. The first research question is: *How is infrastructure planning described in literature?* The second research question is: *How can a solution space be enlarged according to literature?* Various concepts have been researched to answer reasearch question 1 and 2. This is visualised in Figure 9. In this figure, the paragraphs in this chapter can be recognised. Figure 9 will be explained globally first, after which both research questions are answered in more detail. The implications of both the context of infrastructure planning and enlarging the solution space on the planning process are discussed

2.5.1 Conceptual model

There has been found that the context of infrastructure planning and its characteristics, and how the solution space can be enlarged, both imply how the planning process should be organised. Furthermore, the characteristics of infrastructure planning problems affect how the solution space can be enlarged. The ‘freedom’ of the solution space affects how the process should be organised, as well as the level of integration in the solutions. The other way around does how the process should be organised also affects the ‘freedom’ of the solution space.

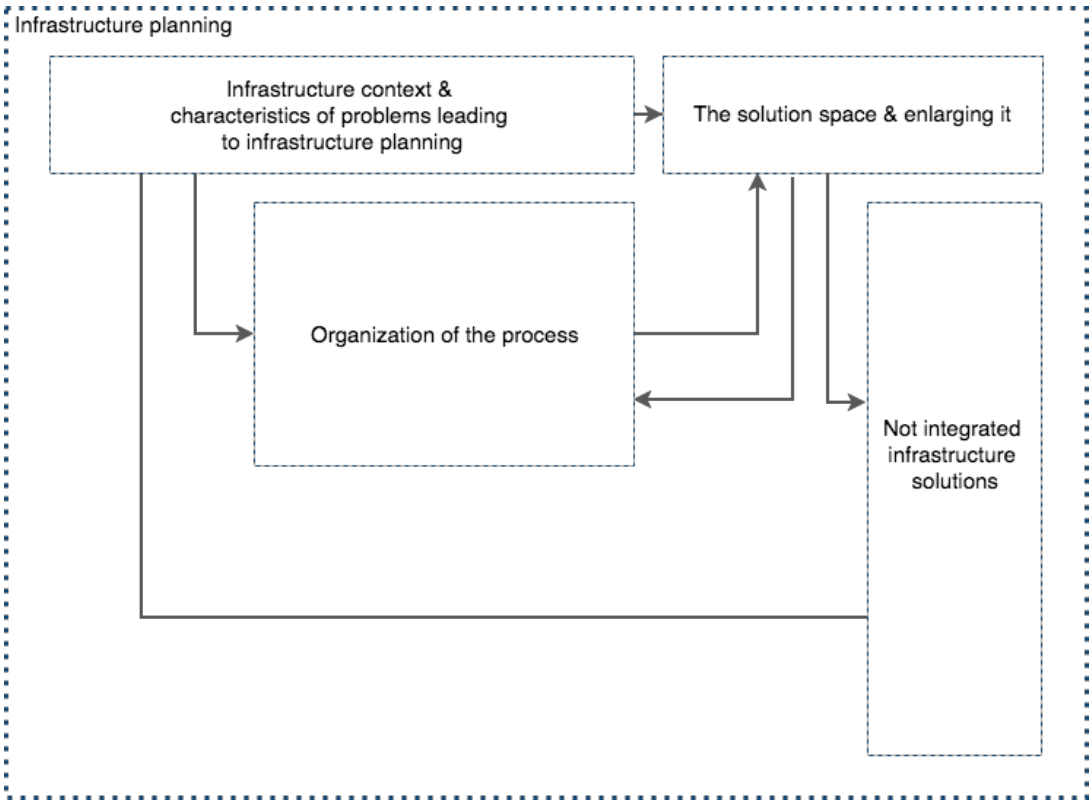

Figure 9 Conceptual model, based on the literature research (own figure)

2.5.2 Research question 1: how is infrastructure planning described in literature?

Infrastructure planning is described as the process, often organised by governments to create infrastructure plans. Infrastructure plans have the objective to organise and regulate infrastructure systems. These systems facilitate the transportation of people and goods in a network. Because such systems are extensive, there are many people and organisations involved. Because of that, there are many people and organisations involved in the infrastructure planning process. These many people and organisations that are involved in infrastructure planning together form a multi-actor network.

Problems, known as policy problems cause the need to create infrastructure plans. Policy problems, including infrastructure planning policy problems, are classified as wicked problems. Wicked in this context means 'vicious', or 'tricky.' Wicked problems cannot be formulated definitively, nor the solution can be determined definitively although this does not mean that it is impossible to formulate a solution.

2.5.3 Research question 2: how can a solution space be enlarged according to literature?

In order to understand how a solutions space can be enlarged, the definition of a solution space is explained. A solution space is the space that contains all feasible solutions to the policy problem. This feasibility is defined by the constraints, 'the boundaries,' of the solution space. By enlarging the solution space is meant that the constraints are formulated freer.

In order to get to a solution, the solution space should be reduced. However, considering the understanding of premature convergence, which is too early choosing a solution and thereby killing of other solutions, it is about the moment in the process at which this convergence takes place.

2.5.4 Implications of the characteristics of infrastructure planning on the planning process

Decision-making process

The understanding that infrastructure planning problems are wicked has significant implications on how decision-making should be organised, as well as how solutions should be developed. In infrastructure planning, the multi-actor network involved in the planning process will be extensive (partly because of the extensiveness of infrastructure systems). The effect on the decision-making process, in which decisions are taken that influence an infrastructure plan, is that it cannot be organised strictly. Decisions cannot be imposed from a hierarchical position but are the result of an open and unstructured process that is globally organised in rounds.

In these rounds, various actors from the multi-actor network can participate. In order to keep this process attractive for the actors, and to keep them involved, it should be organised with several guidelines in mind. Key aspects are to ensure that actors participate by not imposing much on actors and by not enforcing them to take stands quickly. Moreover, a sense of urgency should be created throughout the process.

Solution development process

The process to develop solutions is known as the solution development process. Similar to the decision-making process, the wickedness of infrastructure problems influences how the solution development process should be organised. The design approach, also known as 'Design Thinking' is found to be the appropriate method to develop solutions in this wicked environment. It focusses on creating valuable solutions that fit within a process, rather than only searching for a solution that solves a problem. Furthermore, there is explained that the design approach tries to prevent premature convergence, which is in line with the objective of this thesis.

In paragraph 2.3.3 is stated that framing – or the framing method – is the core of the design approach. Therefore, taking the design approach could also be seen as executing the framing method. The design approach aims to create a solution, which can also be called a design. In the context of this graduation thesis this solution, or design, should be seen as a policy plan.

Framing in itself is the method to develop new contexts and new points of view. Secondly, it is a method to test whether these new contexts and points of view can be added to a solution. Thirdly, it is a method to integrate these new contexts and points of view into a solution. An essential aspect of the framing method that leads to the enlargement of the solution space is finding what actors value. By doing this, the constraints that defined the solution space are questioned and moved outwards. Therefore, the framing method contributes to enlarging the solution space.

Adopting the understanding that infrastructure problems are wicked has some implications on the conceptual model. First, more freedom should be created in both the decision-making process and the solution development process. Secondly, according to the literature, the level of integration of infrastructure plans should be increased, which results in larger infrastructure systems in general. Another implication of adopting the understanding that infrastructure problems are wicked is that

less uncertainty about the final solution can be provided upfront. This, however, does not influence the protection of public values.

2.5.5 Analytical model

In the literature research 3 main concepts are explored, the context and characteristics of infrastructure planning, how the solution space can be enlarged, and finally the organisation of the infrastructure planning process. These concepts are presented in Figure 9. However, in the literature research, each concept is described in more detail, together with the relations between the factors within each concept.

Therefore, the factors in each concept and the relations between those factors are presented in an analytical model that is visualised in Figure 10. In this figure the factors are presented in the boxes, the arrows present the relation between the various factors. Each of the arrows is provided with a 'plus' or a 'minus' sign. This sign explains the relationship between the concepts. For example, the objective of this thesis is to enlarge the solution space, from the literature research than follows that in that case, the constraints should become freer (thus less constraining).

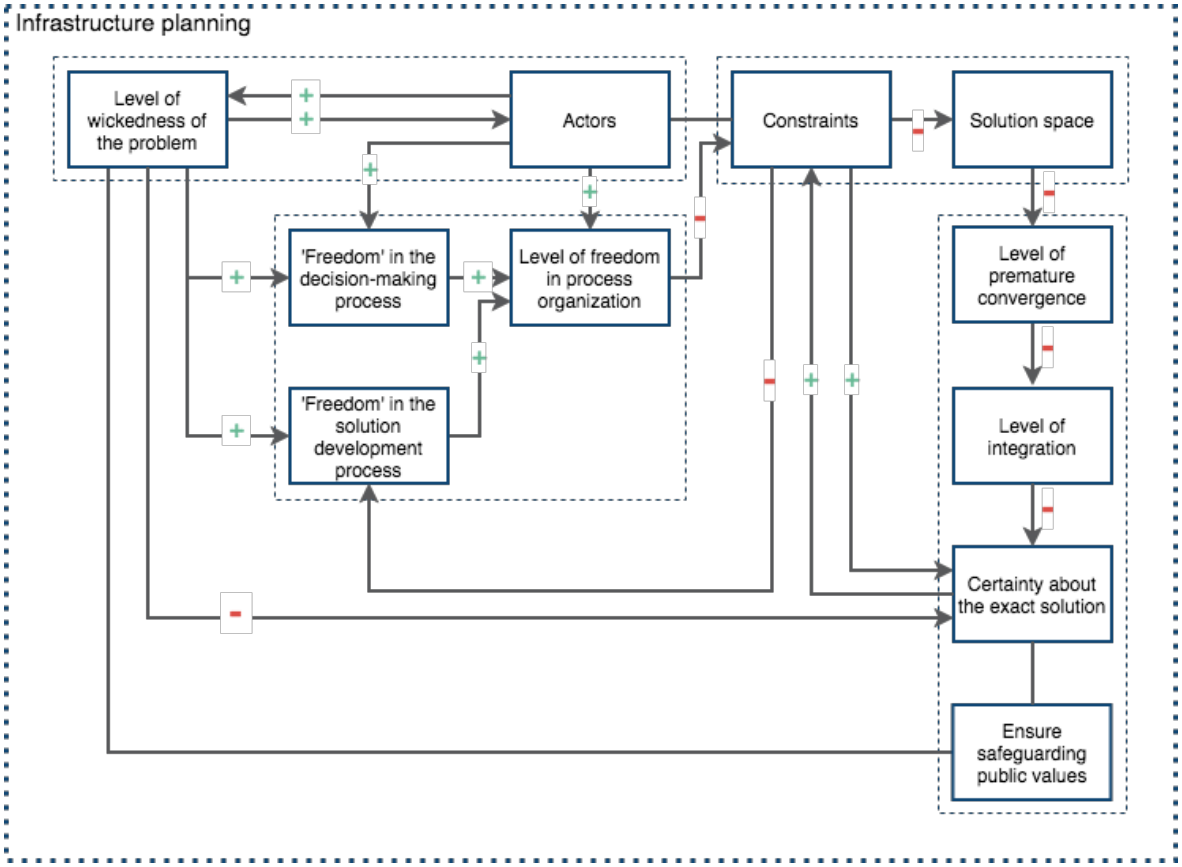

Figure 10 Analytical model, based on the literature research (own figure)

The earlier presented problem analysis overview (Figure 2) can be recognised in the boxes: 'level of integration,' 'certainty about the exact solution,' and 'ensure safeguarding public values.' Between the latter, no influence of each concept is seen, as explained in paragraph 2.4. The area with 'actors' and 'level of wickedness of the problem' is discussed in paragraph 2.1. The area with 'constraints' and 'solution space' is discussed in paragraph 2.2. And, finally, the area about the process is discussed in this chapter in paragraph 2.3.

As explained in the introduction the objective of this graduation thesis is to prevent premature convergence and to study how the solution space can be enlarged in the infrastructure planning process. The objective of enlarging the solution space is made visually in the conceptual model, see Figure 11. This figure presents how the other factors should vary based upon the findings in the literature study. From this figure can be seen that enlarging the solution space fits within what has been found in literature regarding the classification of infrastructure policy problems as wicked.

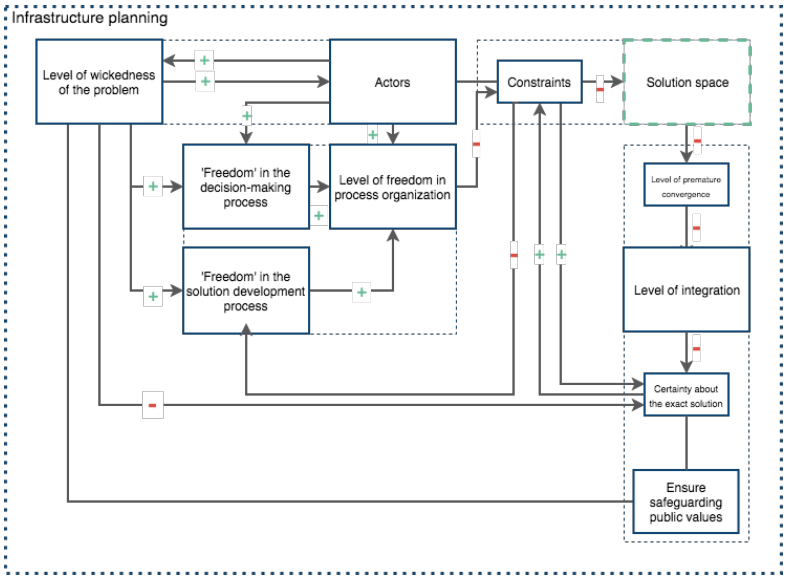

Figure 11 Visualisation of the objective of this thesis in the analytical model (own figure)

In the introduction of this thesis is stated that the level of integration in the infrastructure planning context is insufficient and too small. If this is visualised in the analytical model, the result will be as in Figure 12. There can be seen when this is visualised there are conflicts between the findings in the literature study and the result in this figure. There can be seen that the wickedness of the problem will be small, in other words: is not wicked. Which is in conflict with theoretical findings that state that infrastructure planning policy problems are by definition wicked. Furthermore, the number of actors will be small, which is also in conflict with the large numbers of actors involved in infrastructure planning, due to the significant impacts of infrastructure planning.

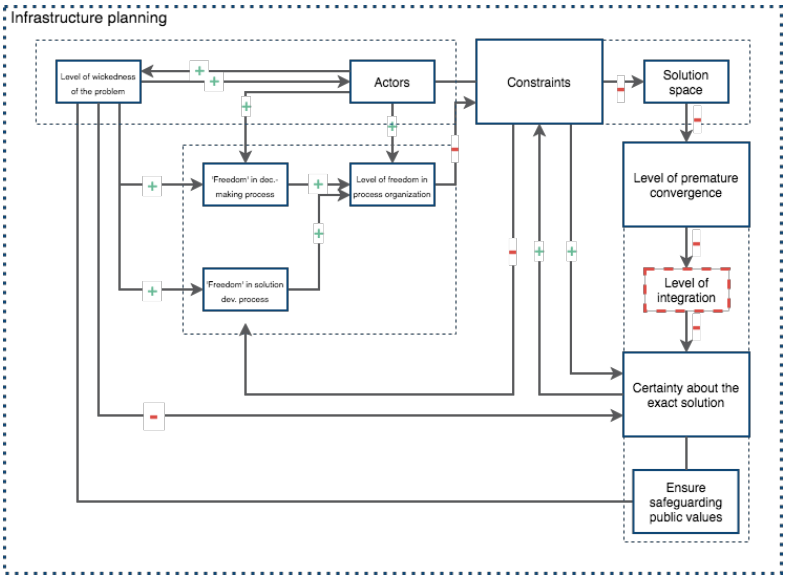

Figure 12 Visualisation of the observed problem in this thesis in the analytical model (own figure)

3 Methodology

This chapter describes the research methodology; it describes how the research is done and which choices are made. The methodology follows from the research objective, the research questions and the scope as described in the introduction. This chapter starts with a general introduction of the research structure, followed by a detailed explanation of each of the research steps.

3.1 General structure

The objective of this graduation thesis is to present a method that focusses on enlarging the solution space and preventing the premature convergence of solutions in the early phases of infrastructure planning policy process. The observation drives this objective that current infrastructure solutions that follow from infrastructure planning processes are not integrated and do not incorporate various societal and environmental trends and developments. The research structure will be explained in this paragraph and is visualised in Figure 13.

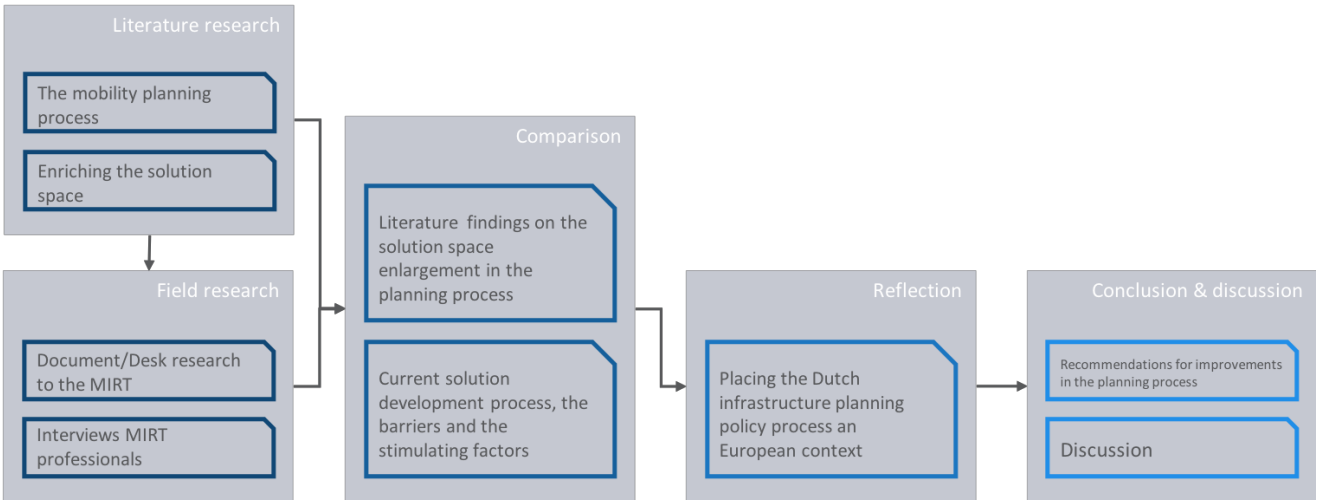

Figure 13 Overview of the research structure (own figure)

The literature research, that already has been presented in chapter 0, and provides the theoretical background needed to meet the objective of this thesis. In this chapter research question 1 and 2 have been answered. The literature research ends with an analytical framework that provides insight into how various factors contribute to the objective of this thesis; enlarging the solution space in infrastructure planning.

Although there is a theoretical understanding of how infrastructure planning should be organised, there is stated in the problem analysis in the introduction of this thesis that European governments are not able to enlarge the solution space and thereby prevent premature convergence in infrastructure planning. To understand the causes of this problem field research is done to the national infrastructure planning process of the Netherlands. The reasons for choosing the infrastructure planning process of the Netherlands are explained in the scope of this research, see paragraph 1.5.

After finishing the field research, the results of the field research are compared with the findings of the literature research, thus with the analytical model. In this comparing step the current national infrastructure planning process of the Netherlands is structured according to the analytical model that has been presented in paragraph 2.5.5. This comparison will provide insight into the factors that are causing the reduction of the solution. Furthermore, based on this comparison there can be concluded how the national infrastructure planning process of the Netherlands should be adapted.

After the factors are known that are responsible for the reduction of the solution space in the national infrastructure planning process of the Netherlands, these factors are placed in a European context. There will be searched how the factors from the analytical model differ in other countries. Comparing the deviations of the factors in various countries provides insight in the extent to which the conclusion can be externalised to other European countries that are dealing with the same problem explained in the problem analysis, see paragraph 1.2. By researching the international context research question 6 will be answered.

3.2 Literature study

The primary objective of the literature study is to provide a theoretical background that supports answering the main question. The researched literature is used to build a theoretical understanding and a conceptual model of the subject. The approach of the literature study is inductive (Saunders, Lewis, & Thornhill, 2012, p. 145) since there has been made use of the proposed direction of other literature studies. A drawback of this approach is the complications with generalisation because it is more focussed on a specific context (Saunders et al., 2012, p. 147).

The literature research aims to answer research questions 1 and 2 which are derived from the main question: *How can the **solution space** be enlarged in the **infrastructure planning policy process** in the Netherlands?* The main question uses the concepts of 'solution space' and 'infrastructure planning policy process', both need a definition on which is the focus of research question 1: *How is infrastructure planning described in literature?* And research question 2: *How can a solution space be enlarged according to literature?*

3.3 Field research

The primary objective of the field research is to create an understanding of the current national infrastructure planning process of the Netherlands. The national infrastructure planning process of the Netherlands is known as the MIRT procedure (Ministerie van Infrastructuur en Milieu, 2016b).

The field research consists of searching for documents that explain this planning process and interviews with professionals who are working on this planning process. By finishing the field research, research question 3 is answered: *How is the current solution development process within the infrastructure planning process of the Netherlands organised?* And research question 4 is answered: *Which factors are influencing the solution development and selection in the current infrastructure planning process of the Netherlands?*

3.3.1 Structure of researching the MIRT procedure

The MIRT procedure is a public procedure executed by the Dutch government. Therefore, it is assumed that enough information is publicly available and documented to get a sufficient understanding of the procedure. The research to the MIRT procedure consists mainly of 2 parts in which the first part is the search for the publicly available documents that describe the procedure. Secondly, this documented research is complemented with interviews. The interviews will be held with professionals who have experience with the MIRT procedure.

3.3.2 Selection of interviewees

The MIRT procedure is executed on behalf of the Ministry of Infrastructure and Water Management (Ministerie van Infrastructuur en Milieu, 2016b). An overview of the procedure is presented in Figure 14 in which 4 phases can be distinguished, of which the first phase consists of 2 different steps, together known as the initiation phase (Ministerie van Infrastructuur en Milieu, 2016b).

Two 'groups' of officials who are working on the MIRT procedure are identified as potential interviewees for this research. The first group are the officials of the Ministry of Infrastructure and Water Management. A second group consists of the officials who are working at Rijkswaterstaat. Rijkswaterstaat is the execution body of the Ministry of Infrastructure and Water management and is responsible for the design, construction, management and maintenance of all the main infrastructures in the Netherlands (Rijkswaterstaat, 2017a). Relating these two groups to Figure 14, it seems to be logic that the first group, the civil servants of the Ministry of Infrastructure and Water Management are more involved in the earlier phases of the MIRT procedure and the civil servants from Rijkswaterstaat are more involved in the later phases.

The understanding that there might be at least two 'groups' of officials who work from two different organisations in the MIRT procedure results in searching interviewees who can represent either the first or the second 'group.' Logically there will be searched for interviewees who have experience with working 'within' the MIRT procedure. Ideally, interviewees have contributed to one or more MIRT procedures themselves. To get the best possible impression of the MIRT procedure an attempt is made to get interviews with:

- at least one official per MIRT phase who has participated in the development of solutions
- one or two officials from Rijkswaterstaat who have participated in the development of solutions (who are assumed to be active in the later phases of the MIRT procedure)
- at least one official who is responsible for organising the process

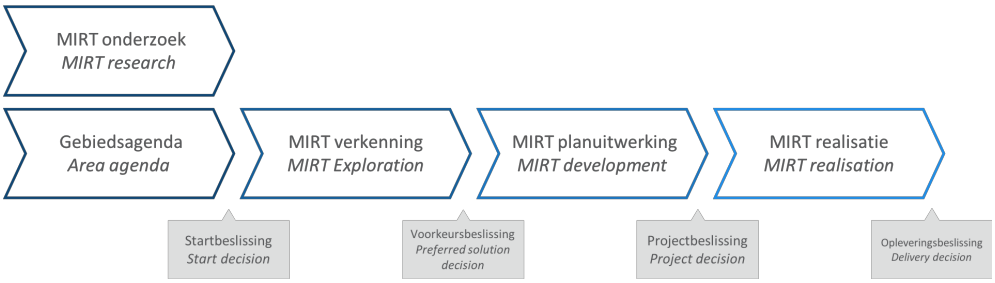

Figure 14 Overview of the MIRT procedure (Ministerie van Infrastructuur en Milieu, 2016b)

It is acknowledged that researching the MIRT procedure could be precarious because it is large amounts of money accompany a working procedure executed by civil servants of the Ministry of

Infrastructure and Water Management and the projects, or other measures, following from the procedure, see paragraph 1.5.4. A large part of the procedure takes very often place before the execution is awarded to any commercial organisation. Thus, everything must be done openly and integer, resulting in an open and level playing field for every organisation (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2009; Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken, & Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2018). This could result in possible difficulties in finding interviewees. Therefore, there will be explained that the research is done from an independent perspective and primarily focussed on improving infrastructure planning. This independent perspective is safeguarded because the research is not driven by any commercial organisation, only by Delft University of Technology.

3.3.3 The organisation of the interviews

The interviews are semi-structured which allows for more in-depth questioning if the interviewee mentions interesting parts (Saunders et al., 2012). But on the other hand, it makes it possible for interviewees to restrict the information they would like to provide in the interviews due to the freedom given with this type of interview, which fits with the precarious nature of the subject. This type of interviews fits with the qualitative nature of this entire research. The objective of the interviews is to create more insight in the MIRT procedure and how the procedure is executed in practice.

The subjects that are discussed in the interviews are:

- The organisation of the MIRT procedure in general
- The organisation and structure of decision-making in the MIRT procedure
- The organisation of the solution development process in the MIRT procedure
- The role of actors in the MIRT procedure
- The barriers (constraints) that exist in the solution development process
- The factors that stimulate searching solutions in the solution development process

An interview guide has been created that is used by the interviewer to guide the interview and to create a structure within the interview. This interview guide can be found in Appendix A. However, depending on the background of the interviewee within the MIRT procedure are some subjects discussed in more detail than others. The interviews take approximately 1 hour and are recorded if allowed by the interviewee. Explicit permission is asked at the start of every interview.

In the interviews will be spoken about MIRT procedures that the interviewees have worked on. These examples will be used to understand the solution development process and to see whether there are differences in the circumstances of individual procedures that led to differences in the solution development process.

3.3.4 Processing of the interviews

The interviews will be transcribed first. The transcription can be found in Appendix B. This transcription is then coded, after which codes will be combined into categories that says something about certain subjects, making the answers from the various interviewees comparable. The groups of codes can be found in Appendix C.

Because of the somewhat precarious information, explained earlier in this paragraph, the interviews are processed anonymous, by referring to quotation numbers. Because of the same reasons, the interview data will not be made publicly available.

3.4 Comparison

The primary objective of the comparison is to understand the differences between the analytical model, visualised in paragraph 2.5.5 and the current solution development process within the MIRT procedure, as will be researched in chapter 4. Each of the factors of the analytical model will be determined in the MIRT procedure. Followed by an evaluation of these factors in the current MIRT procedure. By doing this, research question 5 will be answered: *What are the differences between the current solution development process within the infrastructure planning process of the Netherlands and the theoretical solution development process?*

3.5 International contexts

In the introduction of this thesis, several challenges are stated that are used to justify the search for a method to enlarge the solution space in infrastructure policy processes. This is then scoped further to the national infrastructure planning process of the Netherlands. However, the challenges are stated to be not only actual for the Netherlands, but they provide policy challenges for governments across Europe. The primary objective of placing the MIRT procedure into its European context is to understand how to which extent the proposed solution development process might apply to other planning processes of European countries. By doing this, research question 6 will be answered: *How can the findings of this theses be adapted and implemented in other European infrastructure planning processes?*

3.6 Conclusions and recommendations

Based on the answers of all 6 research questions a conclusion will be drawn that finally answers the main question of this graduation thesis: *How can the solution space be enlarged in the infrastructure planning policy process in the Netherlands.* This answer will contain an overview of the various research questions and will provide recommendations for adaptations in the current infrastructure planning policy process in the Netherlands (the MIRT procedure).

4 The current national infrastructure planning process of the Netherlands

In this chapter, the national infrastructure planning process of the Netherlands will be explained. This process is known as the MIRT procedure; both terms are used interchangeably in this graduation thesis (Ministerie van Infrastructuur en Milieu, 2016b). There will be started with a small introduction and search into the genesis of the MIRT procedure. Secondly, the procedure is explained in more detail by looking at the operationalisation description of the MIRT procedure which is described by Rijkswaterstaat, the government agency responsible for the high- and waterways in the Netherlands. This part reflects what has been found in the documentation of the MIRT procedure. Thirdly, the interviews held with civil servants who are currently working in the MIRT process in all phases are used to get more insights into how the procedure is practised. By considering these aspects research question 3 is answered: *How is the current solution development process within the infrastructure planning process of the Netherlands organised?* And research question 4 is answered: *Which factors are influencing the solution development and selection in the current infrastructure planning process of the Netherlands?*

4.1 The genesis of infrastructure planning in the Netherlands

In the Netherlands is dealt with infrastructure for a long time. The reason for this can be found in the fact that the country is below water level, which demands to keep the infrastructure on sufficient levels regarding safety. Secondly, the Netherlands has a good position in the world economy due to its favourable position relative to other countries; famous in that area is the Port of Rotterdam and Schiphol International Airport. Thirdly the Netherlands does have many people travelling around the country, for work or to spend their spare time. Next, the Netherlands is a tiny and densely populated country compared to other countries. Therefore, there is a long history of infrastructure planning in the Netherlands.

4.1.1 The objective of the MIRT procedure

As already described the MIRT procedure is the current national Dutch infrastructure planning process. The objective of the MIRT is to allocate the national government's budget for spatial and infrastructural programmes and projects. Linked to the allocation of the budgets is the second objective of the MIRT: ordering the different projects and programmes. The third objective of the MIRT procedure is to ensure a certain level of quality of the projects and programmes by prescribing a process that should be followed (Ministerie van Infrastructuur en Milieu, 2016b).

The MIRT procedure visualisation (known as the MIRT project overview) is an annexe to the budget of the Ministry of Infrastructure and Water Management and presents all the governmental projects and programmes. The MIRT project overview is renewed every year, meaning that currently, the projects are in the 2018 version. The projects in the MIRT project overview vary from being in the early planning phase until being almost finished (Ministerie van Infrastructuur en Milieu et al., 2018)

4.1.2 History of the MIRT procedure

In the previous decades, there were infrastructure programmes such as the SNIP (Spelregelkader Natte InfrastructuurProjecten / Guidelines on wet Infrastructure Projects) and the MIT (Meerjaren Infrastructuur en Transport / Multi-year Infrastructures and Transportation). Since 2009 are these planning programmes merged into the MIRT programme (Meerjarenplanning Infrastructuur, Ruimte en Transport / Multi-year planning Infrastructures, Public-space and Transportation). (Ministerie van Verkeer en Waterstaat & Ministerie van Volkshuisvesting, 2009)

Change in the MIRT process based on the commission for accelerating the decision-making in infrastructural projects

In 2008 a committee was installed by the Ministry of V&W (Verkeer en Waterstaat / Traffic and Water) in order to accelerate the decision making regarding Infrastructural Projects. Based on the work of this committee the Guideline MIRT 2009 has been presented (Ministerie van Verkeer en Waterstaat & Ministerie van Volkshuisvesting, 2009). A couple of years later this guideline has been renewed based on an Inter-department Policy Research (IBO) (IBO Werkgroep Flexibiliteit in de infrastructurele planning, 2016). Based on this research, a new version of the guideline, known as the Guideline MIRT 2016 is presented (Ministerie van Infrastructuur en Milieu, 2016b).

Change based on IBO research flexibility in the infrastructural planning

The introduction of the guidelines and the IBO research describe why a new guideline was needed. The reasons that a new guideline has been demanded were described as followed (IBO Werkgroep Flexibiliteit in de infrastructurele planning, 2016):

- There is a higher complexity regarding infrastructural projects
- There is economic growth
- There is growth in the demand for accessibility and mobility
- The former MIRT procedures are very time-consuming
- There is more uncertainty involved in decision-making regarding infrastructural projects

This led to the following conclusions drawn in the report (IBO Werkgroep Flexibiliteit in de infrastructurele planning, 2016):

- The long-term nature of the MIRT procedure is unable to adapt to social developments: technological or macro-economic developments or newly existing social problems.
- Due to early financial awarding in the MIRT procedure, there is an early focus on specific solutions.

The objective of the IBO research is to discover possibilities for new policy frameworks for the planning of infrastructural projects and the awarding of finances. Which led to the result of different variants for the policy frameworks on three different topics:

- Flexibility on the budget level;
- Flexibility within the MIRT itself;
- Possible scope and objectives of the Infrastructure Fund.

However, as already explained in the problem analysis in the introduction of this thesis, see paragraph 1.2, the result of the implementation of the IBO results are unsatisfactory (Leppink, 2017).

4.1.3 The new 'MIRT Guidelines 2016' for the MIRT procedure

Based on the IBO research the Ministry of Infrastructure and Water Management launched the new 'MIRT Guidelines 2016.' This guideline applies to the MIRT research and area agendas that 'start' from the end of 2016. The new 'MIRT Guidelines 2016' is divided into two parts of which the first part describes the MIRT process globally and the second part describes the deliverables in each phase.

The new MIRT process is based on three pillars:

1. Broad view
2. Customisation
3. Collaboration

The new MIRT process is structured into 4 phases, each followed by a decision. This decision should be positive in order to get on to the next phase. An overview of this is presented in Figure 15. The 'MIRT Guidelines 2016' describes the deliverables and the procedure globally. This globally described procedure is translated into a work-process which is presented in 2 documents, the first known as the 'toolkit MIRT research' (Ministerie van Infrastructuur en Milieu, 2014). Moreover, the second document is known as the 'guide MIRT and m.e.r.,' exploration and development' and gives a detailed overview of the exploration and the development phase (Ministerie van Infrastructuur en Milieu, 2016b).

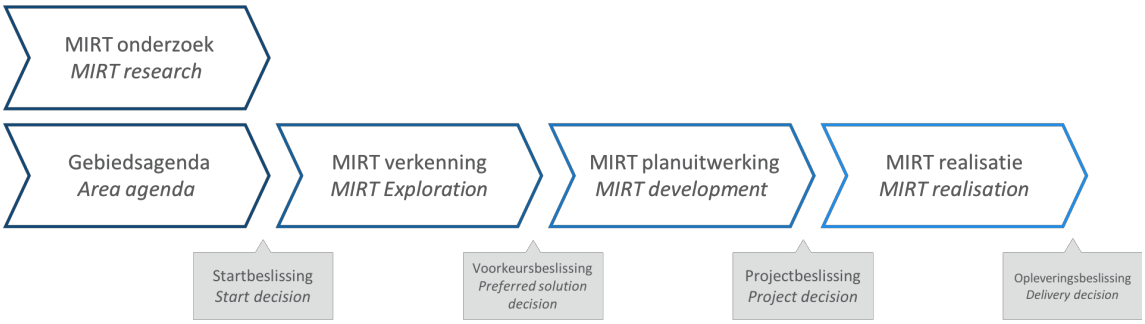

Figure 15 Overview of the MIRT procedure (Ministerie van Infrastructuur en Milieu, 2016b)

In this paragraph and the previous paragraph is explained that the current MIRT procedure should have an open and broad view and that there should be flexibility during the MIRT procedure. However, as already explained in the problem analysis, see paragraph 1.2, the effect of implementing these new MIRT guidelines on improving the level of integration is unsatisfactory (Leppink, 2017).

4.2 A detailed overview of the various MIRT phases

As already explained in the previous paragraph, 2 documents present a more detailed overview of the MIRT procedure, as presented in Figure 15. These different phases will be explored in more detail. Important to note is that 4 phases can be distinguished, of which the MIRT research and

Area Agenda are both parts of the first phase, together referred to as the initiative phase. A more detailed overview of the phases is presented in Figure 16. Although Figure 16 is already a more detailed representation of the work-process and activities that are conducted in the MIRT process, it is still a broad overview. Therefore, the initiation-, exploration-, and development-phase are described in more detail in this paragraph.

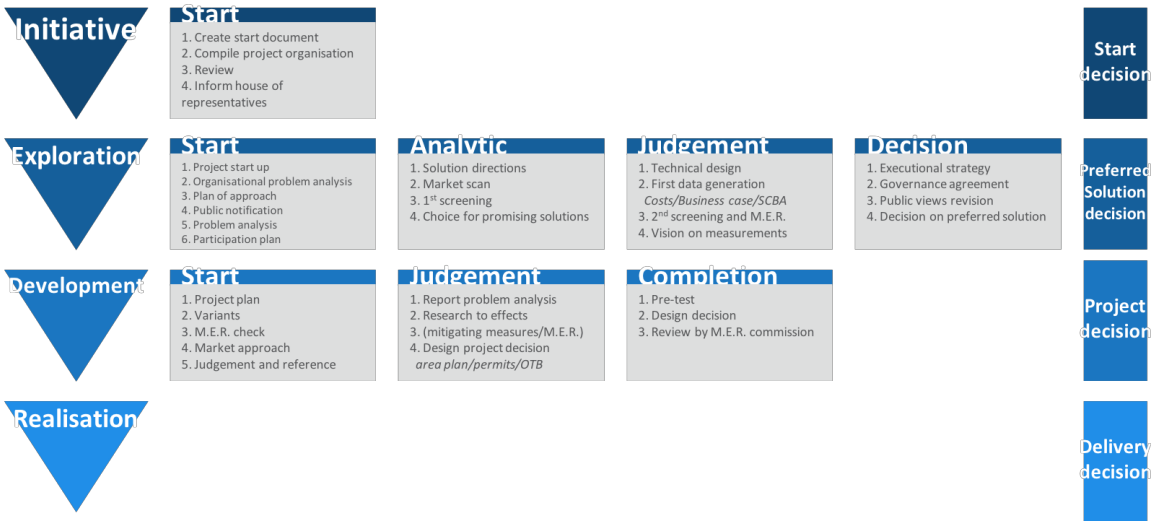

Figure 16 MIRT process 2016 extended procedure (own figure, based on (Rijkswaterstaat, 2017b)*)*

The toolkit MIRT research presents an approach only to the similarly named MIRT phase. And is, mainly written, to inspire the reader by presenting examples, methods and knowledge (Ministerie van Infrastructuur en Milieu, 2014). The objective of the guide MIRT and m.e.r. is to provide the process must be followed by the civil servants of (Rijkswaterstaat, 2017b). The guide focusses on the initiative, exploration and development phase. The last phase, realisation, is named in the document but not described in much detail.

4.2.1 Initiation phase

The initiation phase is about conducting a MIRT-research in order to explore a situation. It can be initiated by either the national government or by local governments. If there is a public initiative, it must be supported and put on the agenda by a local government. This phase is non-committal, thus will not certainly lead to a MIRT project. Secondly, it is explicitly stated that this phase is not a 'pre-research.' The objective of this phase is to map the challenge and possible tasks, the scope and the stakeholders.

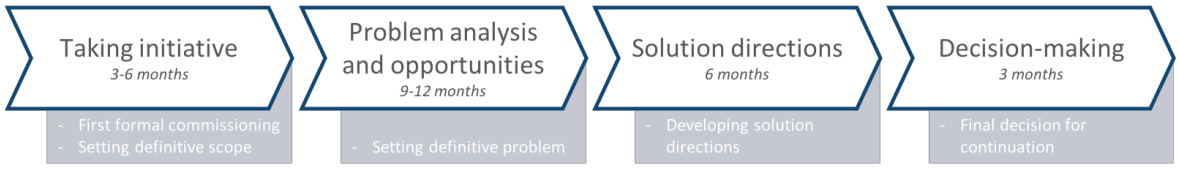

Figure 17 Overview of the process in the MIRT initiation phase (Ministerie van Infrastructuur en Milieu, 2014)

Taking the initiative & problem analysis and opportunities

Figure 17 presents the process during the initiation phase. In the context of this thesis, it is useful to understand how problems are determined during this phase, the following is stated in the toolkit MIRT research (Ministerie van Infrastructuur en Milieu, 2014):

- Trends, in the broadest sense, should be considered, as well as new developments on various topics.
- Ambitions should be explored as well as the possible tasks. This is only done on a reasonable level of abstraction. This is done in cooperation with regional governments.
- A problem analysis takes place, this is done together with the stakeholder analysis and can consists of, e.g., tasks, visualisations and calculations.
- A stakeholder assessment is done by analysing stakeholders and actors. It is explicitly stated that it is essential to consider not only the stakeholders but also the reason for them to be stakeholders. In other words, research should be done to their interests.
- Possible solution directions could be determined with 'the environment' e.g.: (conversations with stakeholders and communities, and by using social media).

Finishing these activities could, but does not necessarily, lead to a decision to continue with the steps 'solution direction' and 'decision-making', see Figure 17. From the toolkit MIRT research, can be seen that step 1 and 2 together take approximately 1 year. Secondly, it is described that after finishing these steps the problem must be defined, resulting in an (almost) fixed problem. It can only be changed with solid reasons.

Solution directions & decision-making

A remarkable aspect in the toolkit MIRT research is the presentation of the following list, which is translated in English to be able to use the list in this thesis (Ministerie van Infrastructuur en Milieu, 2014):

- Better use of existing locations and infrastructure, e.g. inner-city building, traffic junction development, quality improvements of existing nature and rush-hour avoidance.
- Improving the utilisation of new technologies, e.g. information technology and its influence on human behaviour.
- Changing human behaviour, e.g. demanding other 'work times' and improving efficiency in travelling
- Changing law and policy, e.g. environmental law, safety law
- Changing spatial planning policy choices, e.g. living area locations, locations of business parks, locations of nature and spatial reservations
- Using business-cases that can stimulate private organisations to improve infrastructure
- Actively seeking new concepts and ideas

During the initiation phase, the objective is to formulate the solution directions as broadly as possible which could follow from the described list here above. At the end of the initiation phase, there is decided which solution directions are pursued. (Rijkswaterstaat, 2017b, p. 25), this is based on a feasibility study. In this phase, lock-in should be prevented by searching for solution directions in more than a single modality (Rijkswaterstaat, 2017b, p. 38).

4.2.2 Exploration phase

This phase can only be started if a positive 'start-decision' is taken. Which can only be taken by the Minister of Infrastructure and Water Management, or eventually the Secretary of the ministry. It is the official start of the MIRT-procedure. The maximum lead time of the exploration phase is 2 years.

Figure 18 presents the deliverables of every sub-phase in the exploration phase of the MIRT procedure.

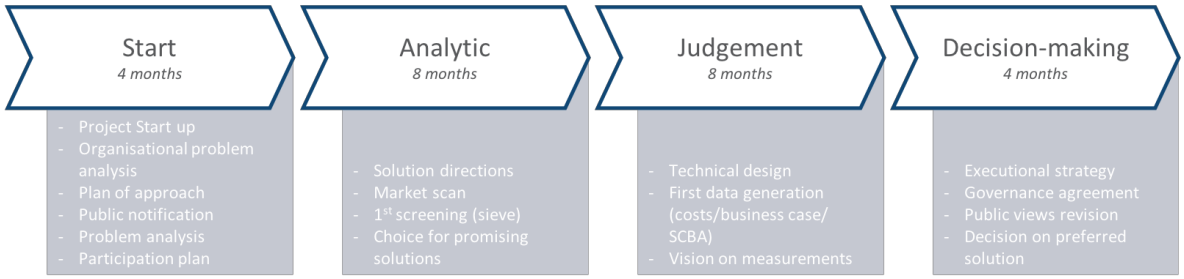

Figure 18 Overview of the process in the MIRT exploration phase (own figure)

Start

During the start of the exploration phase, the plan of approach is writing for the MIRT procedure that will follow. Secondly, an organisational problem analysis is conducted. Thirdly a consultation is held with 'the public' about the described tasks, problem analysis and scope.

In the guide MIRT and m.e.r. is stated to consult the 'environment' during the problem analysis, in other words, stakeholders from the surrounding area (in a broad sense), should be consulted (Rijkswaterstaat, 2017b, p. 53). At that moment the stakeholders have the opportunity to give their perspective on the problem, the objective and the scope. The problem analysis could eventually be adapted after the participation programme with the environment has taken place. The objective of consulting the environment is to ensure that 'the environment' endorses the problem analysis (Rijkswaterstaat, 2017b, p. 55).

Analytical

During the analytical phase, insight should be created in the possible solution directions, while these must be brought back to promising alternatives as well during this phase. The tool 'Zevensprong van Verdaas' is mentioned as a good guideline to get solutions in different directions. This tool mentions 7 possible solution directions that are overlapping with the earlier mentioned list under 'solution directions and decision-making' in paragraph 4.2.1. The solution generation 'process' is visualised in the document as presented in Figure 19. To realise a broad scope of solutions the 'guide MIRT and m.e.r.' states that demands should be described rather than solutions (Rijkswaterstaat, 2017b, p. 101). In the terminology of the MIRT procedure, the solutions developed in this process are defined as alternatives, which consider the primary choice of concept (Rijkswaterstaat, 2017b, p. 136).

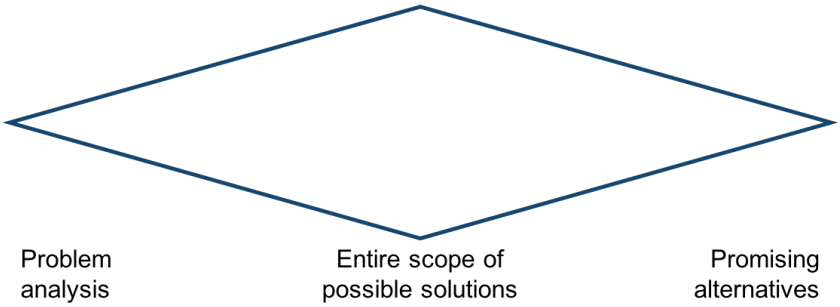

Figure 19 Solution generation visualisation (Rijkswaterstaat, 2017b, p. 98)

It is stated in the 'guide MIRT and m.e.r.' that the problem analysis is the key factor in the determination of the physical scope of the area and the scope of the study area (Rijkswaterstaat, 2017b, p. 67). Furthermore serves the problem analysis as a basis for the social cost-benefit analysis (Rijkswaterstaat, 2017b, p. 116).

Secondly, a market scan should be done in order to create insight into which market organisations are possibly equipped to realise the solutions that are the result of the MIRT procedure. Thirdly, a first judgement is made on the developed solution directions. This judgement is based on:

- The extent to which the problem is solved
- The potential for financial-economic development
- General effects
- Public support

Judgement

During the judgement phase, a technical design is made of one (or more) of the solution directions that followed from the analytical phase. There is mentioned in the 'guide MIRT and m.e.r.' that interaction is needed between the researchers of the initiative phase and the designers of the technical design.

Further, this step is all about deciding which solution is recognised as the best solution. In order to get an objective judgement various analyses are applied to a solution:

- Cost analysis
- Business case analysis
- Global fitting analysis
- Social Cost-Benefit Analysis (SCBA)

These analyses are applied, and the effects are reported. Together with a general vision on the proposed solution a vision is created whether the solution is sufficient. If obligatory, a m.e.r. (Environmental Effects Study) is done.

Decision-making

In this phase, the execution strategy for the development and realisation phase is made. It is stated in the 'guide MIRT and m.e.r.' that this step does have a strong political and administrative nature. Therefore, the focus during this phase is to notify society and create support for the chosen solution. If a m.e.r. has been done it is obligatory to give a public notification. If there are objections

against the solution, it must be reconsidered. If all legal procedures are finished a 'preferred solution decision' can be made.

4.2.3 Development phase

This phase is entered after the 'preferred solution decision' has been made. The abstract and strategic decisions are taken in previous phases. Therefore the development phase focusses on developing the solution in more detail. In this phase, there is only 1 alternative that is followed which still can consist of different variants within that single alternative. In this phase there will be worked towards the 'project-decision,' this formal decision can have different legal backgrounds, e.g., a route decision, a land use plan, an environmental management act, a water management permit, etc. This phase consists, as presented in Figure 20, of 3 different steps.

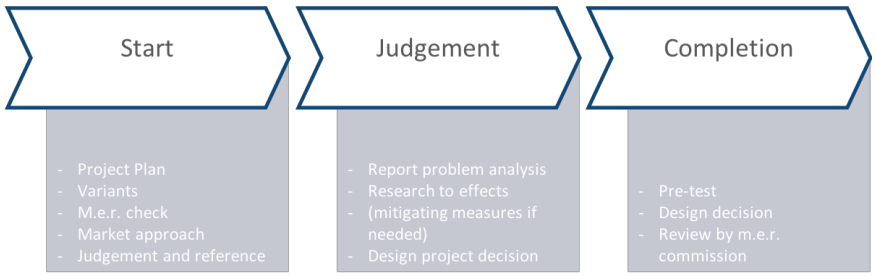

Figure 20 Overview of the process in the MIRT development phase (own figure)

Start

During the start of the development phase the preferred solution, as decided upon in the exploration phase is developed in more detail. One, or more if necessary, studies are done in order to determine the effects of different variants. Variants are smaller choices within a specific preferred solution. Secondly, market parties are approached, this is based on the market research that is done in the exploration phase. It focusses strongly on parties who can realise the developed preferred solution. Lastly, the formal administrative decision is prepared during this step. Which means that the legal procedures are prepared.

Judgement

In this judgement phase, the problem analysis should be reported in detail. The reason for defining the problem during this step is because the problem analysis should justify the measures that will be proposed as a solution. Furthermore, the environmental impact should be considered during the development of the variants. In the terminology of the MIRT procedure are variants minor choices within an alternative which consider only small variations on for example technical details or the exact positions of a solution (Rijkswaterstaat, 2017b, p. 136).

The following aspects should be considered to create a sufficient description of the problem statement (Rijkswaterstaat, 2017b, p. 174):

- Which problems played a part in the current situation or near future;
- How the problems have developed over time;
- What the consequences are of not solving the problem;
- Which parts of the problems are solved in the MIRT project;
- How the environment is affected by the problem

Completion

This final step focusses on getting the final decision on a solution. Therefore, a pre-check is conducted to see the missing parts after which the definitive decision can be taken. By finishing this phase, all legal procedures should be finished, and there can be started with realisation. Public notice must be given on the intention to take a definitive decision. Public notice must be given as well after a 'definitive' decision has been taken. Finally, if all the objections are solved and there are no more (legal legitimate) appeals against the project decision, the project decision could be taken.

4.2.4 Realisation phase

After a project decision has been taken the realisation starts. This is based on the existing information regarding the chosen solution. It depends on the chosen approach if there is already a contractor involved here or if a tender procedure should still be started. It depends on the exact contractual agreements which activities will be done here. However, the final objective of this phase is to deliver the solution in the way it has been figured out in the previous process steps. This phase is finished if a 'delivery decision' is taken. This decision marks the end of the delivery phase and the end of the MIRT procedure.

4.3 Insights from the interviews with people working in the MIRT or having experience with the MIRT

In the previous paragraph has been searched for the described MIRT procedure. However, the documented MIRT procedure does not give much insight in day to day working practices. Therefore, interviews have been held with people, often civil servants, who are involved in the MIRT procedure. Secondly, the interviews give more insights in the MIRT procedure in general, things that are not documented but are essential to get a sufficient understanding of the procedure. The interviewees have a substantive role in the process as described in Figure 15. The following roles are represented in the interviews:

- Policy advisor 2x, working at the Ministry of Infrastructure and Water Management, involved in the phase before the start decision and the MIRT exploration phase. Of which one with a background in water-related projects, the other with a background in transport-related projects. Both have extensive experience in the MIRT procedure, over 10 years.
- Planning manager 1x, working at Rijkswaterstaat, stationed at a regional office of Rijkswaterstaat, involved in the MIRT exploration phase and the MIRT development phase. Extensive experience in the MIRT procedure, over 10 years.
- BO-MIRT coordinator 2x, working at the Ministry of Infrastructure and Water Management, involved in the organisation of the MIRT process. Of which one with extensive experience in the MIRT procedure (over 10 years), the other only working 2 years at the Ministry of Infrastructure and Water Management.
- Advisor MIRT, working at Rijkswaterstaat, stationed at the Ministry of Infrastructure and Water Management. In a linking position between the policymakers at the ministry and the people from Rijkswaterstaat. Does have extensive experience in the MIRT procedure, over 10 years.

The interviews are transcribed first, then organised within the interview structure, and finally coded. The transcribed interviews including the coding can be found in Appendix B and Appendix C.

The interviews are globally structured according to the conceptual model, as presented in paragraph 2.5.1. There has been spoken about the context of the MIRT procedure and the characteristics of the procedure. Furthermore, there has been spoken about specific constraints and, opposite to that, about stimulating factors in the search for solutions. Finally, there has been spoken about the organisation of the MIRT procedure.

4.3.1 Infrastructure planning context and characteristics

One of the subjects that have been spoken about in the interviews was about the background of the MIRT procedure, its context and the actors involved. Furthermore, there has been spoken about how these factors relate to the MIRT procedure.

Infrastructure fund

The MIRT procedure is a consequence of the law on the infrastructure fund and the law on the delta fund (Rijksoverheid, 1993, 2011). It has been recognised in the interviews that, although the idea of the recently renewed MIRT procedure is to broaden the scope and create more integration, see paragraph 4.1.3, the budgets in both funds are organised sectoral and per modality (Quote 2:19; 2:20; 3:1; 6:1).

According to one interviewee this sectoral division is not beneficial for the desired broader search and integration in the planning process: *"we would like to develop broad solutions and take a more integrated and sometimes even an 'area approach', but the distribution of the money for projects is still done in a classical and strict way."* This organisation of the infrastructure fund does not allow wicked problems since problems should directly fit within the structure of the fund.

The role of actors on the initiation of infrastructure planning problems

It is not entirely documented in the MIRT procedure how infrastructure planning problems, are proposed in the MIRT. What became clear from the interviews is that in the initiation phase much activity takes place that has been described as 'the lobbying process.' The objective of lobbying is to get attention to a specific problem or solution (Quote 5:10).

It has been explained in the interviews that the MIRT procedure could be initiated in 2 ways, although both are not equally used. The dominant way in which the MIRT procedure is initiated is by actors who recognise a single problem (Quote 1:29). The actor who recognised the problem and initiated the MIRT procedure is often coupling this problem directly to a first solution. From the interviews becomes clear that this initial solution is very often the final solution (code group 'initiation – single problem').

The other way in which the MIRT procedure could be initiated is by initiation multiple problems and considering these together in the search for solutions. These solutions are based on the ambitions of organisations that are involved in the lobbying process (Quote 2:3). This can lead to a programmatic approach (Quote 2:8; 6:16). In a programmatic approach, the objective is to set a large objective while not defining fixed projects (Quote 3:14).

Specific actors

In the interviews, many examples are given of actors who are involved in the MIRT procedure. The most named are (code group 'actor example'):

- Municipalities (Mayor and Aldermen)
- Provinces
- The House of Representatives
- Water boards
- Ministry of Infrastructure and Water Management and the Minister herself
- Citizens
- NGOs (Non-Governmental Organisations)

4.3.2 The organisation of the process

In the interviews has been spoken about the organisation of the MIRT process, in line with the conceptual model. In the documented MIRT procedure 4 formal decisions are presented in the process about which has been spoken. Furthermore, there has been spoken about the development of solutions in the process.

Start-decision

An essential point in the MIRT procedure is the start-decision, which is the formal start of the MIRT procedure, see paragraph 4.2. In the interviews is stated that already at the start-decision there is chosen for a solution, while the exploration phase still should follow, in which, according to the described MIRT procedure, a search for solutions should be done (Quote 1:6; 2:29; 4:16). The reason for this can be a strong lobby for a solution, the sectoral organisation of the funds or the idea that a proposed solution will probably be the best (Quote 5:22; 4:17; 4:16).

"In the search for solutions, one aims to search very broadly. However, this is only done because it is an obligation in the MIRT procedure to look for a variety of solutions. Often the only reason for searching other solutions is to improve the support for the already desired solution."

From the explanation given in the interviews becomes clear that in practice there are cases known in which the freedom in the organisation of the process is entirely reduced at the start-decision. Furthermore, this is in contrast with the guidelines MIRT and m.e.r. as presented in paragraph 4.1.3

Preferred solution decision

A second important point in the MIRT procedure is the preferred solution decision. If there has been room left at the start decision to search for alternative solutions at the preferred solution decision the final solution will be chosen. From that moment there is no noteworthy room left for other solutions or exploration (Quote 4:28; 1:8; 4:20).

"From the moment that a 'preferred solution decision' is taken it is straightforward to the project finish. It only rarely happens that we go back in the MIRT procedure once the 'preferred solution decision has been taken."

From the explanation given in the interviews about the preferred solution decision becomes clear that in practice, from the preferred solution decision, the freedom in the process is entirely bound.

Solution development process

The solution development process starts with the objective of the MIRT, which comes down to solving problems (Quote 3:1). In order to do so there are various ways in which problems, and initiatives that presume to be about a problem, are analysed. One base themselves on capacity, economic and safety analyses (Quote 5:14).

When it comes to analysing the individual problems there has been mentioned various times in the interviews that causes of problems are not sufficiently analysed or analysed at all (Quote 1:3; 3:11; 4:10).

In the interviews are some specific methods mentioned that are used to create more solutions for problems. For example, there are projects known in which there was a capacity problem at the highway that started with the search for a solution to stimulate better use of the road capacity throughout the day. This was part of the 'better use' (beter benutten) program (Quote 6:12). Secondly, there has been mentioned that public transport could play a role when it comes to mitigating traffic jams (Quote 5:23). This can even be combined with 'smart mobility solutions' consisting of digital innovations that should regulate car traffic (Quote 5:24). Other solutions for transport infrastructure regarding traffic congestion problems are to shift the traffic to the secondary road network (Quote 1:32).

From the explanation given can be seen that there are methods known that broaden the search for solutions and that these are sometimes used. These predefined methods create some freedom in the solution development process.

4.3.3 Constraints and the solution space

The third concept that has been spoken about in the interviews are about the constraints that are experienced in the MIRT procedure by the interviewees. Several aspects are mentioned and indicated as constraining. However, there are aspects mentioned as well are experienced as stimulation for a broad search and the development of alternative solutions.

Funds and money

As already explained in paragraph 4.3.1, 2 funds provide the budgets in the MIRT procedure. These funds, and thus the budgets, are strictly organised (Quote 2:19). In the infrastructure fund the modalities road transport, public transport and water transport are mentioned. The delta fund is divided, according to the interviews in water safety, water quality and freshwater (Quote 2:20). Because of this organisation, it is hard, or even impossible to create projects in the MIRT procedure that consist of more modalities or that combine various water-related measures from different sectors. The following statements done in the interviews reflect these thoughts:

"The biggest disadvantage of the MIRT procedure is that the current infrastructure fund, from which the MIRT procedure is steered, is very sectoral organised."

"The largest disadvantage of the MIRT procedure is the funding system if you would like to develop more out of the box solutions."

The sectoral organisation of the MIRT is also reflected in the organisation of the various policy areas present at the Ministry of Infrastructure and Water Management. There is a sharp division recognised between the 'transport infrastructure side' and the 'water infrastructure side.' This results in solutions that are not integrated and covering multiple policy areas:

"The reason that broad solutions are not further developed and utilised in the MIRT procedure in the Netherlands lies in the fragmentation of policy areas in the Netherlands. I think that certain problems could be solved by taking spatial planning measures instead of focussing on infrastructure planning."

The problem of having two funds, both sectoral organised, and the effect of this organisation on the freedom of the process is extensively mentioned in every interview. Every interviewee recognised this as a problem and explains that because of this sectoral organisation it is difficult to transcend policy areas while developing solutions. Thus, this is reducing freedom in the process.

Actors

In the interviews has been mentioned that involving more actors is experienced as complicating the process. The reason is that actors could impose limitations due to the drive to only pursue their interests (Quote 3:3; 4:2). Secondly having more actors involved means that more attention should be paid to managing them all (Quote 4:4).

The exclusion of actors in the MIRT procedure is done because of practical reasons, as explained in the previous paragraph. However, it has been stated in the interviews as well that excluding actors is not beneficial for the solution that will be delivered through the MIRT procedure (Quote 4:30; 1:18; 5:38).

In the opinion of the interviewees, more actors should be involved. There should be focused not only on including more actors but especially more actors with different backgrounds. The reason for this is that the interviewees recognise that when an actor has a different background, the actor also brings a different perspective on the problem and translates this into different solutions (Quote group 'include many people/views').

"in my opinion, too little experts are involved in the development of solutions. Secondly, the experts that are involved often have the same background and do not provide a genuinely different perspective. Resulting in a process in which everyone thinks the same way in the same conventional patterns."

A second reason for including more actors is that some actors have much specific knowledge that can be useful in understanding a problem and secondly because the specific knowledge can lead to alternate solutions (Quote 1:30; 1:36). It is mentioned that the clear MIRT procedure can contribute to including actors since the procedure can be understood easily by outsiders (Quote 5:33).

There can be seen that regarding the inclusion and exclusion of actors there has been recognised by the interviewees that it is valuable to include more actors and especially more actors with various backgrounds in the MIRT procedure. However, at the same time, the interviewees state as well that this is currently avoided because of the fear for limitations that are imposed by actors, as well as because of the practical problems that are foreseen with managing those actors. Thus, there can be seen that the current organisation of the process does not allow for actors that pursue their interests, which negatively affects the number of actors involved and the extent to which they are involved in the process.

Political influence

In the interviews is explained that there is much political influence in the MIRT procedure (Quote group 'political pressure'). This is either be experienced as constraining as well as stimulating the search for solutions, as will be explained here.

One of the negative sides of having political influence in the MIRT procedure is that politicians are only pursuing their political agenda, which narrows down their view (Quote 2:4). And, secondly, that they only provide solutions rather than exploring the problem sufficiently before presenting a solution (Quote 2:9; 1:17). This behaviour stimulates the initiation of single problems as described in paragraph 4.3.1.

Another negative aspect of the political influence is that politicians pressurise the MIRT procedure because within their administrative period they want to have things to 'harvest' in order to become popular by their voters (Quote 2:22; 4:38). This time pressure results in fewer possibilities to explore various solutions but demands instant, easily understandable and implemented solutions.

"A major motive can be seen at politicians who aim to 'score' with projects."

It is seen that the public pressurises politicians, who propose and stimulate specific solutions, their followers and media to act. According to the interviewees, these problems are often visible and are approached superficially (Quote 4:7; 5:7; 3:4), which is negative as well.

One of the positive aspects of political influence considering is that including political views can be related to the arguments of 'including many actors.' Because politicians represent citizens, they bring forward many ideas that they have heard from the citizens they represent (Quote 1:39).

In contrast to the first statement that there is much political influence in the MIRT procedure is recognised as well that there could be even more influence, according to the following quote:

"One of the large advantages of the MIRT is that it is not that sensitive for politics. One of the things you could imagine is when politicians tomorrow decide to put all the money in transport infrastructure, there would be a massive change in the budgets simply because transport infrastructure is more popular." "However, how the MIRT procedure is organised prevents taking such emotional decisions".

Thus, there can be seen that political influence is mainly seen as a constraint in the solution development process. However, in some cases, which are not as extensively mentioned as the downsides, political influence could be stimulating the solution development process.

Other

Beyond these 3 main aspects influence the constraints in the MIRT procedure some other aspects are mentioned that are recognised as constraining the solution development process:

- Too long lead time of the MIRT procedure negatively affects solutions. It is seen that decisions for solutions are taken in another time with a different 'zeitgeist.' Thus, what seemed to be a good solution 10 years ago may not be the best solution nowadays, due to changed circumstances (Quote 1:26; 1:33; 6:11).
- One of the pillars in the Dutch administrative system is to provide legal certainty to citizens, which means that citizens may expect from the government that they spent tax money purposeful and that money is not wasted. Therefore, it is difficult to spend money on 'R&D solutions' in which the result is unsure, or to leave the definition of the expected results to the market (Quote 4:21; 5:46; 5:47).
- The strict organisation of the MIRT procedure is mentioned to be an aspect that has a negative influence on the development of a broad scope of solutions. Because it is strict 'out of the box solutions' are automatically out of scope (Quote 2:15; 3:6; 3:10; 5:41).

Summary of factors that constrain the solution space

Factor	***Positive***	***Negative***
Toolkits in the initiation phase	+	
The organisation of the infrastructure fund		-
Fixation of the budget at the start decision		-
Fixation of the solution at the start decision		-
Fixation of the solution at the preferred solution decision		-
Including actors in the process	+	-
Political influence	+	-
Lead time		-
Legal certainty		-
The strictness of the MIRT procedure		-

Table 5 Factors influencing the development of solutions (own table)

4.3.4 Proposed improvements

In every interview has been asked to the interviewee how the MIRT procedure could be improved in the opinion of the interviewee. There are 3 main improvements found that are discussed in this subparagraph.

Flexibility and programs

The first improvement that is mentioned in various interviews is to add more flexibility to the MIRT procedure (Quote 5:51). It is already explained in the previous paragraphs that there is not much flexibility and room to manoeuvre in the MIRT procedure. As a result of this, it is difficult to deal with recent developments (Quote 5:41).

How this could be achieved, according to the interviewees is by creating more programs in the MIRT procedure, see paragraph 4.3.1. for an explanation of the programmatic approach. The result of creating more programs should be that it is prevented that budgets are allocated directly to projects (which are more or less definitive solutions), but that the decision for definitive solutions is postponed (Quote 3:13; 4:36).

Integrating spatial and infrastructure measures

The second improvement that is mentioned is to create a more integrated approach in the MIRT procedure. This Implies that the boundaries between policy areas become more flexible and that it is easier to create solutions in more policy areas (Quote 1:34; 5:49). Not only should the MIRT procedure give more room for this development, but the solution should be found primarily at the organisation of the infrastructure fund and the delta fund, which both are too strict organised (Quote 2:31; 5:50).

Initiation cause analysis and re-check

The third improvement that is mentioned is to improve the initiation process in, or actually before, the MIRT procedure. It is recognised that it might be difficult, or even impossible, to regulate this process (Quote 4:34). However, according to every interviewee, it should be possible to improve the problem analysis procedure (Quote 4:5; 4:13; 5:20; 2:3).

All the proposed improvements are generally about the level of freedom in the process organisation. The freedom to be creative and flexible is experienced too limited.

4.4 Cases mentioned in the interviews

As can be seen from the interviews various aspects can both be beneficial in the search for a broad scope of solutions as well as disadvantageous. In order to understand how these factors have worked in practice, 4 cases are discussed in this paragraph; the focus is primarily on understanding how the solutions are developed. The presented cases are discussed with the interviewees. However, not every case is discussed with every interviewee. Eventually, if the information provided by the interviewees is not sufficient, it is complemented with the information from other sources.

4.4.1 Case 1 Ring Road Eindhoven

The problem/assignment

The case about the ring road of Eindhoven is mentioned from 2010 the MIRT overview. In the documentation is explained that the city of Eindhoven is surrounded by a Ring Road around the West and Southern side, but that the Ring road is missing at the North and Eastern side. This causes, according to the documentation, congestion. And, secondly, does not improve the future economic competitiveness of the region (Ministerie van Infrastructuur en Waterstaat, 2010c). Furthermore, the robustness of the entire road network is questioned (Decisio, 2014).

Figure 21 Project overview ring road Eindhoven (Ministerie van Infrastructuur en Waterstaat, 2010c)

Evaluation of the case related to the analytical model

Level of wickedness

The MIRT exploration document is a summary of ambitions that are used to justify the execution of the Ring Road project. However, this is written almost entirely from the perspective of stimulating economic growth and strengthening the knowledge position in the international context (Ministerie van Verkeer en Waterstaat, 2008).

There could be argued that the level of wickedness is high when comparing it to the characteristics of wicked problems, see paragraph 2.1.2. In hindsight, the problem is still present, which is explained in the next paragraph. Furthermore, the proposed solution could not be tested and needs much attention to propose. Finally, the challenge is unique in the Netherlands, and the problem or challenge could be caused by another problem or challenge.

In the previous points is summarised why the case of the Ring Road around Eindhoven should be considered wicked. However, according to the problem description of the project in the MIRT exploration one did consider the problem to be straightforward. Predictions about the continuous growth of the traffic demand resulted in proposing the solution to finalise the Ring Road around Eindhoven. (Ministerie van Verkeer en Waterstaat, 2008). Thus the wickedness of the problem or challenge is not considered as such.

Organisation of the process

The timeline presented in Figure 22, is entirely based on the decision overviews of the directors' meetings that are held twice per year. In these meetings, the minister of the Ministry of Infrastructure and Water Management are involved together with other directors of public organisations in the Netherlands. It can be seen that the first initiative is taken to consider the problem or challenge of completing the ring road around Eindhoven already in 2007. Two years of research took place before the formal decision has been taken by the Minister to start with the project and to allocate the budget for the project. After that, the project has been developed, and alternative routes for the road have been proposed. These alternative routes are tested in a social cost-benefit analysis. Based on this analysis the preferred solution decision was taken in 2014. From that moment one started to develop the preferred alternative, however, it can be recognised from documentation that after the preferred solution decision should be taken the project is suddenly not mentioned anymore in further decision overviews (Ministerie van Infrastructuur en Waterstaat, 2007, 2008a, 2013a, 2013b, 2014a, 2015, 2016, 2017, 2018, 2008b, 2009b, 2009a, 2010b, 2010a, 2011b, 2011a, 2012a)

From one of the interviews, the reason behind this sudden stop in the procedure has become clear. The interviewee stated the following (Quote 5:26):

"once the region became aware of this plan, one started to object against the plan. A powerful lobby started in which the main argument was that the eastern part of the ringway should go through a nature park. Because it was an undesired solution for the region finally it had been chosen to change the plan and to expand the western part of the ringway. From a traffic and mobility point of view, it is known that it is not the best solution, however considering the arguments of the region you could say that the chosen solution, seen from a broader perspective is the best."

An informative letter written to the city council provided more insight into this situation. In that letter is stated that it is tried to create alignment between 21 surrounding municipalities, however, that it is difficult, or even impossible, to create such alignment (Gemeente Eindhoven, 2014).

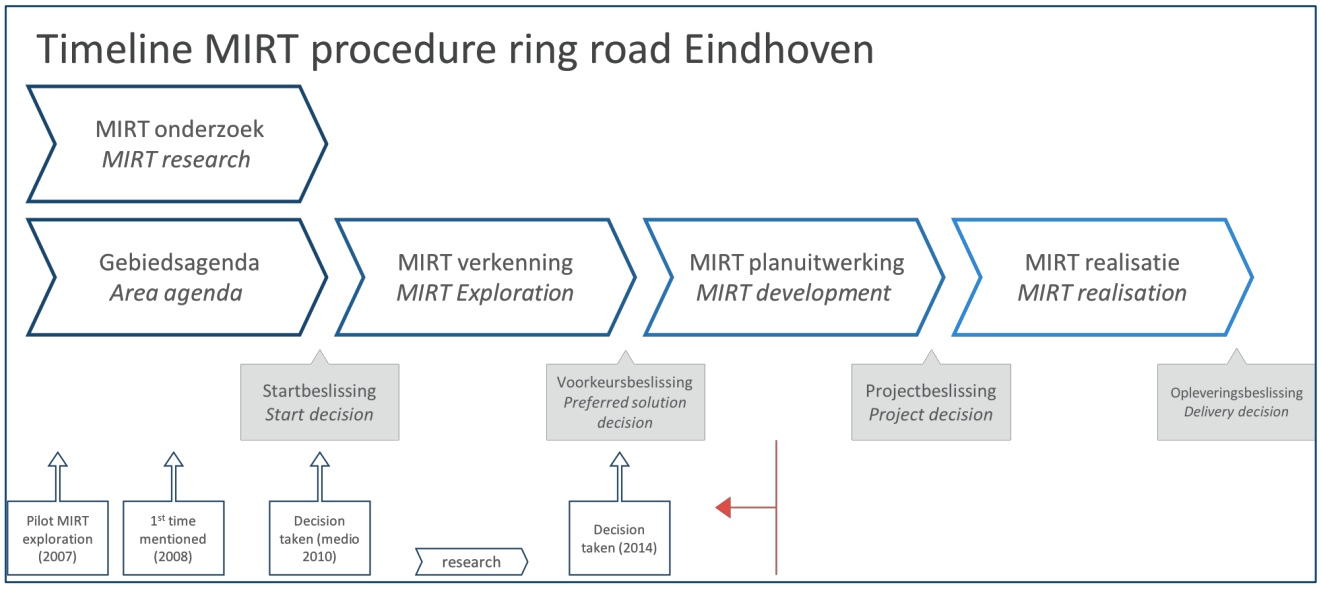

Figure 22 Timeline decisions and process ring road Eindhoven (own figure)

Number of Actors

From the description of the process became clear that during the process there have been actors who are not satisfied with the proposed solution. The quote presented on the previous page implies that the region, thus actors from the region, were not involved at the beginning of the process.

Another visionary document written in 2007, in which the first proposal for the solution is made, is signed by the aldermen from the largest surrounding municipalities (Eindhoven, Breda, Helmand and Tilburg) (Nieuwenhuizen, 2007). However, a letter of the municipality of Eindhoven, written in 2014, states that the 21 affected surrounding municipalities should be aligned. The difference between 21 municipalities who are not aligned about the chosen solution and the 4 municipalities who were involved at the beginning of the process, implies at least that not all actors were involved at the beginning of the process. The MIRT exploration document provides the same picture of the situation (Ministerie van Verkeer en Waterstaat, 2008) only a couple of governments are involved.

In the public available official documentation is not precisely described which actors are approached, but from other sources has become clear that surrounding municipalities and other stakeholders are invited later in the process (Gemeente Eindhoven, 2014; Graat & Rood, 2013; Willems, 2014).

Constraints

The desired functionality of the project, in this case, is to concentrate employment opportunities at the north and eastern side of the city and secondly to relieve traffic pressure from the centre area (Ministerie van Infrastructuur en Waterstaat, 2010c, 2013d, 2014c). This functionality is directly constrained in the MIRT exploration in 2008 by proposing the ring road around the city, as visualised in Figure 21. Within this main choice, various scenarios are explored, but these scenarios are all based upon the assumption that the ring road around the city of Eindhoven will be executed.

Reflection on the case in relation to the analytical model

From this case study can be seen that actors are neglected during the process. This led to not considering the wickedness of the problem during the MIRT procedure. The solution is developed from a national perspective. The local interests are neglected, or at least considered to be of less importance, since the highway is planned through a nature park that is highly valued by the region. This case proves the importance of incorporating all actors in the decision-making process because otherwise, it could be that a group of actors does not accept a developed solution.

Current results

The final result of stopping the MIRT procedure is that even until today there is no execution of the procedure. However, from the same information letter mentioned earlier in this subparagraph can be learned that some additional measures are proposed (Gemeente Eindhoven, 2014). Remarkable of these measures is that these finally lead to the program SmartwayZ, a program in which several ‘smart infrastructure’ solutions are developed and executed. Smart in this case often means new digital technologies. (Programmateam SmartwayZ.nl, 2017)

4.4.2 Case 2 Utrecht – Breda railway link

The problem/assignment

In the case of the railway link between the city of Utrecht and the city of Breda the problem, or assignment, is that there is no railway link between these cities. The yellow line in Figure 23 presents the railway link that still today does not exist. This 'missing' link has been recognised by a large Dutch contractor: BAM, who took the initiative to create a vision for this railway link and to present how they would execute it (BAM & Goudappel Coffeng, 2008). The problem according to the initiators follows the argumentation of rapid growth of travellers using trains. Similarly, they recognise the daily traffic junctions at the highway A27 which is the highway from the city of Utrecht to the city of Breda. This brought them to the idea of proposing the railway link (BAM & Goudappel Coffeng, 2008).

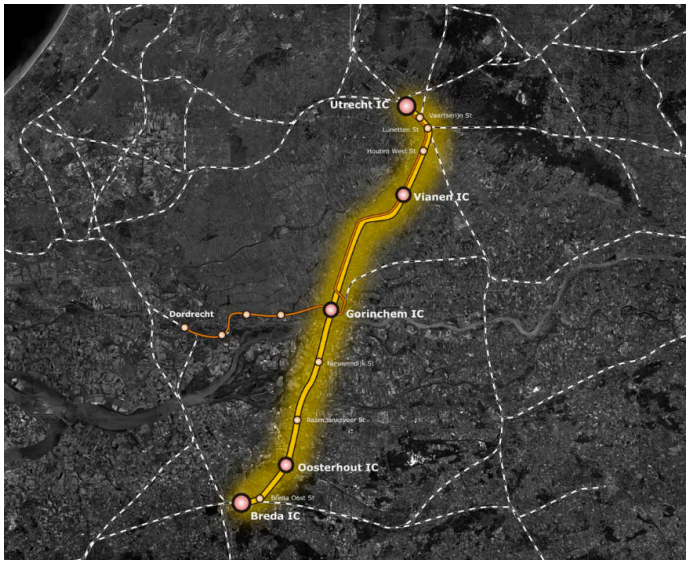

Figure 23 Missing railway link made visual (BAM & Goudappel Coffeng, 2008)

Evaluation of the case related to the analytical model

Level of wickedness

The original plan, as launched by the Dutch contractor BAM does not intend to approach the problem as a wicked problem. The objective of launching the plan and describing the problem of the missing railway link is to create attention for this option. Thus, from the point of view that a railway link is missing between Breda and Utrecht one could conclude that this problem is not wicked since the problem is apparent and the solution as well.

However, seen from the perspective of what is driving this plan: a congested A27 highway and the need to improve the accessibility between Utrecht and Breda one might end up concluding that the problem is wicked. Other documents, such as the SCBA report (social cost-benefit analysis) and an audit that has been executed by the KIM (knowledge centre for mobility policy, acknowledge that there is a mobility problem. Another conclusion drawn by both the SCBA report and the audit is that the benefits of creating such a railway link do not weigh-up against the costs (Decisio, 2010; Savelberg & van Mourik, 2008).

The problem, which is at least acknowledged as such by 2 official reports, does have a lot of the characteristics of a wicked problem. There is no definitive formulation of what the problem might be exactly. In this case, one could argue that there is a missing link, but also that the highway is not on a sufficient level to deal with all the traffic. The problem is still ongoing. There is not an ultimate

test to know when this problem has been solved. The problem is unique in a way that it has been addressed by a commercial contractor and due to its geographical and social factors. The problem can be considered to be a symptom of another problem, and the problem could be explained in various ways, see paragraph 2.1.2.

Organisation of the process

This noteworthy initiative is only rarely seen in the way in which these large projects are initiated. The entire process is visualised in Figure 24. The initiative was presented early in 2008, in the same year, the Dutch national government came with a reaction, embodied by an audit done by the Dutch national knowledge centre for mobility policy (KiM) (Savelberg & van Mourik, 2008). This resulted finally in considering the project seriously in the directors' meetings which are held twice a year. From 2008 the project is mentioned in the decision overview from 2008 up to 2011. In 2011 the following conclusion was drawn that the project will not be executed in the near future, but that it might be feasible to create physical space already when the highway A27 is renewed. The only boundary condition given to this decision is that the adaptions that should be done in order to create space should be paid by the region (Ministerie van Infrastructuur en Waterstaat, 2008b, 2008a, 2009b, 2009a, 2010b, 2010a, 2011b).

The interviews provided more insight into this situation as well. It has been mentioned that from that moment there was relative silence around the project. Occasionally the project got some more attention, but currently, the creation of plans to improve the A27 are at an advanced stage, meaning that the project decision is almost taken. One of the interviews learned that currently both the Minister of the Ministry of Infrastructure and Water Management, who is responsible for the highways and the Secretary of the same ministry, who is responsible for the railways and public transport both become aware of this project. In the interview, this is explained as follows (Quote 5:18):

"There is a strong lobby from the province of Brabant. What you could see now is that both the minister and secretary are being sensitive to that lobby and recognise that something should be done there. Because of that sense of awareness, they have worked together and are now proposing that a smart public transport solution should be implemented while the A27 (the highway road between Breda and Utrecht) is renewed. What you could see here is that because the minister and secretary are working together and give a certain freedom to us, the civil servants who should develop this solution further it is suddenly possible to create a smart public transport link."

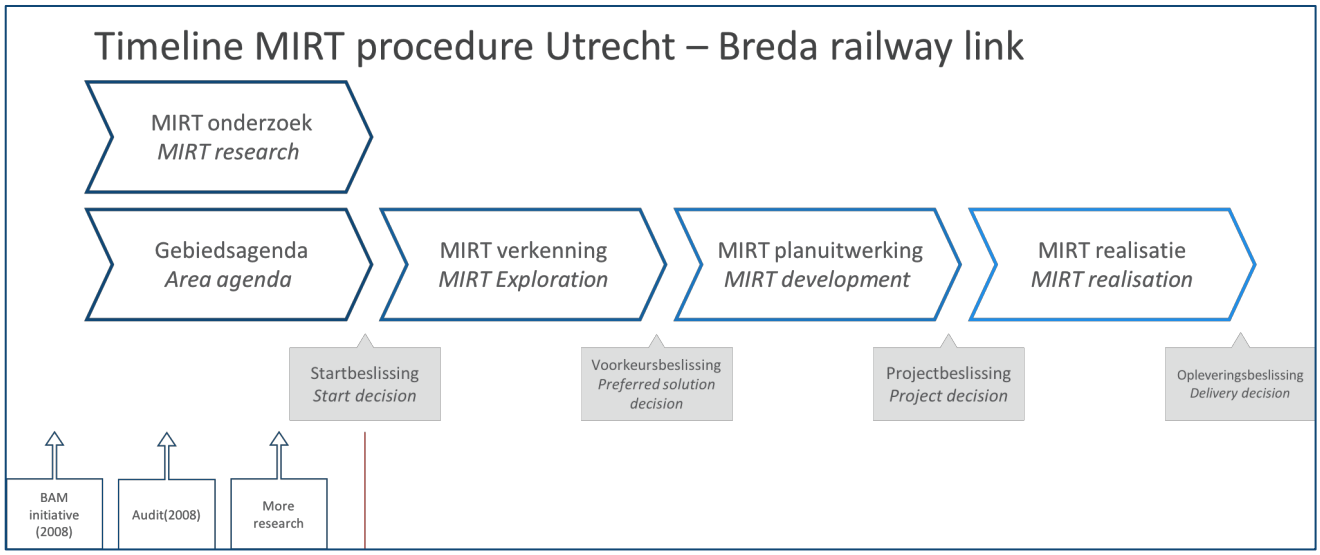

Figure 24 Timeline decisions and process Utrecht – Breda railway link (own figure)

Number of actors

In the proposed plan, the initiative by BAM, there is no sign of the involvement of actors. It is purely a proposal without considering those who can affect or are affected by the plan. The plan is recognised by the Ministry of Infrastructure and Water Management but is not further explored after the SCBA, and the following audit of the SCBA both have a negative advise about continuing exploring the proposed railway link solution.

Constraints

Because the plan is written as a project proposal for the missing railway link, the solution space is strongly constrained. After the plan, the discussion is only about the railway link, rather than about how to improve the mobility problem between Utrecht and Breda.

Reflection on the case in relation to the analytical model

From this case study can be learned in the first place that even if a governmental organisation does not propose an initiative, it is taken very seriously. Which can lead to the conclusion that the organisation of the process is not free enough to include these actors directly in the MIRT procedure. Secondly, it can be recognised that how the minister and secretary are working together is rarely seen. It is because of this collaboration between these two that a new smart public transport link will be developed. It is thus the political influence of these two people that created the space for this development. Thus, in this case, the mainly seen constraint of political influence, see paragraph 4.3.3, has become a stimulating aspect in this project.

Current results

The initiative and solution described in the interview is not a widely spread solution yet. The actual solution is to be developed in the coming years. Therefore, the actual result cannot be determined.

4.4.3 Case 3 RotterdamseBaan

The problem/assignment

Currently, the accessibility of the city of The Hague via the routes into the city centre is under pressure. This is especially the case for the highway A12, also known as the 'UtrechtseBaan.' The capacity at that highway is not enough to accommodate the future growth of car traffic. Secondly, the city of The Hague aspires to improve the industrial area 'the Binckhorst,' which is an inner-city industrial area. These problems combined lead to the initiation of the 'RotterdamseBaan' a new connection between the highway A4, which is passing the Hague, and the city centre. In Figure 25 the 'RotterdamseBaan' trajectory is presented as the green arrow. Part of the trajectory is a bored tunnel, which is presented as the dotted part of the green line (Comissie voor de milieueffectrapportage, 2013; Ministerie van Infrastructuur en Waterstaat, 2011c).

Figure 25 Project overview RotterdamseBaan (Gemeente Den Haag, 2013)

Evaluation of the case related to the analytical model

Level of wickedness

Executing the RotterdamseBaan as such is not a wicked problem. It should solve the problem of the insufficient capacity when there is a growth in the traffic demand at roads to the inner city ring road. However, taking the perspective of improving the accessibility and mobility of the municipality of The Hague the problem might be seen as a wicked problem. One could argue whether car accessibility should be improved or whether one should start a broad discussion about accessibility and livability in the city. In the context of the latter, the problem is wicked. From the process, documentation becomes clear that several actors pointed at the wickedness of the problem and proposed to search for alternative solutions (Gemeente Den Haag, 2015). However, it becomes clear as well that the RotterdamseBaan alternative is the most desired alternative and the only option that is seriously considered (Gemeente Den Haag, 2015).

Organisation of the process

From the timeline, presented in Figure 26, a couple of things stand out. First can be seen that compared to the other cases no such thing as an area agenda has been considered. The project is

mainly driven by the expected future traffic growth and the problems that follow from this growth. Secondly, the project was, in the first instance, a municipality project of the municipality of The Hague. Only from 2008 the Minister of Infrastructure and Water Management decided to include the project in the MIRT overview and regulate it accordingly (Gemeente Den Haag, 2015; Ministerie van Infrastructuur en Waterstaat, 2008a).

The project has been initiated in 1999 and followed by a study done with the objective of analysing the future accessibility of the city of The Hague. The 'start decision' has been taken in a policy agreement that was made as a result of the city council elections in 2002. The time in between the start decision and the preferred alternative decision has been about 10 years. In those years much research has been done to the solution. From the process documents can be seen that it was clear from the beginning that a tunnel would be the best alternative. However the exact details are negotiated in the years after (Comissie voor de milieueffectrapportage, 2013; Gemeente Den Haag, 2015; Ministerie van Infrastructuur en Waterstaat, 2018). The reason for the lead time of 10 years in between the 'start decision' and the 'preferred alternative decision' can be found in the high number of views and objections raised against the plan to build a tunnel into the city centre. The interviewee admits that the process took a while and that this could negatively affect the situation of the project, (Quote 5:39):

"In the case of the Rotterdamsebaan one of the arguments was to improve the capacity, and another aspect during the decision-making process was, for local authorities, to improve the old industrial area 'the Binckhorst.' At those moments when decisions were taken, it seemed to be a good idea to demolish the area. The reason for this demolishment is that one of the tunnel entrances has been planned there. However, nowadays you could see a lot of creative industry and a rediscovery of industrial urban heritage. Thus, you could question whether it was a good idea to plan one of the tunnel entries at that location. The reason that this could not be foreseen is that the decisions were taken almost 10 or 15 years ago."

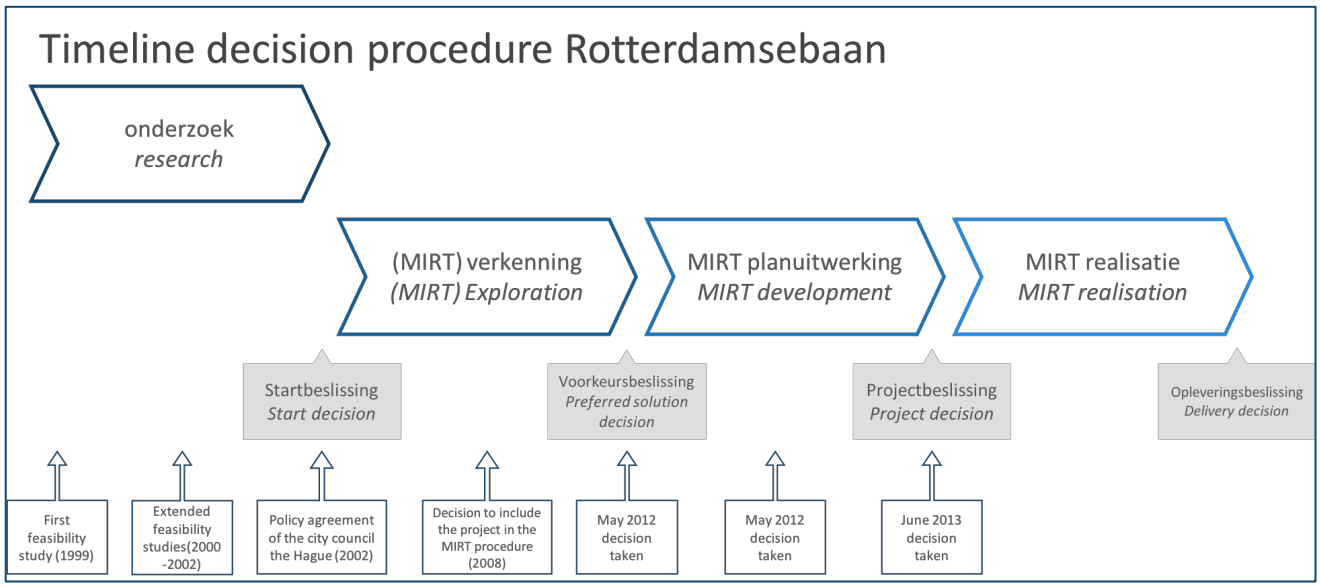

Figure 26 Timeline decisions and process Rotterdamsebaan (own figure)

Number of Actors

From the process description provided by the municipality of the Hague becomes clear that from the beginning of the process the city council and the regional development board are involved. However, only in later stages, other actors are approached to give their opinion about the plans (Gemeente Den Haag, 2015). These opinions are, though, considered by the municipality to be very useful (Gemeente Den Haag, 2017).

Constraints

When looking to the decision-making process of the project Rotterdamsebaan, it becomes clear from the decision-making process of the project Rotterdamsebaan, that functionality is an important aspect rather than focussing on the solution. An important document that explains the desired functionality is the environmental impact assessment (Comissie voor de milieueffectrapportage, 2013) in which the functionality is clearly stated. However, from other documentation becomes clear that during the process the currently executed solution is the central solution. Other alternatives are not extensively considered (Gemeente Den Haag, 2015). Thus, on the one hand, the solution space is not constrained by other aspects rather than the functionality requirements, but on the other hand, the tunnel alternative is the only solution that has been pursued seriously, which constrains the solution space.

Reflection on the case in relation to the analytical model

From this case can be learned that the main problem of the project is an expected future traffic growth that is not considered to be wicked. This, however, is combined with what has been considered to be another problem: the existence of an inner-city industrial area. The proposed solution for the first problem has been a tunnel, which then has become an opportunity, or motive, to demolish the inner-city industrial area. The final solution for building a tunnel was already proposed during the initiation phase as the best solution. Since it was already clear that this solution would be chosen, there was little freedom in the solution development process to find alternative solutions. One of the reasons for this reduction of freedom in the solution development process could be the not negotiable geographical constraint of the coastline near the city. (Quote 5:25).

Current results

The result of this procedure is that currently, the execution of the Rotterdamsebaan takes place, even though the lead time of the project has been quite long.

4.4.4 Case 4 RRAAM (Rijks Regioprogramma Amsterdam Almere Markermeer)

The problem/assignment

The realisation of the ambition to growth of the city of Almere is needed, especially when that growth is seen in the growth of the entire Randstad, the metropolitan area in the west of the Netherlands. Therefore, it is needed to search for new locations in, or on the borders of that metropolitan area, of which Almere is such a location. In order to realise sustainable growth, a programmatic approach is chosen. This means that besides focussing on the growth of dwellings in the city of Almere, one is focussing as well on ecology, the environment and accessibility. The focus area of this program is presented in Figure 27. (Ministerie van Infrastructuur en Milieu, 2016a; Ministerie van Infrastructuur en Waterstaat, 2012b, 2013c, 2014b).

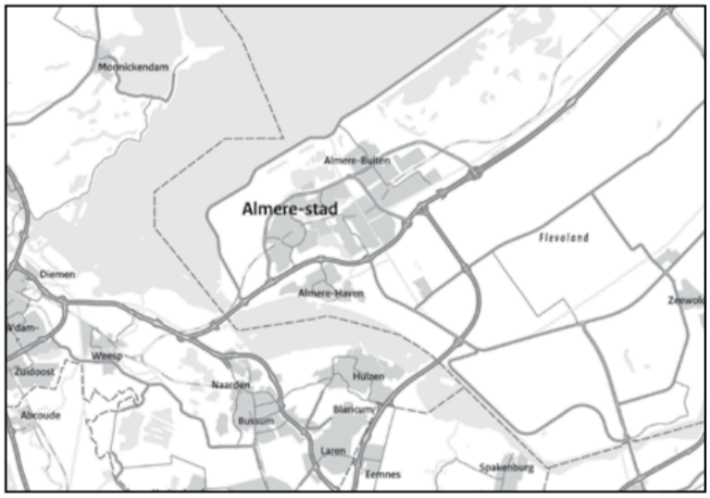

Figure 27 RRAAM program focus area (Ministerie van Infrastructuur en Waterstaat, 2012b)

Evaluation of the case related to the analytical model

Level of wickedness

The problem is wicked since there is no definitive formulation of how the growth should take place or how there could be dealt with the problem. Furthermore, the demand for houses and living areas will be high. Finally, there are various solutions possible, the situation is unique, and once there is responded to the problem (by building new houses), there is no way back. Thus the problem is a wicked problem.

In the project description in the MIRT overview of 2016 is explained that the challenge in the area is extensive, complex and has a significant impact on the surrounding areas. Furthermore, there is explained that it is not possible to adequately describe the problem due to the variety of actors and interests. Thus, there can be said, that the wickedness of the problem is fully acknowledged.

Organisation of the process

The timeline presented in Figure 28 is based on the decision-making overviews of the director's meetings together with an overview presented in the 'structure vision' for the area which is presented in 2016. What can be seen from the timeline is that there has been started to do a MIRT research and to create an area agenda. Both resulted in a 'structure vision' that is applicable to a large area. The program RRAAM has been mentioned for the first time in a director's meeting held in 2010. However, the 'structure vision' from 2016 gave the insight that the actual preparations of

this program started already in 2008 (Ministerie van Infrastructuur en Milieu, 2016a; Ministerie van Infrastructuur en Waterstaat, 2010b, 2012b).

In 2012 the decision was taken to pursue 4 different sub-programs, rather than 4 projects. Each of these programs could consist of more measures of which each measure will, in the end, be translated into a project. The 4 sub-programs are themed environment, urbanisation, accessibility Amsterdam – Almere and nature. In each of the themes currently, MIRT explorations take place or, where the measures are not infrastructural these are moved out of the MIRT procedure into other decision-making and policy creating structures (Ministerie van Infrastructuur en Milieu, 2016a).

From one of the interviews became clear that the city of Almere would like to create an extra highway connection between their city and the city of Amsterdam. It has been researched and decided that such an additional connection is not feasible yet. However, at the moment that the city of Almere passes a certain limit the desired connection will be reconsidered (Quote 4:37). The following statement has been made by the interviewee that followed this explanation of the programme:

"The smart aspect, and the adaptive aspect as well, can be found in the fact that the city of Almere would like to have a direct connection with Amsterdam via a bridge over the lake or something like that. What then is decided in the RAAM program is that once 25000 dwellings have been built in Almere, everyone will come together again and check if it is needed to build such a link. In my opinion, in this case, there has been taken an adaptive measure which has been made possible by making it a program."

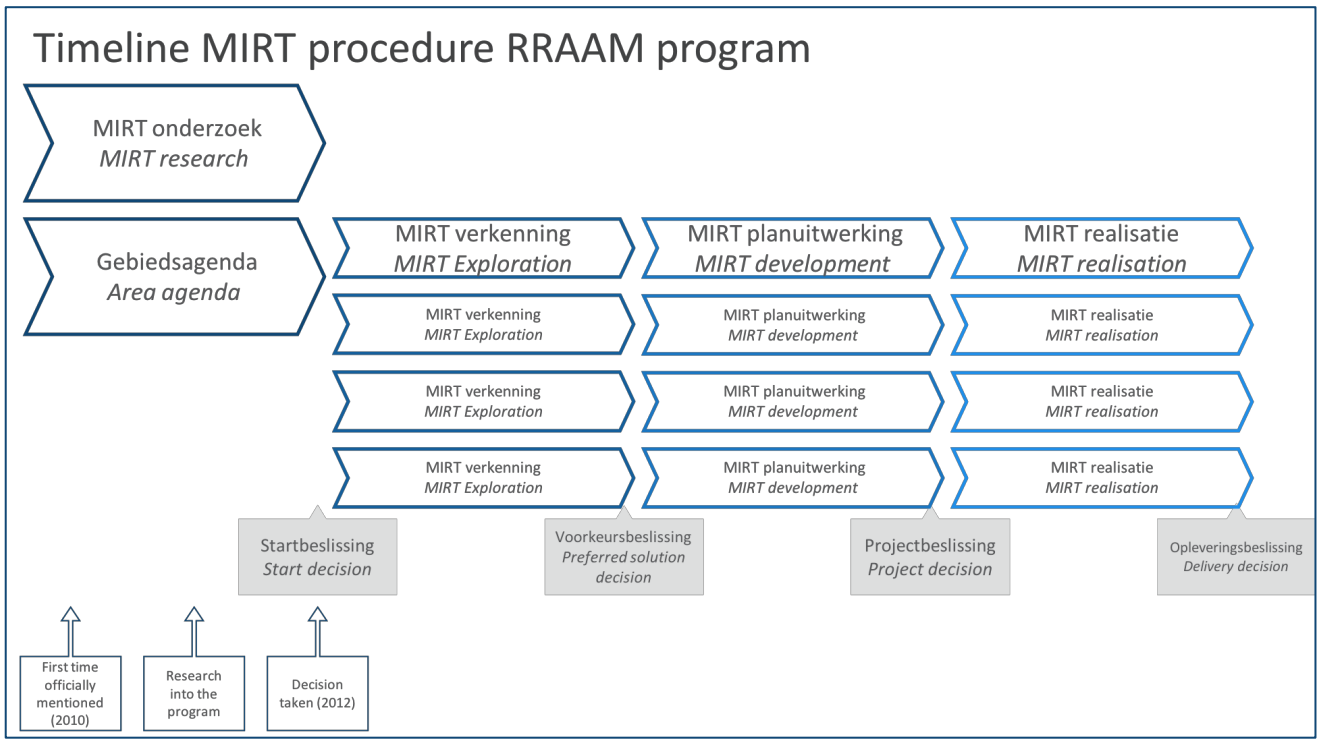

Figure 28 Timeline and process RRAAM program (own figure)

Number of actors

From the central government vision about the general structure of the area becomes clear that many actors have been involved, all the surrounding municipalities and the provinces. Furthermore, there has been stated that social organisations and private organisations will be involved as well (Ministerie van Infrastructuur en Milieu, 2016a). Due to the open organisation of the program, the idea is that actors actively participate in the programme.

Constraints

In this programme the functionality is the base of formulating solutions. Various functionality aspects are recognised, such as a well functioning eco-system, livability for citizens and sufficient accessibility and mobility. These functionality aspects are not translated directly into solutions but are discussed and researched for further development (Ministerie van Infrastructuur en Waterstaat, 2012b, 2013c, 2014b). This leaves room for changes and adaptivity during the execution of the programme.

Reflection on the case in relation to the analytical model

From this case can be learned that taking the program approach during the very early stages of the MIRT procedure results in a wide range of possible solutions. There has been accepted that the problem or problems cannot be defined definitively, which has led to establishing a program that provides freedom in the process to adapt to changes in the problem context. Even solutions can be considered within this program that are out of the scope of the MIRT procedure. Thus, there can be seen that by introducing a program more freedom is given regarding the constraints.

Current results

From a recent MIRT overview (2018) can be learned that several measures initiated in one of the MIRT explorations have become real projects resulting in preferred solution decisions (Ministerie van Infrastructuur en Milieu et al., 2018).

4.5 Conclusion

In this conclusion research question 3 will be answered: *How is the current solution development process within the infrastructure planning process of the Netherlands organised?* And research question 4 will be answered: *Which factors are influencing the solution development and selection in the current infrastructure planning process of the Netherlands*

4.5.1 Research question 3: How is the current solution development process within the Dutch infrastructure planning process organised?

In order to answer research question 3, there has been searched for the Dutch infrastructure planning process, which is known as the MIRT procedure. This procedure is presented in Figure 29. The MIRT procedure consists of 4 phases each with, on paper, a different objective. The objective of the first phases, the MIRT research and the creation of an area agenda is to understand the challenge/problems that are existing. Also, a first, very early, search into possible solutions is done. During the MIRT exploration phase, the objective is to develop different solutions and to select, after extensive research, the most feasible solution. From the MIRT development phase, a specific solution is chosen, and only minor details in the solution can be changed or adapted. In the MIRT realisation phase, the solution is executed.

The MIRT procedure is visualised in the documents with 4 blocks is presented in Figure 29. Each of the 'large' blocks consists of many sub-blocks consisting of steps and sub-procedures that are obliged to follow. The obligations in the MIRT procedure follow are regulated in Dutch law. In Figure 29 3 solution development processes can be recognised, visualised with the blue lines, the grey dotted dots are representing individual problems, and the grey filled dots are representing individual solutions. The big dots in Figure 29 represent the solutions that relate to the main concepts that can be selected to solve the problems. The smaller dots are variants within the main solution. There are differences found between the documented MIRT procedure and the actual execution of the procedure.

The first 'process line' is described in the documentation about the MIRT procedure, see paragraphs 4.1 and 4.2. Remarkable in this process is that during the MIRT initiation phase problems should be explored wider and secondly, that in the exploration phase various solutions should be developed and explored (which is visualised with the 'bumps in the line' in Figure 29). From the start-decision, the final problem is set.

However, from the interviews became clear that projects are known in which multiple solutions are developed in the early phases of the project. But, there has been explained that in some cases the other solutions are only developed since one is obliged to do so. (This is visualised in the second 'process line' with the funnel in Figure 29). It might even be possible that in the early phases a single solution is found and that this solution is the only solution that is considered during the MIRT procedure (which is visualised with the straight lines in Figure 29).

Another interesting aspect is, that some projects, for example the project of the Ring Road around Eindhoven has been in the initiation phase for about 5 years, after which it disappeared from the

MIRT overview. This means that the timeline of a MIRT procedure is not always as strict as described in the MIRT documentation.

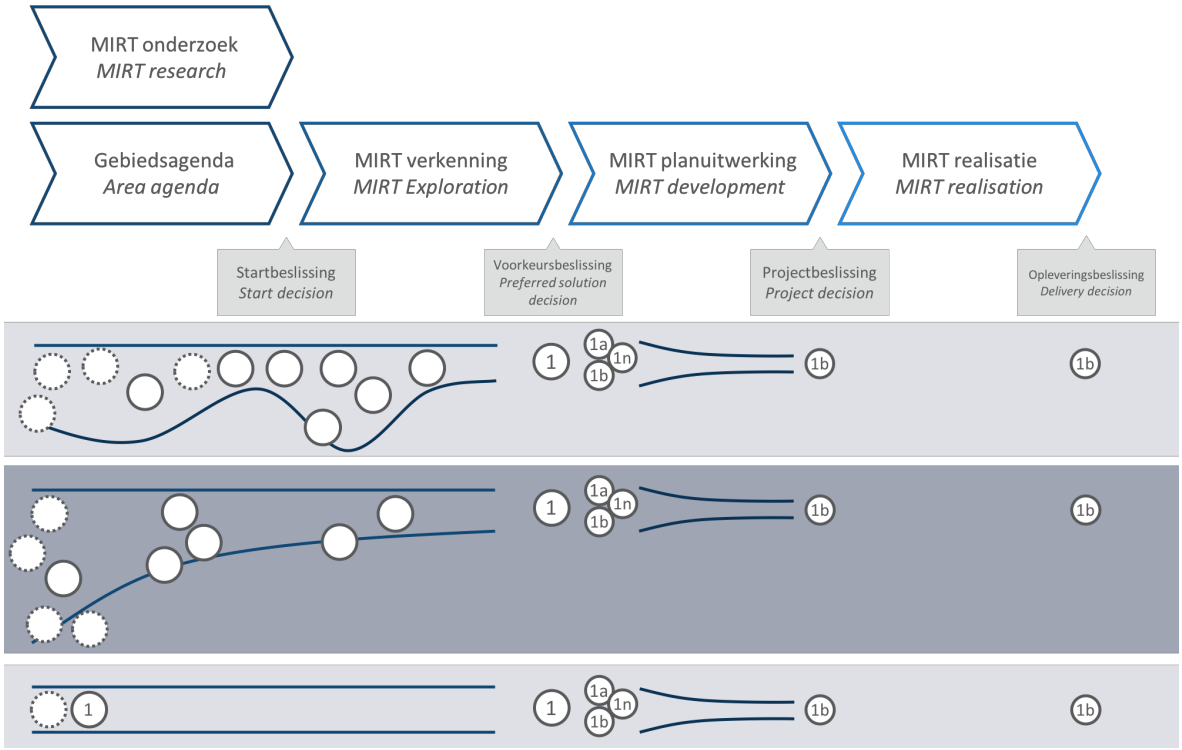

Figure 29 MIRT procedure phases and the search to solutions (own figure)

4.5.2 Research question 4: Which factors are influencing the solution development and selection in the current Dutch infrastructure process?

From the documents that describe the MIRT procedure a couple of factors can be determined that, on paper, influence the development of solutions in the MIRT procedure. The interviews revealed that there are a couple of factors that have a positive influence on the development of solutions in the MIRT procedure. However, there are also many factors described, primarily in the interviews that have a negative influence on the development of solutions. These factors are listed in Table 5 together with the qualification whether a factor is constraining or stimulating the search to a broad scope of solutions.

What can be seen from the table is that some factors can both stimulate and hinder the search for solutions. Whether a factor, that can be both positive and negative, respectively stimulates or hinders, the development of solutions depends primarily on the behaviour of actors that influence that specific factor.

5 Comparing the national infrastructure planning process of the Netherlands with the analytical model

In this chapter, a comparison will be made between the findings in the field research and the analytical model that is presented as a result of the literature research, see paragraph 2.5.5. By doing this research question 5 will be answered: *What are the differences between the current solution development process within the infrastructure planning process of the Netherlands and the theoretical solution development process?* In order to be able to compare the analytical model with the findings, it is needed to structure the findings according to the analytical model. To do so the factors of the analytical model, of which a copy is included in Figure 30, will be discussed in relation to the findings from the field research chapter 0.

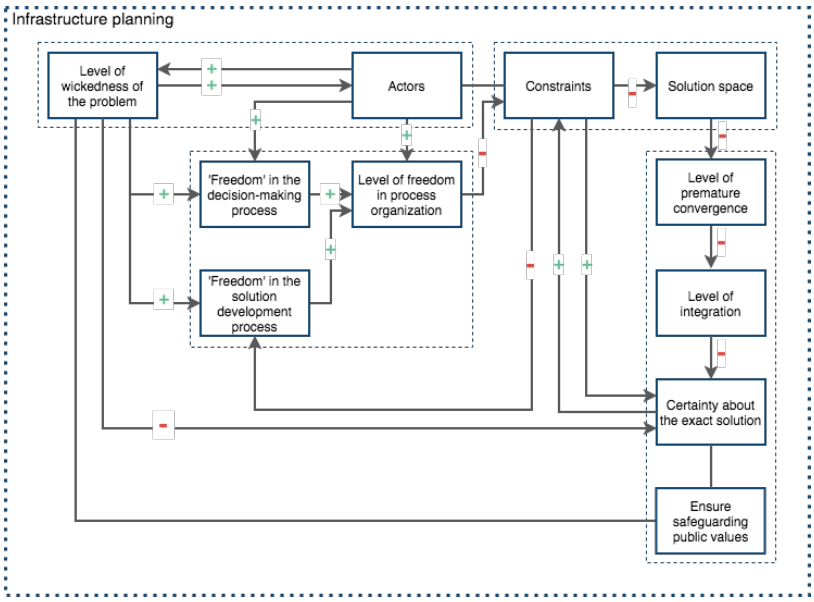

Figure 30 Copy of Figure 10 Analytical model, based on the literature research (own figure)

5.1 Comparing infrastructure context & characteristics of problems leading to infrastructure planning

The first concept in the conceptual model, see Figure 9, is about the context of infrastructure and the characteristics of problems leading to infrastructure planning. This central concept has been researched in the literature study and is divided into 2 factors: the level of wickedness of the problem that leads to infrastructure planning and the number of actors involved in the infrastructure planning process. The findings that relate to these factors will be discussed in this paragraph.

5.1.1 Level of wickedness

In the documented MIRT procedure has been found that problems should be fixated after a period with a maximum duration of 1 year, see paragraph 4.2.1. This could be considered as quick, taken into consideration that the entire MIRT procedure could take more than a decade.

In the documented MIRT procedure is nothing like an ‘escape’ described. Which means that that once there has been chosen to be in the MIRT procedure, even when it is in the initiation phase,

there is no route described to go back or to transfer the problem to another policy area, see paragraph 4.2.1 and 4.2.2. However, in reality there are examples known, see paragraph 4.5.1, in which decisions are delayed, in order to get improvement on plans.

The organisation of the MIRT procedure is a result of the organisation of both an infrastructure fund and a delta fund. These funds are the primary funds from which the MIRT procedure and the solutions that follow from a MIRT procedure can be paid. However, these funds do not allow for cross-sectoral solutions, see paragraph 4.3.1. The funds are the result of political negotiations of the importance of modalities in which the ratios cannot be changed easily. Furthermore, it is necessary to have a clear problem and solution before the infrastructure fund can be used, see paragraph 4.3.1.

These findings present that the level of wickedness of infrastructure policy problems is not taken into consideration. Neither that this wickedness could be considered. This leads to only accepting not-wicked problems, which is beyond reality.

5.1.2 Actors

In the documented MIRT procedure has been stated that collaboration is currently one of the pillars. Thus, this should be one of the critical aspects of the current MIRT procedure, see paragraph 4.1.3. However, there is not explained with who, or to which extent.

From the guideline MIRT and m.e.r becomes clear that collaboration is not necessarily needed but that actors should be consulted, see paragraph 4.2.2. It has been explained that the main reason for this consultation is to ensure that actors endorse the problem analysis.

From the interviews becomes clear that actors play a role in the initiation of the MIRT procedure. However the Ministry itself is not considered to be an actor, see paragraph 4.3.1. Furthermore, there has been stated in the interviews that it is preferred to keep the number of actors as low as possible. This is done to make the process manageable and because involving actors is often associated with the inclusion of more constraints in the process. However, it is recognised as well, that including more actors in the process could be beneficial since they could bring new perspectives that might be valuable for the solution, see paragraph 4.3.3. However, this view is not seen with every interviewee. Finally, the interviewees state that one could speak about a monoculture in the MIRT procedure, implying that there are currently too little perspectives included in the MIRT procedure.

From the cases and the interviews becomes clear that in practice there are many actors involved in the MIRT procedure, see paragraph 4.4.1 and 4.4.2. The actors that are involved are not always seen as regular sectors, as shown in the case of the railway link between Utrecht and Breda, in which a contractor initiates an infrastructure plan.

These findings present that currently, the number of actors, and especially, actors with various backgrounds and perspectives is too low. This is in contrast with the findings in the literature study that explain that in infrastructure planning the number of actors is high, due to the large size of

infrastructure networks. There is a change visible in the way of thinking. However, it is not entirely implemented.

5.2 The solution space and enlarging it

The second concept in the conceptual model, see Figure 9, is about the solution space and enlarging it. The central concept of the solution space and how to enlarge it has been researched in the literature study. This has led to the conclusion that the maximum size of the solution space is determined by requirements about functionality and quality, but that the actual solution space is defined by other constraints. In order to enlarge the solution space, the constraints should be moved 'outwards,' thus providing more freedom. In other words, the constraints should be formulated freer. The factor constraints, as presented in the analytical model will be discussed in this paragraph.

5.2.1 Constraints

An overview of the factors that cause constraints in the infrastructure planning process is given in Table 5. The overview is based upon the findings in the documented MIRT procedure as well as the findings in the interviews.

It could be said that the MIRT procedure is experienced as a strict procedure with little room for other solutions or other ways of thinking. In the interviews has been stated that this is caused by the organisation of the infrastructure fund and the need to ensure legal certainty to citizens, see paragraph 4.3.3. The latter can be seen as a public value, as explained in the literature study in paragraph 2.4. The strictness is created to have certainty about the exact solution as quickly as possible in the process, which is in line with the statements in the problem analysis about premature convergence, see paragraph 1.2. Thus, almost everything that is done in the MIRT procedure should contribute to creating clarity and certainty.

In Table 5 are 3 unique factors presented that not only cause the enlargement of constraints (making the constraints stricter). However, those factors could cause more freedom in constraints as well. These factors are discussed here. Firstly, can be learned from the interviews that there is no direct link experienced between the number of actors involved and the strictness of the constraints. It could work in two ways; some interviewees experience a high number of actors as constraining, whereas others plead for enlarging the number of actors. This because in their opinion, raising the number of actors leads to more perspectives and possible solutions, see paragraph 4.3.3. Secondly, a similar way of argumentation can be found for political influence, which can either cause that constraints are added or become stricter. However, it might be possible that politicians provide new insights or remove constraints as well, see paragraph 4.3.3. Finally, there is a toolkit provided and explained in the documented MIRT procedure that should stimulate to search for other solutions, see paragraph 4.2.

5.3 The organisation of the process

The third concept in the conceptual model, see Figure 9, is about the organisation of the organisation of the process. This concept has been researched in the literature study and can be divided into 2 factors, the decision-making process and the solution development process. Which together could be combined into the general factor: the level of freedom in the process organisation.

5.3.1 Decision-making process

In the literature study, a table is provided with the characteristics of 2 main types of decision-making processes, see Table 2 When comparing the findings of the field research there can be seen that the decision-making process in the current MIRT procedure can be classified as hierarchical. The hierarchical organisation of the decision-making process results in a process with little freedom, compared to a networked decision-making process.

The reason to classify the current decision-making process as hierarchical are explained here. The first reason for this is because the MIRT procedure is structured in strictly defined sequences and phases with clear marking points between the phases, see Figure 16. There are little possibilities described to deviate from this structure. Secondly, there is one arena in which the decision-making takes place, with clear starting points and ending points. Thirdly the content of the problem is stable during the entire process, it should be defined early in the process and will be the same during the entire process, see paragraph 4.2.1. Finally, the entire MIRT procedure is focussed on realising predictable and consistent results, see paragraph 4.3.1. All these characteristics point in the direction of a hierarchical decision-making process. The first characteristic that is in line with the networked decision-making process is how actors could join and lobby during the initiation phase, as explained in paragraph 4.3.1. The second characteristic that is more in line with the networked decision-making process is the newly introduced programmatic approach, as presented in the 4th case, see paragraph 4.4.4. In the programmatic approach, decisions could be postponed which allow in some respect to renegotiate substantive aspects and is in line with the flexibility aspect of the networked decision-making process.

5.3.2 Solution development process

In the literature study, various solution development processes are described, see Table 3 and the explanation that follows the table. The current solution development process of the MIRT procedure, as found in the documentation could be described as rational-analytic. The rational analytic approach embodies a clear path to the solution based on fixating a problem, identifying the requirements to solve it, addressing solutions and measuring to which extent various developed solutions meet the requirements set for the solution. In paragraph 4.2.2 is explained that an analysis should be done. In the same paragraph is explained that judgements are done on the solutions that are developed, which implies the existence of requirements. Furthermore, there is explained that the final chosen solution should be the most optimal solution. Which is again in line with the rational-analytic approach.

However, the interviews present a slightly different view of the solution development process. According to the findings in the interviews, the current execution of the MIRT procedure could sometimes be classified as authority approach. In the authority approach, there is confidence in people with power who determine the right solution to problems. In the interviews is found that there are cases known in which the proposed solution during the initiation phase has been the only solution that is genuinely considered, see paragraph 4.3.3. This has become clear from the case in paragraph 4.4.1 as well. In which a solution has been chosen by a group of actors who had initially the power to decide upon the exact solution. However, in that specific case, the ‘deciding actor’ had underestimated the power of local actors, which finally lead to a change in the final solution.

Both the rational-analytic and the authority solution development approach do not allow for maximum freedom in the process. And, secondly, both do not entirely fit with the by nature wickedness of infrastructure planning problems, as explained in paragraph 2.1.2 and 2.3.2.

The framing method, which is the core of the design approach, see paragraph 2.3.4, could be compared in detail with the solution development process found in the MIRT procedure. The steps found in the MIRT procedure that are most similar to the steps taken in the framing method are compared in Figure 32. After which each step is discussed in more detail. In general, can be seen from the comparison that some aspects the current solution development process narrow.

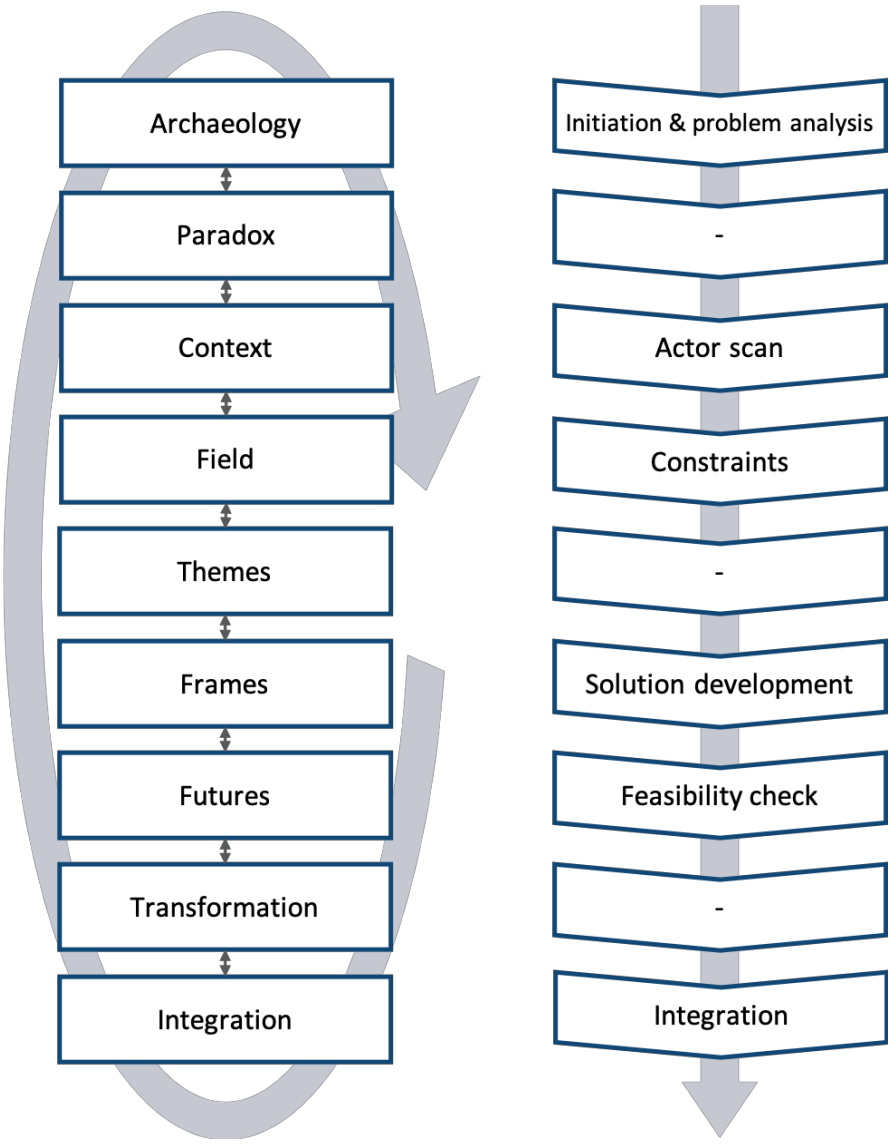

Figure 31 Comparing solution development processes; framing (left), MIRT procedure (right), (own figure)

1. **Archaeology** Is about finding the problem to be solved, the same can be seen in the MIRT procedure by how the problem is initiated and analysed. However, the difference in this step in the MIRT procedure is that it is not only about the problem as perceived by the actors, but it can also follow straight from analyses.
2. **Paradox** The problem definition itself is not investigated and questioned, a more in-depth search to the causes of the problem appears to be superficial
3. **Context** The context of what seems to be the problem and to possible actors is executed. However, due to the nature of the MIRT, the primary focus is on infrastructure and transport. And thus, only actors are involved who have an interest in the infrastructure process. The context is not broadened otherwise.
4. **Field** The field in the MIRT procedure is determined already from the start of the procedure. It is not based upon what actors value and the reasons for valuing something. But the constraints are instead taken for granted rather than researching them. Many of the constraints listed in Table 5 are predefined in the MIRT procedure itself, such as the budget certainty or the organisation of the infrastructure fund or the delta fund. Other constraints follow directly from using the procedure, such as the lead time and strictness in the MIRT procedure.
5. **Themes** As already explained at the previous point in the process, the needs and values of actors are not considered and thus also not thematised further.
6. **Frames** Frames is about creating solutions. However, the process by which this is done is entirely different. The approach and logic behind the development of solutions are that they solve the problems, which is another view on design, as presented in paragraph 2.3.3.
7. **Futures** Developed solutions are tested extensively on their feasibility and the requirements. However, again these requirements in the MIRT procedure are based upon the constraints rather than on values. In the framing method, this step should be seen as an early test and thinking about the consequences of a solution instead of extensively testing.
8. **Transformation** This step does not come back in the MIRT procedure because of the different, rational-analytic, approach.
9. **Integration** The chosen solution in the MIRT procedure is integrated into the problem context, but similarly to what has been described at step 7, it differs from the intention of integration as it is seen in the framing method. The framing method recognises that solutions, but problems as well, can be entirely different due to the evolvement of both. Therefore, solutions should also be fitted into the early problems that have caused the need for finding a solution.

5.3.3 Level of freedom in the entire process

From the previous 2 sub-paragraphs can be learned that the organisation of the entire MIRT procedure is strictly organised and does not provide much freedom. This is found in both the decision-making process and the solution development process.

This has been confirmed in the interviews, in which the interviewees generally advocate for more flexibility in the process, see paragraph 4.3.4. Furthermore, the interviewees would like to have more integration of other policy areas and improved problem analyses, which is in line with the findings in the literature study.

5.4 Conclusion and Implementation of the findings in the analytical model

In this conclusion research question 5 will be answered: *What are the differences between the current solution development process within the infrastructure planning process of the Netherlands and the theoretical solution development process?* This question is answered in this chapter by discussing each of the factors of the analytical model, as presented in Figure 10. In this paragraph, a final conclusion is drawn, and the results of the comparisons in this paragraph are implemented in the analytical model.

5.4.1 Research question 5: What are the differences between the current solution development process within the infrastructure planning process of the Netherlands and the theoretical solution development process?

The key difference between the current solution development process in the infrastructure planning process of the Netherlands and the theoretical solution development process is that the current solution development process is more narrowed and not broadly oriented compared to the proposed solution development process in the theoretical model.

Some factors are contributing to this more narrowed process. The first factor that contributes to this narrowed process is that the wickedness of infrastructure planning problems is overlooked. The first for this is the desired certainty about the exact solution. Secondly, it is the number and variety of actors that is kept small. If infrastructure planning problems are considered to be less wicked, a solution development process that is narrower could be justified, which is the case in the current MIRT procedure. The second factor that contributes to a narrower solution development process is the number and variety of actors which is kept small in both numbers and variety of backgrounds — resulting in the incorporation of only a few perspectives in the process, leading to a monoculture and same-way thinking when it comes to developing solutions. The third factor is the strictness of the MIRT procedure caused by many constraints. These constraints are summarised and discussed earlier in this chapter. The interviewees argue that the number of actors involved does not influence the strictness of the constraints, it is only about their behaviour.

5.4.2 Implementation of the conclusion in the analytical model

The result of implementing the findings in this chapter is visualised and presented in Figure 32. In order to simplify the comparison, a copy of the analytical model in which the objective of this thesis is implemented is presented in Figure 33.

The grey boxes in Figure 32 represent that real wickedness of the problem and the number and variety of actors should be considered to be large. However, as already explained earlier in this chapter, in the MIRT procedure these factors are tried to be kept as small as possible. Furthermore, there has been concluded that the level of freedom in the entire process organisation is small. The dotted box around the factor ‘freedom in the decision-making process’ represents that in some cases in the current organisation of the MIRT procedure more freedom is provided by using a programmatic approach. Although, this is not done in every MIRT procedure that has been started. The current MIRT procedure is described as too constrained, leading to a large box. However, the current MIRT procedure aims to reduce some constraints, which is represented by the dotted box in the factor constraints in Figure 32.

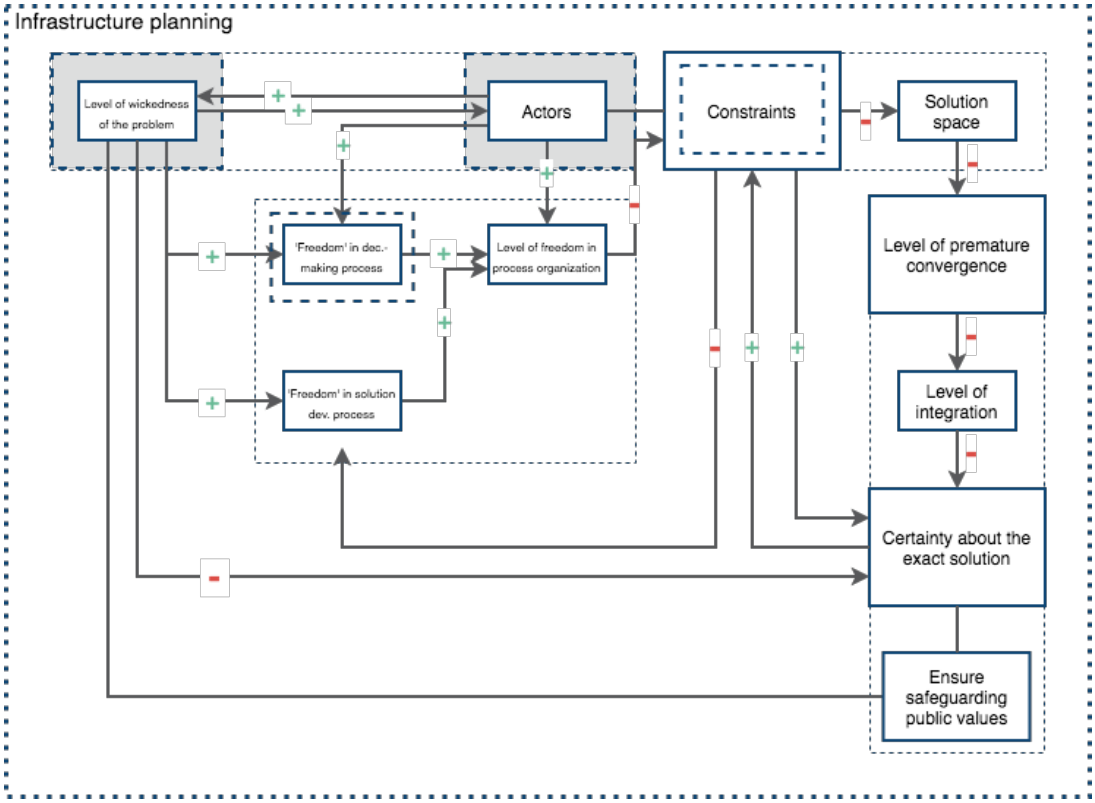

Figure 32 Implementation of the compared factors in the analytical model (own figure)

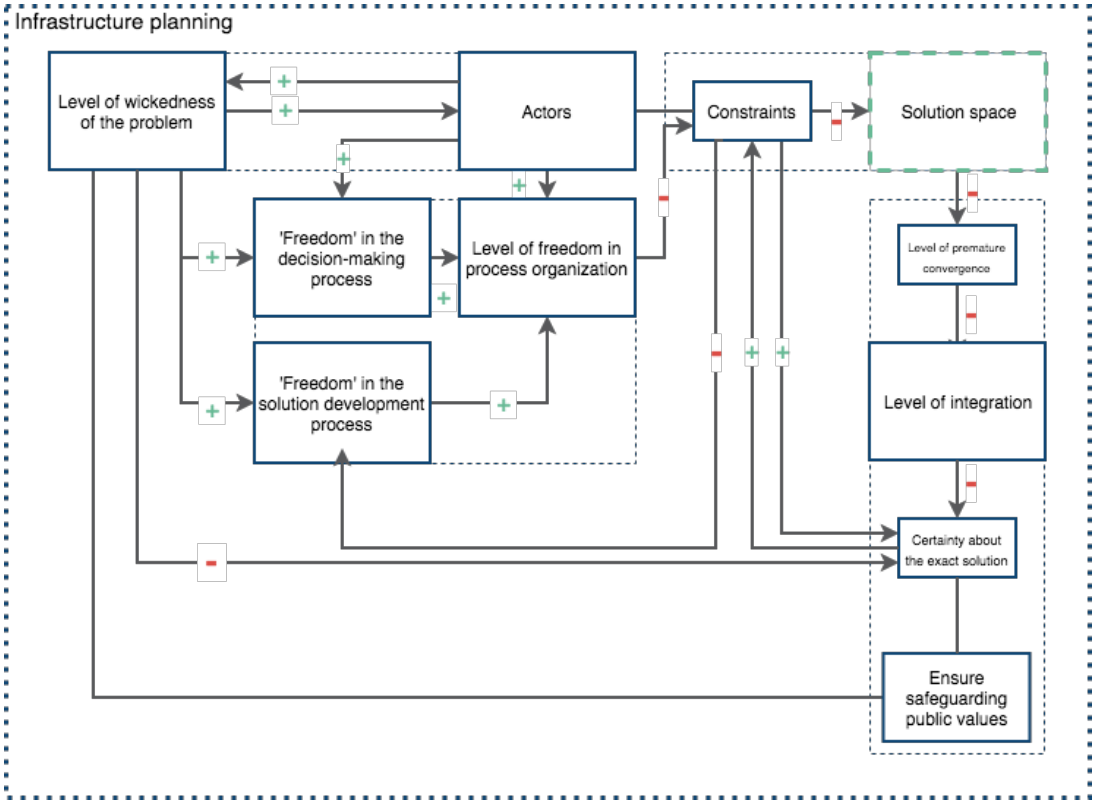

Figure 33 Copy of Figure 11 Visualisation of the objective of this thesis in the analytical model (own figure)

6 The current national infrastructure planning process of the Netherlands in an international context

In this chapter infrastructure, planning processes of other countries will be explored in order to be able to understand how the findings in this thesis can be adapted and used within other infrastructure planning processes than the Dutch national process. By doing this, research question 6 will be answered: *What are the main considerations when implementing the findings of this thesis in other European infrastructure planning processes?* In order to be able to answer this question, the legal and public administration systems of other countries are researched. The reason for researching other systems is because in paragraph 2.1.1 has been stated that governments organise infrastructure planning. Secondly, the cultural differences between various countries will be explored. The reasons for explored cultural differences is because it could provide more context and could say something about how interactions take place in infrastructure planning processes. The information of both explorations will be used to reflect on the analytical model and to present how this model could be different in various countries. This will lead to an understanding of how the findings should be adapted.

6.1 Planning systems and families

Within Europe, 4 legal and administrative systems are recognised see Figure 34 (Newman & Thornley, 1996). Actually, 5 systems are presented, the British, Napoleonic, Germanic, Scandinavian and the East European system. However, from the detailed description, following after the figure will become clear that the East European is not a separate system. In most cases, the legal and administrative system is the same in each country. However, there are some differences as visualised in Figure 35.

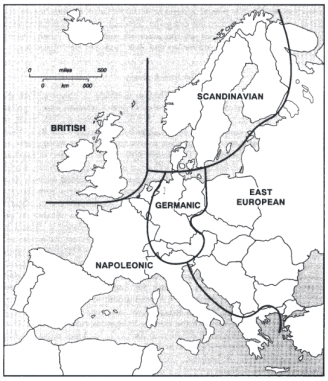

Figure 34 Visualisation of the legal systems according to (Newman & Thornley, 1996)

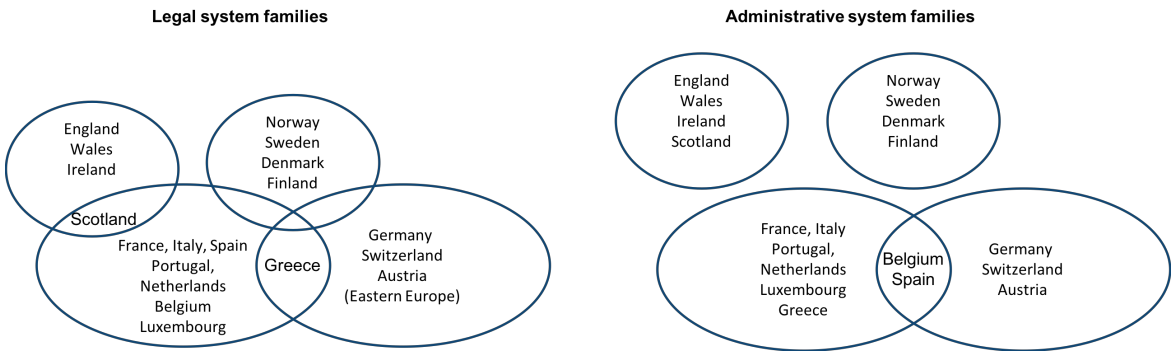

Figure 35 The legal and administrative 'families' across Europe, according to (Newman & Thornley, 1996)

6.1.1 British

The British legal system can be seen in isolation from the other legal systems across Europe. It evolved from the tradition of English Common law, a system of case law that has gradually built up decision by decision. The mode of thinking originates by considering the relationships between parties and the rights and duties they are having to each other. Traditionally the power to provide services is laid down at the local governments who have thereby also the rights to impose decisions (Newman & Thornley, 1996).

6.1.2 Napoleonic

The Napoleonic legal system consists of an abstract formulation of principles and rules that should apply to many situations. The mode of thinking originates by thinking of problems in advance rather than reacting on those as the British system does. Due to many developments, different administrative systems regulate the division of power between the central and local authorities, however, in general, can be seen that there is a substantive bit of decision power at central authorities. The general trend in this power division is that poorer countries have more centralised decision powers (Newman & Thornley, 1996).

6.1.3 Germanic

The Germanic legal system can be seen as a branch of the Napoleonic legal system. However, there are vast differences as well which makes it a system on its own. The Germanic system is very abstract, even more than the Napoleonic. Much importance is given to the written constitution, which generally describes the division of power very detailed and precise. Much of the decision power is given to local and regional authorities, less to central authorities for historical reasons (Newman & Thornley, 1996).

6.1.4 Scandinavian

The Scandinavian legal system is a mixture of Napoleonic and Germanic systems. Although it is based upon these systems which are both abstract, the Scandinavian system tends to be more pragmatic. In line with this, the legal system is more accessible and written in a more straightforward language. Due to the large, and not densely populated countries, decision power is distributed and described as 'Local self-government.' This is complemented only with central government decision power if necessary (Newman & Thornley, 1996).

6.1.5 East European

The East European legal system is only developed recently because of the movement away from the Russian communist system. Because of this development, the countries are influenced by ideas from all other European systems. The same can be seen with the division of powers; one has to get used to the fact that central authorities do not have all the decision power (Newman & Thornley, 1996).

6.2 The (infrastructure) planning systems within the legal systems

In the work of (Reimer et al., 2014) various infrastructure planning systems are researched. This research ends in a comparison of those systems and the primary objective of each system. The results are summarised in Table 6:

Legal system	*Country*	*The objective of planning policy:*	*Planning organisation and regulation*	*Institutional settings*
British	United Kingdom	cannot be determined	Planning is market led, the first plan regarding strategy is regionally seen	Since there is not a planning system as such local powers, have strong influences in planning
Napoleonic	Nether-lands	is to foster the competitiveness of the country.	Planning follows a national strategic vision that is followed up regionally	The shift towards regional follow-ups already increased actor participation
	Belgium	is to create coherence and coordination among spatial planning, transport, regional and rural development, environment and housing	Planning takes place at local, regional and national level and is aimed to be integrated nationally	The permit system is dominant in organising and regulating the planning system
	France	is to create territorial coherence and coordination	Planning regulations focus on bringing back coherence and integration on a national level	Intermunicipal cooperation is becoming more critical in the planning process
	Italy	is to focus on the promotion of economic growth, social cohesion and sustainability	Planning conflicts with national and regional interests	Contractual agreements should regulate the relationship between local, regional and national levels
	Greece	is to focus on the implementation of major infrastructure projects	Planning is steered national and regional in harmony	Multi-actor participation takes place more regularly
Germ anic	Germany	is to strengthen the competitiveness of the country.	Planning is regionally steered	Long established structures do not change and established parties are involved
Scandinavian	Denmark	is to be 'holistic,' focus on local development and it is related to economic planning.	Planning takes place at the regional and local level	Since 2007 increased multi-actor participation takes place during the planning process
	Finland	is connected to the shift towards territorial governance, and to strengthen urban and regional competitiveness and sustainability within neo-liberal conditions.	Central government aims to prioritise local priorities in the planning process	Participation takes place together with the trend of devoluting the planning process
East European	Czech Republic	is to make spatial planning more flexible	Planning is a regional process	Planning is not very collaborative organised; many conflicts exist between stakeholders, which are solved behind the scenes
	Turkey	is to connect sustainable development and globalisation	Planning is very local organised	Planning is strongly regulated by law
	Poland	is to create alignment with European Union planning programmes.	Planning is organised on the national, regional and local level, on each of the levels is focussed on integration with the other levels	Planning is open and friendly organised

Table 6 Summary of the results of comparing European planning systems, according to (Reimer et al., 2014)

From this table, it becomes clear that already across countries in Europe there are many differences in the objective behind infrastructure planning processes, as well as differences in the organisation. In the work of Reimer, et al. (2014) is stated that the organisation and the institutional settings are changing currently towards a more bottom-up, consensus-based and decentralised approach. Another trend recognised by them is that planning systems become more aware of the strategic

objectives that can be the input of planning policy processes and related to that the connection with other planning policy processes within Europe.

Furthermore, it is recognised by Reimer et al. (2014) that there is a 'change of mind' towards involving more actors in the infrastructure policy processes. The reason behind this is stated as the need for creating more innovative solutions. However, it is stated as well that how this is implemented is different across all countries due to different cultural backgrounds (Bramley & Gurran, 2017; Reimer et al., 2014).

6.3 Cultural backgrounds

As explained in the introduction of this chapter not only will European legal systems be explored in which the Dutch infrastructure planning process can be placed. However, there will be looked to the culture behind those systems in various countries as well. A well-known and often referred to the body of knowledge regarding expressing cultures is the cultural dimensions framework (Hofstede & Bond, 1984; Koops, Coman, Bosch-Rekveldt, Hertogh, & Bakker, 2015; Sui Pheng & Yuquan, 2002; Wu, 2006). This framework presents 6 dimensions along which a culture can be 'measured.' These dimensions are (Hofstede, Jan Hofstede, & Minkov, 2010):

- Power Distance (PDI)
    - The extent to which the less powerful member of institutions and organisations within a country expect and accept that power is distributed unequally.
    - When relating this index to the analytical model, there could be seen that it influences the relation between actors and the decision-making process. A high level of PDI means that it is harder for actors without decision power to be involved in the decision-making process.
- Individualism (IDV)
    - Individualism belongs to societies in which the ties between individuals are loose, meaning that everybody is expected to look at him- or herself and his or her immediate family.
    - When relating this index to the analytical model, there could be seen that it influences the extent to which individual interests prevail above shared-interests. A high level of IDV could mean that powerful actors do not allow much freedom in the decision-making process, it could mean as well that more constraints are imposed by actors which influences the solution-development process negatively.
- Masculinity (MAS)
    - A masculine society is a society in which emotional gender roles are clearly distinct. Men are supposed to be assertive, tough and focussed on material success and winning, whereas women are supposed to be more modest, tender and concerned with the quality of life.
    - Since a part of masculinity is about winning and material success, it could be that solutions developed in a planning process in a masculine society could influence how solutions are developed. However, it cannot be stated how relations or factors in the analytical model are affected.
- Uncertainty Avoidance (UAI)
    - A measure of the extent to which the members of a culture feel threatened by ambiguous or unknown situations.

    - When relating this index to the analytical model, there could be seen that it directly influences the factor 'certainty about the exact solution.' Which, according to the analytical model influences the extent to which infrastructure problems are seen as wicked problems. Thus, a high level of UAI means less desired wickedness of problems.
- Long Term Orientation (LTO)
    - A long-term oriented society stands for the fostering of virtues oriented towards future rewards. Short-term oriented society stands for the fostering of virtues related to the past and present.
    - This index could be related to the analytical model in the way that a long-term oriented infrastructure planning process does not have to deliver solutions straight away, which might be beneficial to incorporate new and innovative solutions in the infrastructure planning process.
- Indulgence versus Restraint (IVR)
    - Indulgence stands for a tendency to allow relatively free gratification of fundamental and human desires related to enjoying life and having fun. Its opposite pole, restraint reflects a conviction that such gratification needs to be curbed and regulated by strict social norms.
    - This index explains how actors deal with results, which is not described by the analytical model.

In the work of Hofstede et al. (2010) each of these indicators is researched for many countries across the world. Including the countries that are presented in paragraph 6.2. Therefore, these dimensions are presented in Table 7. The exact numbers presented in the table are the extent to which a particular dimension is found in the culture of the specific country. Thus, high numbers mean that the dimension is more present in a culture compared to other cultures with lower scores.

To get an easy comparison the Dutch culture to the other cultures in the Table the method of the 'least squares' has been applied as can be seen in the last column of Table 7. In this method, the number of the variables in the set (in this case the various countries) are compared with the fixed set (in this case the set of numbers of the Netherlands. The difference between the numbers in each category is squared and then summarised. The result is that the smallest numbers present the countries which are most similar. From this least-squares method can be seen that the order of countries with the most similar cultures is:

1. Finland
2. Denmark
3. United Kingdom

Legal system	*Country*	*PDI*	*IDV*	*MAS*	*UAI*	*LTO*	*IVR*	*R^2*
British	United Kingdom	35	89	66	35	51	69	3340
Napoleonic	**Netherlands**	**38**	**80**	**14**	**52**	**67**	**68**	-
	Belgium	65	74	52	95	82	57	4404
	France	68	71	69	86	63	48	5578
	Italy	49	74	70	74	61	30	5257
	Greece	60	35	57	112	45	49	8803
Germanic	Germany	35	67	66	65	83	40	4091
Scandinavian	Denmark	18	74	16	23	35	70	2309
	Finland	33	63	26	59	38	57	1469
East European	Czech Republic	57	58	57	74	70	29	4708
	Turkey	66	36	45	85	46	49	5572
	Poland	68	60	64	93	38	29	7843

Table 7 Cultural dimensions of specific countries, according to (Hofstede et al., 2010)

6.4 Comparing the systems and cultures with the Dutch system and culture

6.4.1 The British system compared with the Netherlands

The legal and administrative system

From the description of the British legal and administrative system can be learned that decision-making is locally focussed, which is in contrast with the decision-making focus of the Netherlands within the Napoleonic system that has a national focus. The regional-focussed decision-making structure might imply that the decision-making process is already more open and flexible organised when it comes to large infrastructure planning processes.

Culture

Comparing the culture of the United Kingdom, which is within the British system and the Dutch culture in more detail one could conclude that the culture is almost similar in the dimensions PDI, IDV and IVR, but different in MAS, UAI and LTO.

It is described in Table 6 that infrastructure planning is market led, which implies the existence of a competitive solution development process. This is in line with the high masculinity in the United Kingdom, that is associated with material success and winning as well. The drawback of this solution development approach is that losers will come back and that the search to solutions keeps going on. The proposed solution development approach in this thesis that is based on shared views rather than single parties who propose a solution and win based upon their proposal is very different. Implementing this solution development approach requires a significant change in the way of thinking. Because there is less uncertainty avoidance, it might be that problems are seen more wicked, which, in the end, contributes to a larger solution space. The existence of a lower long-term orientation could result in more freedom in the process since plans are less planned. This is in line with the description in Table 6 in which is stated that there is no specific objective. However, a drawback might be that there is more opportunistic behaviour in the infrastructure planning process.

Conclusion

Based on the findings and comparison there could be said that the level of wickedness of infrastructure planning is acknowledged as such, as well as the number of actors. The decision-making process might be adapted to this already. However, the solution development process could possibly be changed. Since it is market driven one should highly be aware of the interest of market organisations in the current solution development process, which might frustrate a more open and free solution development process.

6.4.2 The Napoleonic system compared with the Netherlands

The legal and administrative system

Since the Dutch system is part of the Napoleonic 'family' of systems, there are generally seen no differences. However, when looking in more detail to the findings, there has been stated that the poorer the country, the more centralised the decision-making process. From the example countries in Table 6, one could conclude that the Netherlands is amongst the more prosperous countries. This means that providing more freedom in the process in poorer countries means that the decision-making process needs to be changed to a more significant extent. Secondly, this more centrally organised planning process could affect the number of actors that are looked after in the planning process. Thus, when implementing the result of this thesis, this should be considered.

From the description in Table 6 can be seen that in all Napoleonic countries, integration, more or less, depending on the specific country, takes place on the national level. However, there is stated in the same table as well that there are currently conflicts between local and national interests. The aim of the solution development and decision-making process, as proposed in this thesis is to overcome these conflicts and create new insights from these interests. Thus the result of this thesis might be useful for all Napoleonic countries.

Culture

When comparing the cultures in the various Napoleonic countries, there can be seen that there are significant differences. The difference in the PDI predicts that it will be harder to incorporate actors in the decision-making process and to create more freedom in the decision-making process. This difference in culture could make it hard to implement the result of this thesis in those countries. The IDV index is almost similar in all Napoleonic countries used in the example, except Greece. Actually, a lower IDV is positive for the freedom in the proposed decision-making process and solution development process. The MAS index is one of the lowest in the Netherlands, and in all other countries higher, however, there is explained that this does not have direct effects on the planning process. Higher UAI indexes are beneficial in enlarging the perceived wickedness of the infrastructure planning problem, which is beneficial for the proposed solution development process and decision-making process. The only aspect that should be considered in this respect is the opportunistic behaviour of actors. Lower levels of the LTO index are beneficial to give more room for alternative solutions and for the latest trends and developments to be considered. Thus, only in Belgium, it might be harder to have a more open solution development process.

Conclusion

Although the legal and administrative systems of the other Napoleonic countries are similar to the legal and administrative system of the Netherlands, there are significant differences between the countries. The significant difference in the PDI between the Netherlands and the other countries might make implementation of the proposed solution development process and decision-making process hard. However, the other countries have another aspect that is in favour of implementing a more open and free process, which is the higher UAI.

6.4.3 The Germanic system compared with the Netherlands

The legal and administrative system

The most important aspect of the Germanic administrative system is that most decision power is given to regional authorities. This implies, similar to the British system that the decision-making process might be more open and flexible in order to allow various regional authorities to take decisions. This might simplify implementing the proposed decision-making process in this thesis.

Culture

Comparing the culture of Germany, which is within the Germanic system and is taken as an example, and the Dutch culture, it could be seen that significant differences can be found in the MAS index, LTO index and IVR index.

The MAS and IVR index do, as already explained in paragraph 6.3, not directly influence factors in the analytical model. The LTO index, however, has a negative influence on the extent to which new and innovative solutions are incorporated. Thereby it does influence the level of freedom of the solution development procedure. This dimension should be considered when implementing the proposed solution development process of this thesis in a Germanic planning system.

Conclusion

Although the Germanic legal and administrative system is different from the Dutch systems, the proposed solution development and decision-making processes might fit well within this system. From a cultural perspective can be said that the critical dimension that should be considered when implementing the result of this thesis is the LTO index.

6.4.4 The Scandinavian system compared with the Netherlands

The legal and administrative system

The main difference between the legal and administrative system of the Scandinavian family and the Netherlands is the fact that decision-making is done at the local level. This implies that when large infrastructure systems are planned, there are many actors involved. Probably the decision-making process is already organised as proposed or can adapt easily towards the proposed networked decision-making process since one is used to incorporating many actors. This is stated as well in Table 6.

Culture

The cultures of the Scandinavian countries have the most in common with the Dutch culture of all cultures compared in this paragraph. Significant differences are found at the UAI index in the case

of comparing Denmark and the Netherlands and for both Scandinavian example countries at the LTO index. A lower LTO index might, however, be beneficial for the incorporation of new and innovative solutions in the solution development process, which is proposed in this thesis by providing a more open solution development process.

Conclusion

Since the cultures of the Netherlands and both Scandinavian example countries are very similar, the results of this thesis could possibly easily be implemented in the infrastructure planning processes of the Scandinavian countries. However, one should consider that the infrastructure planning process of the Netherlands is probably still even more focussed on integrating on a national level rather than having its focus on the local levels. Thus, in that respect, it is unsure to which extent the findings presented in this thesis are desired for Scandinavian countries.

6.5 Conclusion

In this conclusion research question 6 will be answered: *What are the main considerations when implementing the findings of this thesis in other European infrastructure planning processes?* This question is answered in this chapter by discussing the characteristics of legal and administrative systems of other European countries. And by discussing the cultural characteristics of some example countries. These characteristics are then compared to the characteristics of the Netherlands and are related to the analytical model as presented in Figure 10.

6.5.1 Research question 6: What are the main considerations when implementing the findings of this thesis in other European infrastructure planning processes?

The main finding is that there is no country amongst the compared countries with a similar combination of legal and administrative system and culture. However, this does not imply that the result of this thesis, which is the proposed decision-making process and the solution-development process cannot be used in other countries.

There are characteristics of the legal and administrative systems have influence on the factors in the analytical model. These characteristics should be considered when implementing the findings of this thesis in other European infrastructure planning processes. The first characteristic of the Dutch process that should be considered is the focus on integration at a national level. The second characteristic is that the Dutch process is law-based. Thus making it harder to implement the process in the British system and possibly East-European systems.

There are cultural dimensions that influence the analytical model; these should be considered when implementing the findings of this thesis in other European infrastructure planning processes. Firstly, it is found that the PDI (power distance index) is preferably low since an essential aspect in the entire proposed process organisation is that actors speak out and are incorporated. Secondly, the UAI (uncertainty avoidance index is preferably low, since it contributes to allowing actors to perceive problems as wicked. Finally, the LTO (long-term orientation) should preferably be in the higher regions, since it implies that results should not be delivered straight away, which creates room for new and innovative solutions to prove their value.

7 Conclusion

In this chapter the main question of this thesis will be answered: *How can the solution space be enlarged in the infrastructure planning policy process in the Netherlands?* To do so the analytical model, as presented in Figure 10 has been compared with the findings from the empirical part of this thesis: the field research. In this field research is searched for how the current infrastructure planning process of the Netherlands is organised. Various sources have been used to find information: documentation and interviews. The conclusion that follows from the comparison of the theory based analytical model and the empirically based model will be presented. First, this part will include the recommendations that are specific to the situation in the Netherlands. Followed by the findings and conclusion of the reflection of the model in the European context. This will be present what should be considered in order to use the findings in other countries. Finally, recommendations will be given for further research.

7.1 Main question: How can the solution space be enlarged in the infrastructure planning policy process in the Netherlands?

In this paragraph copies of the theory based analytical model, Figure 36 and the empirical based analytical model, Figure 37 are presented. In the theoretical based analytical model, the objective of this thesis: enlarging the solution space has been visualised. In the empirical based analytical model, the current situation of the infrastructure planning process in the Netherlands has been visualised. In both models, the relations between various factors that influence the size of the solution space are presented. A positive mark is given if there is a directly proportional relation, a negative mark for inversely proportional relations. The size of the boxes presents the extent to which the factor in a box is present. More details can be found in paragraphs 2.5.5 and 5.4.2.

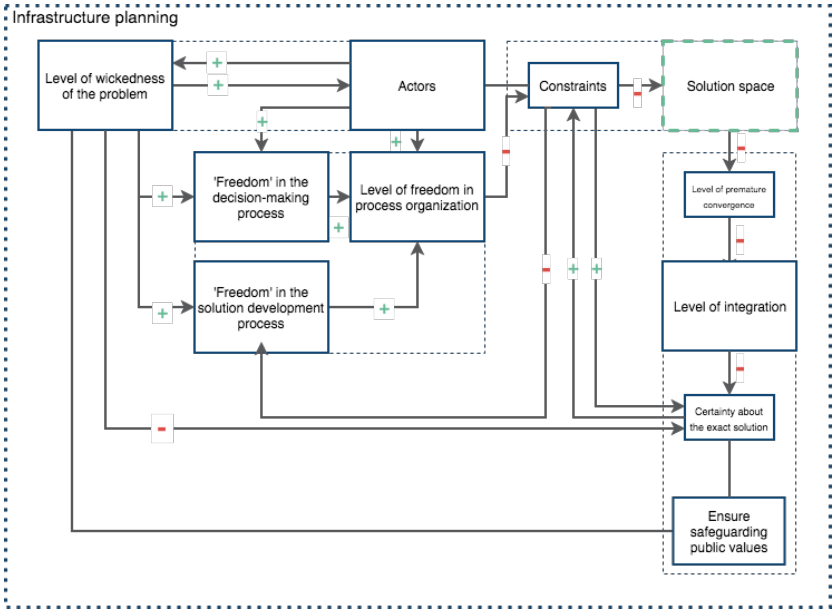

Figure 36 Copy of Figure 11 Visualisation of the objective of this thesis in the analytical model (own figure)

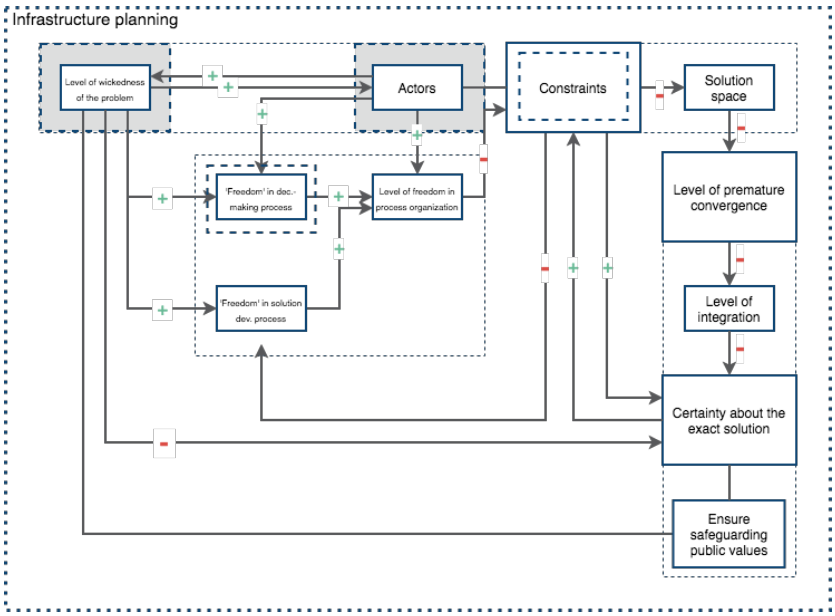

Figure 37 Copy of Figure 32 Implementation of the compared factors in the analytical model (own figure)

In the analytical model in which the objective of this thesis, enlarging the solution space, is visualised can be seen how the other factors should be, see Figure 36. Comparing this to the current situation in the infrastructure planning process in the Netherlands (the MIRT procedure), see Figure 37, there can be seen that there are significant differences between the factors.

By identifying these different factors, the main question is answered. The solution space can be enlarged by acknowledging that infrastructure planning problems are wicked. This implies that should be acknowledged that the problems that currently lead to infrastructure planning are experienced differently by whoever recognises them. Furthermore this implies that many actors are affected and try to (or even have) influence the process, which is not negative but should be seen as a positive fact.

In practice could the solution space be enlarged by implementing another solution development process, known as the design approach. The design approach focusses on creating valuable solutions in situations that are complex and multi-faceted, thus wicked. Furthermore, the design aproach focusses on searching new and innovative ideas for solutions. Central in this approach is the search for the desired value of a solution. The desired value is based on the idea behind the required functionality of a solution. By taking the desired functionality of a solution as a starting point in the solution development process, the maximum solution space is created. A detailed overview of how the process should be shaped is presented in Figure 39. This figure is based upon the design approach as proposed in paragraph 2.3.4.

There should be acknowledged that in the current MIRT procedure, one strives for certainty about the exact solution as early in the process as possible. This has already been stated in the problem analysis and is confirmed in the empirical research. This is caused by the idea that public values can only be safeguarded if this certainty is provided. However, there has been explained in the theoretical research that this is not true. The proposed networked decision-making process is also named to be a sufficient method to ensure the safeguarding of public values.

7.1.1 Recommendations for the national infrastructure planning process in the Netherlands

In order to change the national infrastructure planning process to a more open and adaptive process, the following is recommended:

1. To change the strict organisation of the infrastructure fund and create more room to change within modalities. This has an effect on the certainty of budgets at both the start-decision and preferred solution decision. Budget certainty could ensure the commitment of actors, thus having the certainty of a budget is recommended. However, it should not be taken as an outline for the solution.
2. To improve the research to problems that are currently causing the need for infrastructure planning. This will lead to improved problem analyses and, secondly, makes the process more attractive for actors to join. This requires an open attitude towards actors to bring up and pursue their own problems.
3. To reduce the strictness of the MIRT procedure and to focus primarily on functionality. Providing fewer constraints will ensure an enlarged solution space, which makes it possible to consider other and more various solutions.
4. To reduce the lead time of the MIRT procedure by creating more urgency with the actors and by reorganising the organisation of the infrastructure fund, which is one of the causes of the current lead times.
5. To allow for a change of the policy area once it has been concluded that the problem that leads to the call for an infrastructure measure is not within the infrastructure policy area, which means in practice that problems will be transferred to other Ministries.
6. To implement the design approach solution-development process, which aims to overcome the strictness of the MIRT procedure and aims for searching novel and creative solutions that are based upon the input of actors.
7. That the Ministry of Infrastructure and Water Management takes a leading role in implementing the proposed process and recommendations, since it is currently responsible for the process and have the power to decide upon the process organisation.

7.1.2 Implementation of the solution development process in the national infrastructure planning process in the Netherlands

In order to understand how the enlargement of the solution space could be implemented in the national infrastructure planning process of the Netherlands, Figure 38 has been presented. This figure is based upon the findings in the documentation of the MIRT procedure as presented in Figure 17, Figure 18 and Figure 20. It is advised to keep the general structure of the MIRT procedure but to create other points of focus in the initiation phase and the exploration phase. The objective and focus point of every step is stated in Figure 38, furthermore has been visualised how the size of the solution space should develop throughout the process.

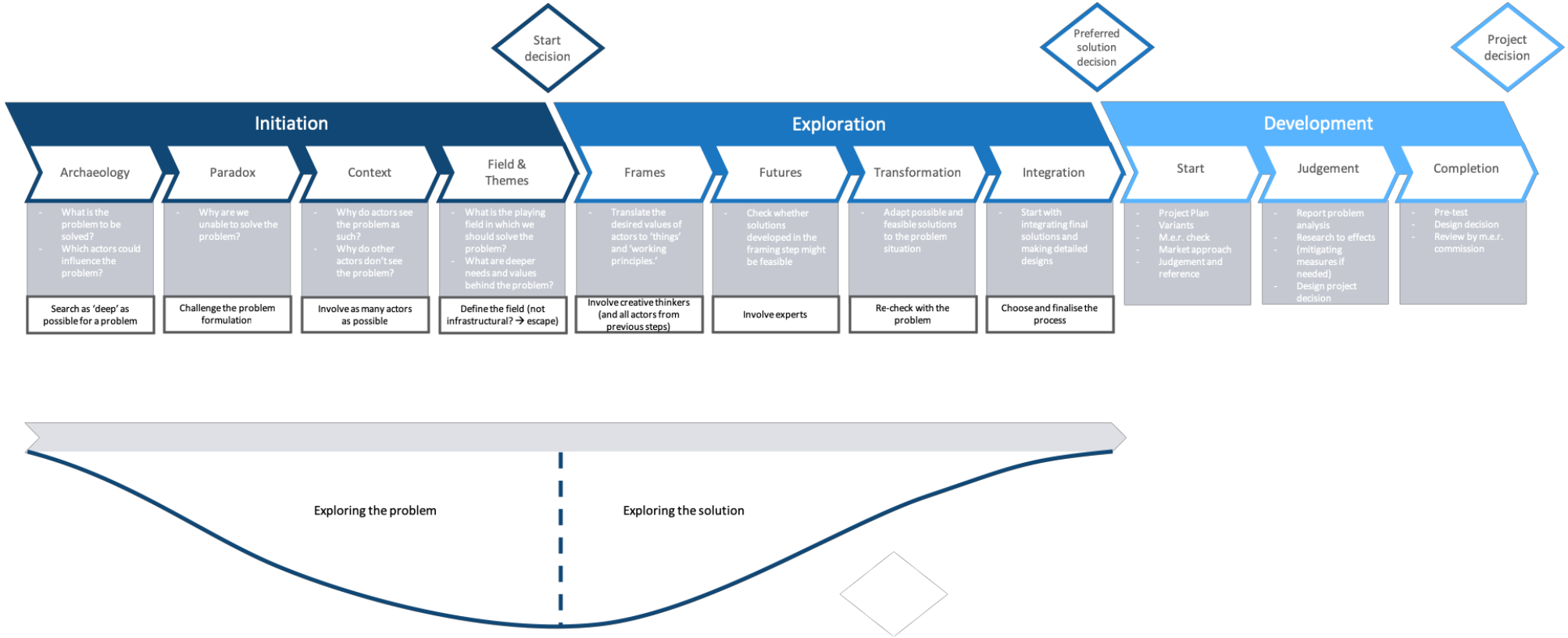

Figure 38 Proposed solution development process in the Netherlands (own figure)

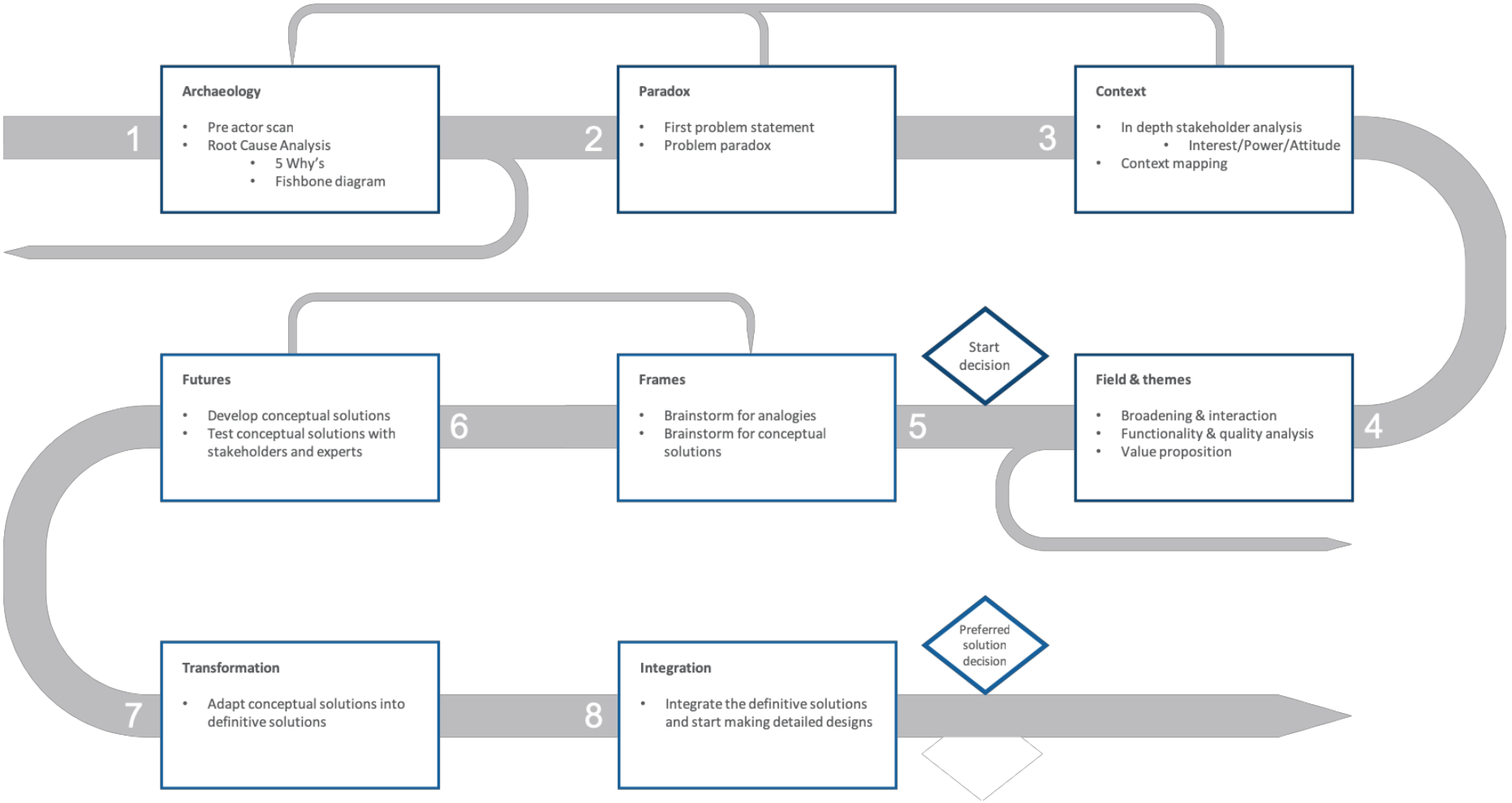

Figure 39 Overview of the focus activities in each step (own figure)

In order to implement the recommendations in the national infrastructure planning process in the Netherlands Figure 39 is presented. In this figure, activities are suggested to implement in the planning process. The activities will be explained in more detail:

- Archaeology
    - Pre actor scan
        - The pre actor scan is needed to create a first general overview of possible actors that are involved with the likely problem. This pre actor scan should be as large as possible. A workshop should be organised to determine the various actors. In this workshop, people with various backgrounds should participate.
    - Root cause analysis
        - The root cause analysis is needed to find the deeper problem that one tries to solve. To create insight into the problem and find root causes the fishbone analysis and the '5 why's' analysis is proposed. The fishbone analysis is a structured way of mind mapping in which every 'bone' of the entire fishbone visualises an aspect of the entire challenge. This can further be structured by grouping 'themed' aspects together. In this way, a problem gets visualised and is more structured. In the '5 why's' analysis the question 'why?' is repeatedly asked, by which symptoms are peeled away, leading to root causes of problems.
    - If from the pre actor scan and root cause analysis follows that the problem is probably not within the field of infrastructure planning or land use planning one should stop pursuing solutions in the direction of infrastructure planning and search for solutions in the other fields.
- Paradox
    - First problem statement
        - The first problem statement is needed to have an idea of the global problem that is to be solved. In this problem statement, the information from the root cause analysis should be combined with the actor scan.
    - Problem paradox
        - The idea of this point is to analyse why the problem has not been solved earlier. This should lead to identifying the things that kept one from solving the problem and recognising if these things are available in the present situation or not.
- Context
    - Stakeholder analysis
        - The stakeholder analysis builds upon the earlier actor analysis and should lead to identifying stakeholders. These can be ordered along the 'axes' of interest, attitude and power. Stakeholders are not only those who are negatively influenced by the problem but also those who are positively influenced.
    - Context mapping
        - Context mapping is an alternative form of interviewing a stakeholder directly about the problem. The objective is to understand the stakeholder in its context, to know its behaviour and its patterns. This will lead to an improved view of the stakeholder and to understanding the aspects that

the stakeholder values. To do so, during the interview is not focussed on the problem and the opinion of the stakeholder about the problem. However, the interview is about the daily life, patterns of behaviour and about the experience the stakeholder have related to what is considered as the problem.

    - If from the stakeholder analysis and context mapping becomes clear that not all stakeholders are involved or stakeholders experience the problem differently, one should go back to the 'Archaeology' step and make an iteration.

- Field and themes
    - Broadening and interaction
        - Once the context is clear, and the closest stakeholders are determined and analysed one should start by broadening the field and context radically. This is the step to invite solution providers; these are not necessarily only from the construction sector but from other sectors as well. An overview of all business sectors can be found at the CBS (the central organisation for statistical analysis in the Netherlands). Solutions providers, as well as other stakeholders, should be invited for interaction and discussions about the perceived problem. By doing this one could get a better idea about the problem and push the problem into new directions.
    - Functionality and quality analysis
    - Value proposition
        - The functionality and quality analysis, and the value proposition might be developed together. The functionality and quality analysis are needed to form the boundaries of the solution space while the value proposition provides insight into the collective desires of the stakeholders in the process.
    - If from this step follows that solutions might not be found in the construction sector one could choose here to deviate from following the MIRT procedure and pursue these solutions out of the MIRT procedure.
    - Once this step is taken the information needed for the 'Start decision' should be clear. As a result, the decision should be taken whether to continue with the MIRT procedure or, as already described, quit the procedure and pursue solutions elsewhere.
- Frames
    - Brainstorm for analogies and conceptual solutions
        - The focus of this step should be to find analogies in which new conceptual solutions can be designed. Core question to ask in a brainstorm is: *"If the problem situation is approached as if it is …, then …* It is an advantage to have a diverse team during the brainstorm, with a combination of backgrounds and at least some with experience from other brainstorms. Finally, it is advised to have independent facilitators. Good facilitators will help with creating the optimal team for the brainstorm and generating analogies.
- Futures
    - Development of conceptual solutions & checking with stakeholders and experts

        - The conceptual solutions that are developed in the previous step should be developed further in order to make them viable for implementation. This should be done by inviting experts and stakeholders to give their opinion on the concepts. The experts might provide insight into the feasibility of solutions while the stakeholders are checking whether solutions are in line with their desired value. This is a way of 'future' thinking.
        - If it becomes clear that solutions do not entirely deliver the desired result one could go back to the previous step and make an iteration.
- Transformation
    - Adapting developed conceptual ideas
        - In this phase, specialists should be invited to develop conceptual solutions into more definitive solutions that can be applied in the existing situation. In this phase, various concepts can still exist in parallel and developed in parallel.
- Integration
    - Integration of all ideas in the definitive situation
        - In this phase, all solutions that are developed in parallel should be integrated into 1 working solution. This is also the moment to do all the necessary quality and functionality checks. After this phase, everything should be ready to continue to the 'preferred solution decision' and to make detailed designs.

7.2 Using the findings internationally

The result of this thesis is an analytical model with the factors that influence the infrastructure planning process. The comparison between the theoretical analytical model and the findings in the Dutch infrastructure planning lead to recommendations on how to implement the model. However, this does not mean that the model cannot be used in other countries, there has been concluded in the reflection of the model that the model could be used in other countries as well.

The findings can be used if one acknowledges the following:

- In the Netherlands, the legal and administrative systems aim to deal with problems proactively. This is mainly centrally coordinated. Thus, implementing the infrastructure planning system of the Netherlands could be harder if the system is more reactive and more decentralised.
- In the Netherlands, the distance between actors with and without power is small, which means that actors without power easily speak out to the actors with decision-power. When different, extra attention should be paid to overcoming this gap.
- If there is low uncertainty avoidance, it will be easier to implement the proposed model, since it is based upon the idea that problems are wicked, which implies that during a process a sufficient solution will be explored. If one aims to have certainty from the start of the process, it will be harder to implement the proposed model.
- A long-term orientated country is more suited to provide room for new and innovative solutions since these novel solutions do not have to prove their value straight away. If not, it will be harder to, finally, incorporate these novel solutions.


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8 Discussion

In this chapter, the results of this thesis will be discussed. First, there will be discussed to which fields the result contributes, followed by a discussion of the limitations of this research. Based on these limitations, suggestions will be made for further research.

The objective of this thesis was to study how premature convergence could be prevented and, related to that, how the solution space can be enlarged in infrastructure planning processes. As a result, an analytical model has been presented with the factors that influence the solution space in infrastructure planning processes. Secondly, a solution development process, that should be seen within the analytical model has been proposed for the national infrastructure planning process of the Netherlands.

8.1 The contribution of the result

The result contributes to science and society in various aspects, which will be discussed in this paragraph. First, there has been stated in the introduction, that premature convergence should be prevented. This statement is based on a study done by Hertogh & Westerveld (2010). They introduce and explain the idea of premature convergence and explain that this should be prevented in order to improve the level of integration of infrastructure planning processes and the solutions following from those processes. The need to improve integration in infrastructure planning processes is not only recognised by Hertogh & Westerveld (2010) but is seen by various other scholars as well (Busscher et al., 2014; Cantarelli, Flyvbjerg, van Wee, & Molin, 2010; Razaghi & Finger, 2018; Romero-Lankao, 2012; Winter & Szczepanek, 2008). Since the result of this thesis provides insight into how premature convergence should be prevented and thus how integration could be improved, the result contributes to the need expresses by the scholars in their studies.

Since the result of this thesis is to provide insight into how premature convergence could be prevented, which is automatically focussed on the early moments in infrastructure planning processes. The research provides insight as well in the organisation of the early moments of infrastructure planning processes. These early moments are sometimes referred to as the 'front-end phase' of infrastructure planning (Matinheikki, Artto, Peltokorpi, & Rajala, 2016; Nobelius & Trygg, 2002; Samset & Volden, 2016). Various studies state that research is needed to the organisation of these so-called 'front end phase' of infrastructure planning processes (Artto, Lehtonen, & Saranen, 2001; Busscher et al., 2014; Gil, Beckman, & Tommelein, 2008; Kim & Wilemon, 2002; Samset & Volden, 2016), which is one of the contributions of this thesis as well.

In this thesis, the Design approach, also known as 'Design Thinking' is proposed as a solution development process in the infrastructure planning process. According to various studies, the application of the Design approach in this context is new and not developed in much detail (Belton & Stewart, 2002; Ferretti & Gandino, 2018; Ferretti et al., 2018; Heeres et al., 2017; Joore & Brezet, 2015). This thesis contributes to building knowledge in this field.

8.2 Limitations of the research

The research done in this thesis is somewhat limited. These limitations are caused by the scope set in the introduction and the method that has been followed.

The literature research explained the concept of wicked problems, which is not necessarily only related to infrastructure planning. Wicked problems could be related to various kinds of (policy) problems for which the best problem-solution pair is unclear (Samset & Volden, 2016). Examples of these policy areas are: immigration; water planning; waste management; fishery and food production; housing (Candel & Pereira, 2017; Casarico, Facchini, & Frattini, 2015; Goti-Aralucea, 2017; J. C. Morris, 2017; Simatele, Dlamini, & Kubanza, 2017; Tan, Bowmer, & Baldwin, 2012; Walter & Holbrook, 2015). Because of the scope limitation, in which is explained that in this search only would be focused on the infrastructure context, these other policy fields are not researched. Thus, the findings of this research cannot be used in other policy areas without any research.

The Empirical research is narrowed down to the Netherlands. This is limiting the value of the findings since the analytical model is only tested in the specific situation of the Netherlands. This has been covered, partly, by a reflection on the model in which is explained how the legal, administrative and cultural differences of other countries influence the model. Furthermore, the scope is even limited to only researching the national infrastructure planning process of the Netherlands, which limits the value of the findings regarding the usability on other governmental levels.

A third limitation of this research is the number of interviewees that could be reached. As explained in the method the subject of this thesis is precarious since the civil servants working in the process are not always allowed to give information, since this information could influence the playing field of market organisations. During the research, it has been recognised that it was hard to reach people working at the Ministry that felt free to have an interview and provide information. This limited the validation of the analytical model in practice.

8.3 Recommendations for further research

Based on the conclusion and the discussion the following recommendations for further research are made. First, it is recommended to compare various solution development processes from European infrastructure planning processes to each other. By doing this, it must become clear how various solution development processes are shaped and whether factors should be added to the analytical model as presented in this thesis.

A second recommendation for further research is to search other policy areas, for example, the areas named in paragraph 8.2, for which the proposed design approach could be beneficial. Various policy areas can be determined as well as the common solution approaches. It might be interesting to understand how the design approach could contribute to those areas.

Finally, the MIRT procedure, and especially the solution development process could be compared to various other solution development processes that are exectued by regional or local governments. By comparing these, insight could be created in the way in which all Dutch infrastructure solutions are developed.


TU Delft

9 Bibliography

Alford, J., & Head, B. W. (2017). Wicked and less wicked problems: A typology and a contingency framework. *Policy and Society*, *36*(3), 397–413. https://doi.org/10.1080/14494035.2017.1361634

Arts, J., Hanekamp, T., Linssen, R., & Snippe, J. (2016). Benchmarking Integrated Infrastructure Planning Across Europe - Moving Forward to Vital Infrastructure Networks and Urban Regions. *Transportation Research Procedia*, *14*, 303–312. https://doi.org/10.1016/j.trpro.2016.05.024

Artto, K. A., Lehtonen, J. M., & Saranen, J. (2001). Managing projects front-end: Incorporating a strategic early view to project management with simulation. *International Journal of Project Management*, *19*(5), 255–264. https://doi.org/10.1016/S0263-7863(99)00082-4

Baccarini, D. (1996). The concept of project complexity - A review. *International Journal of Project Management*, *14*(4), 201–204. https://doi.org/10.1016/0263-7863(95)00093-3

Badke-Schaub, P., Frankenberger, E., & Birkhofer, H. (1998). *Designers. The key to successful product development*. *Journal of Experimental Psychology: General* (1st ed., Vol. 136). London: Springer London. Retrieved from http://video.yahoo.com/watch/111582/992708

Bakker, H., & de Kleijn, J. (2014). *Management of engineering projects - people are key*.

BAM, & Goudappel Coffeng. (2008). Breda - Utrecht: de vergeten corridor: visienota spoorverbinding.

Beck, K. (2000). Extreme programmaing explained: embrace chagne.

Belton, V., & Stewart, T. J. (2002). *Multiple criteria decision analysis: an integrated approach*. *Kluwer Academic Publishers*. https://doi.org/10.1017/CBO9781107415324.004

Biegelbauer, P., Lindloff, K., & Sager, F. (2017). Infrastructure Policy Between Regional Interests and Societal Goals, *3*(2), 212–225. https://doi.org/10.1002/epa2.1024

Boujut, J. F., & Léon, J. C. (2005). *Design process improvement*. *Design Process Improvement: A Review of Current Practice*. https://doi.org/10.1007/978-1-84628-061-0

Brady, T., Davies, A., & Gann, D. M. (2005). Creating value by delivering integrated solutions. *International Journal of Project Management*, *23*(5 SPEC. ISS.), 360–365. https://doi.org/10.1016/j.ijproman.2005.01.001

Bramley, G., & Gurran, N. (2017). *Urban Planning and the Housing Market: International Perspectives for Policy and Practice*.

Branke, J., Deb, K., Miettinen, K., & Slowinski, R. (2008). *Multiobjective optimization*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-88908-3-8

Broennum, L., & Clausen, C. (2013). Configuring the development space for conceptualization. In *International conference on engineering design* (pp. 1–10).

Bueren, E. M. Van, Klijn, E., & Koppenjan, J. (2003). Dealing with Wicked Problems in Networks : Analyzing an Environmental Debate from a Network Perspective. *Journal of Public Administration Research and Theory*, *13*(2), 193–212.

Busscher, T., Arts, J., & Tillema, T. (2014). *Towards a programme-oriented planning approach : linking strategies and projects for adaptive infrastructure planning*. Retrieved from https://www.rug.nl/research/portal/publications/pub(70e1580e-010a-46e1-b68d-4bfb017b46fe).html

Busscher, T., Tillema, T., & Arts, J. (2013). Revisiting a programmatic planning approach: Managing linkages between transport and land use planning. *Planning Theory and Practice*. Taylor & Francis. https://doi.org/10.1080/14649357.2013.845685

Candel, J. J. L., & Pereira, L. (2017). Towards integrated food policy: Main challenges and steps

ahead. *Environmental Science and Policy*, *73*(April), 89–92. https://doi.org/10.1016/j.envsci.2017.04.010

Cantarelli, C. C., Flyvbjerg, B., van Wee, B., & Molin, E. J. E. (2010). Lock-in and its influence on the project performance of large-scale transportation infrastructure projects: Investigating the way in which lock-in can emerge and affect cost overruns. *Environment and Planning B: Planning and Design*, *37*(5), 792–807. https://doi.org/10.1068/b36017

Casarico, A., Facchini, G., & Frattini, T. (2015). Illegal immigration: Policy perspectives and challenges. *CESifo Economic Studies*, *61*(3–4), 673–700. https://doi.org/10.1093/cesifo/ifv004

Comissie voor de milieueffectrapportage. (2013). *Milieueffectrapport Rotterdamsebaan*.

Convertino, M., & Valverde, L. J. (2013). Portfolio Decision Analysis Framework for Value-Focused Ecosystem Management. *PLoS ONE*, *8*(6). https://doi.org/10.1371/journal.pone.0065056

Crosby, B., Bloomberg, L., & Bryson, J. (2014). Public Value Governance: Moving Beyond Traditional Public Administration and the New Public Management. *Public Administration Review*, *74*(4), 445–456. https://doi.org/10.1111/puar.12238

Cross, N., Dorst, K., & Roozenburg, N. (1992). *Research in design thinking*. *Animal Genetics* (1st ed.). Delft: Delft University of Technology.

Daviter, F. (2017). Coping, taming or solving: alternative approaches to the governance of wicked problems. *Policy Studies*, *38*(6), 571–588. https://doi.org/10.1080/01442872.2017.1384543

de Bruijn, J. A., & Dicke, W. (2006). Strategies for safeguarding public values in liberalized utility sectors. *Public Administration*, *84*(3), 717–735. https://doi.org/10.1111/j.1467-9299.2006.00609.x

De Bruijn, J. A., & ten Heuvelhof, E. . F. (2012). *Management in networks: On multi-actor decision making*. *Management in Networks: On Multi-actor Decision Making*. https://doi.org/10.4324/9780203885666

de Bruijn, J. A., ten Heuvelhof, E. . F., & In't Veld, R. (2010). *Process management - Why project management fails in complex decision making processes* (second). https://doi.org/10.1007/978-3-642-13941-3

de Bruijn, J. A., & ten Heuvelhof, E. F. (1999). Scientific expertise in complex decision-making processes. *Science and Public Policy*, *26*(3), 179–184. https://doi.org/10.3152/147154399781782428

de Bruijn, J. A., & ten Heuvelhof, E. F. (2002). Policy analysis and decision making in a network: How to improve the quality of analysis and the impact on decision making. *Impact Assessment and Project Appraisal*, *20*(4), 232–242. https://doi.org/10.3152/147154602781766627

Decisio. (2010). *MKBA spoorlijn Breda – Utrecht*.

Decisio. (2014). *MKBA Ruit Eindhoven*.

Delft Hyperloop. (2018). Hyperloop explained. Retrieved September 23, 2018, from https://delfthyperloop.nl/nl/hyperloop

Deuten, J. J., & Rip, A. (2000). Narrative Infrastructure in Product Creation Processes. *Organization*, *7*(1), 69–93. https://doi.org/10.1177/135050840071005

Dorst, K. (1997). *Describing design - A comparison of paradigms*. Delft University of Technology. Retrieved from file:///C:/Users/Ibrahim/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/Unknown - Unknown - ide_dorst_19970908.PDF.pdf

Dorst, K. (2011). The core of "design thinking" and its application. *Design Studies*, *32*(6), 521–532. https://doi.org/10.1016/j.destud.2011.07.006

Dorst, K. (2015). *Frame innovation - create new thinking by design*. (K. Friedman & E. Stolterman, Eds.). The MIT press.

Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem-solution. *Design Studies*, *22*(5), 425–437. https://doi.org/10.1016/S0142-694X(01)00009-6

Elia, G., & Margherita, A. (2018). Can we solve wicked problems? A conceptual framework and a collective intelligence system to support problem analysis and solution design for complex social issues. *Technological Forecasting and Social Change*, *133*(October 2017), 279–286. https://doi.org/10.1016/j.techfore.2018.03.010

Elliott, C. S., & Hayward, D. M. (1998). The expanding definition of framing and its particular impact on economic experimentation. *Journal of Socio-Economics*, *27*(2), 229–243. https://doi.org/10.1016/S1053-5357(99)80086-9

Evbuomwan, N. F. O., Sivaloganathan, S., & Jebb, A. (1996). A Survey of Design Philosophies, Models, Methods and Systems. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *210*(4), 301–320. https://doi.org/10.1243/PIME_PROC_1996_210_123_02

Farrell, R., & Hooker, C. (2013). Design, science and wicked problems. *Design Studies*, *34*(6), 681–705. https://doi.org/10.1016/j.destud.2013.05.001

Ferretti, V. (2016). From stakeholders analysis to cognitive mapping and Multi-Attribute Value Theory: An integrated approach for policy support. *European Journal of Operational Research*, *253*(2), 524–541. https://doi.org/10.1016/j.ejor.2016.02.054

Ferretti, V., & Gandino, E. (2018). Co-designing the solution space for rural regeneration in a new World Heritage site: A Choice Experiments approach. *European Journal of Operational Research*, *268*(3), 1077–1091. https://doi.org/10.1016/j.ejor.2017.10.003

Ferretti, V., Pluchinotta, I., & Alexis, T. (2018). Studying the generation of alternatives in public policy making processes. *European Journal of Operational Research*, *273*(1), 353–363. https://doi.org/10.1016/j.ejor.2018.07.054

Flyvbjerg, B. (2007). Policy and planning for large-infrastructure projects: Problems, causes, cures. *Environment and Planning B: Planning and Design*, *34*(4), 578–597. https://doi.org/10.1068/b32111

Flyvbjerg, B., Ansar, A., Budzier, A., Buhl, S., Cantarelli, C. C., Garbuio, M., … van Wee, B. (2018). Five things you should know about cost overrun. *Transportation Research Part A*. https://doi.org/10.1016/j.tra.2018.07.013

Gann, D. (1997). Should governments fund construction research? *Building Research and Information*, *25*(5). https://doi.org/10.1080/096132197370228

Gassmann, O. (2006). Opening up the innovation process: towards an agenda. *Research and Design Management*, *16*(1), 14–17. https://doi.org/10.1049/em:20060102

Gemeente Den Haag. (2013). Aanbestedingsleidraad selectiefase De Rotterdamsebaan. Den Haag. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/66304/viewContent/748441/View

Gemeente Den Haag. (2015). Procesdossier ROTTERDAMSEBAAN (voormalig Trekvliettracé), RIS 135585, (november 2009), 1–23.

Gemeente Den Haag. (2017). *Nota zienswijzen ontwerp-omgevingsplan Binckhorst*.

Gemeente Eindhoven. (2014). Raadsinformatiebrief over standpunt college t.a.v. de Ruit.

Gestel, N. van, Koppenjan, J., Schrijver, I., Ven, A. van de, & Veeneman, W. (2010). Managing Public Values in Public-Private Networks: A Comparative Study of Innovative Public Infrastructure Projects. *Public Money and Management*, *28*(3), 139–145. Retrieved from http://www.tandfonline.com.ezproxy.lib.swin.edu.au/doi/abs/10.1111/j.1467-9302.2008.00635.x#.VPTsFC7QNWE

Gil, N., Beckman, S., & Tommelein, I. D. (2008). Upstream problem solving under uncertainty and

ambiguity: Evidence from airport expansion projects. *IEEE Transactions on Engineering Management*, *55*(3), 508–522. https://doi.org/10.1109/TEM.2008.922635

Goti-Aralucea, L. (2017). Assessing the social and economic impact of small scale fisheries management measures in a marine protected area with limited data. *Marine Policy*, (December 2016), 1–11. https://doi.org/10.1016/j.marpol.2017.10.039

Graat, J., & Rood, S. (2013). "Ruit" rond Eindhoven zonder tunnels | Brabant | bndestem.nl. Retrieved February 19, 2019, from https://www.bndestem.nl/brabant/ruit-rond-eindhoven-zonder-tunnels~aeb911b7/

Groot, P., Saitua, R., & Visser, N. (2016). *Investeren in de infrastructuur. Trends en beleidsuitdagingen*.

Haskins, T. C. (2009). Uncertainty, change management the application to risk & safety for infrastructure projects how it happens in Australia. *4th IET International Conference on Systems Safety 2009. Incorporating the SaRS Annual Conference*, *2009*(555 CP), P1–P1. https://doi.org/10.1049/cp.2009.1574

Haupt, G. (2015). Learning from experts: fostering extended thinking in the early phases of the design process. *International Journal of Technology and Design Education*, *25*(4), 483–520. https://doi.org/10.1007/s10798-014-9295-7

Heeres, N., & Arts, J. (2017). *Towards area-oriented approaches in infrastructure planning. Development of national highway networks in a local spatial context*. Rijksuniversiteit Groningen.

Heeres, N., Tillema, T., & Arts, J. (2016). Dealing with interrelatedness and fragmentation in road infrastructure planning: an analysis of integrated approaches throughout the planning process in the Netherlands. *Planning Theory & Practice*, *17*(3), 421–443. https://doi.org/10.1080/14649357.2016.1193888

Heeres, N., van Dijk, M., Arts, J., & Tillema, T. (2017). Coping with interrelatedness and fragmentation at the infrastructure/land-use interface: The potential merits of a design approach. *Journal of Transport and Land Use*, *10*(1), 409–435. https://doi.org/10.5198/jtlu.2016.883

Heineke, K., Kampshoff, P., Mkrtchyan, A., & Shao, E. (2017). Self-driving car technology: When will the robots hit the road? *McKinsey&Company*, 1–11. Retrieved from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/self-driving-car-technology-when-will-the-robots-hit-the-road#0

Hekkert, P., & van Dijk, M. (2011). *Vision in Design - a guidebook for innovators* (1st ed.). BIS Publishers.

Hermans, M., Volker, L., & Eisma, P. (2014). A public commissioning maturity model for construction clients. *Proceedings 30th Annual Association of Researchers in Construction Management Conference, ARCOM 2014*, (September), 1305–1314. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84911428735&partnerID=40&md5=dd052b689a039a7ad8d5b2545a2b389a

Hertogh, M., & Westerveld, E. (2010). Playing With Complexity. Management and Organisation of Large Infrastructure Projects. *World*, 377. https://doi.org/10.4028/www.scientific.net/AMM.397-400.1681

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75–105. https://doi.org/10.2307/25148869

Hjelmbrekke, H., Klakegg, O. J., & Lohne, J. (2017). Governing value creation in construction project: a new model. *International Journal of Managing Projects in Business*, *10*(1), 60–83. https://doi.org/10.1108/IJMPB-12-2015-0116

Hobma, F. A. M., & Jong, P. (2016). *Planning and development law in the Netherlands*. IBR instituut voor bouwrecht.

Hofstede, G., & Bond, M. H. (1984). Hofstede's culture dimensions: an independent validation using rokeach's value survey. https://doi.org/10.1177/0022002184015004003

Hofstede, G., Jan Hofstede, G., & Minkov, M. (2010). *Cultures and Organizations*. *Cultures and Organizations* (3rd ed.). McGraw Hill. https://doi.org/10.1007/s11569-007-0005-8

IBO Werkgroep Flexibiliteit in de infrastructurele planning. (2016). *IBO Flexibiliteit in de infrastructurele planning*. Retrieved from https://www.rijksoverheid.nl/documenten/rapporten/2016/09/20/kabinetsreactie-ibo-flexibiliteit-in-infrastructurele-planning

IPCC. (2014). *Climate change 2013 - The physical basis - summary for policy makers*. (Intergovernmental Panel on Climate Change, Ed.). Cambridge University Press. https://doi.org/10.1017/CBO9781107415324.004.

Janssen, R., Graaf, R. de, Smit, M., & Voordijk, H. (2016). Why local governments rarely use PPPs in their road development projects: Understanding the barriers. *International Journal of Managing Projects in Business*, *9*(1), 33–52. https://doi.org/10.1108/IJMPB-06-2015-0043

Joore, P., & Brezet, H. (2015). A Multilevel Design Model: The mutual relationship between product-service system development and societal change processes. *Journal of Cleaner Production*, *97*, 92–105. https://doi.org/10.1016/j.jclepro.2014.06.043

Kamarudin, K. M., Ridgway, K., & Hassan, M. R. (2016). Modelling Constraints in the Conceptual Design Process with TRIZ and F3. *Procedia CIRP*, *39*, 3–8. https://doi.org/10.1016/j.procir.2016.01.034

Kang, J. E., & Chen, A. (2016). Constructing the feasible space–time region of the Household Activity Pattern Problem. *Transportmetrica A: Transport Science*, *12*(7), 591–611. https://doi.org/10.1080/23249935.2016.1189708

Kasper, E. (2015). *A definition for infrastructure - characteristics and their impact on firms active in infrastructure*. Technische Universität München.

Kessler, A. (2007). Weekend Interview with Facebook's Mark Zuckerberg. Retrieved July 27, 2018, from http://www.andykessler.com/andy_kessler/2007/03/wsj_weekend_int.html

Kilian, A. (2006). Design Innovation through Constraint Modeling. *International Journal of Architectural Computing*, *4*(1), 87–105. https://doi.org/10.1260/147807706777008993

Kim, J., & Wilemon, D. (2002). Focusing the fuzzy front-end in new product development. *R and D Management*, *32*(4), 269–279. https://doi.org/10.1111/1467-9310.00259

Koops, L., Coman, L., Bosch-Rekveldt, M., Hertogh, M., & Bakker, H. (2015). Public Perspectives on Project Success – Influenced by National Culture? *Procedia - Social and Behavioral Sciences*, *194*(October 2014), 115–124. https://doi.org/10.1016/j.sbspro.2015.06.126

Koppenjan, J., Charles, M. B., & Ryan, N. (2010). Editorial: Managing Competing Public Values in Public Infrastructure Projects. *Public Money & Management*, *28*(3), 131–134. https://doi.org/10.1111/j.1467-9302.2008.00632.x

Lawson, B., & Dorst, K. (2009). *Understanding Design*. *Design Expertise*.

Leffingwell, D., & Widrig, D. (1999). *Managing Software Requirements* (1st ed., Vol. 10). Addison Wesley. https://doi.org/10.1002/spip.383

Leiringer, R. (2006). Technological innovation in PPPs: Incentives, opportunities and actions. *Construction Management and Economics*, *24*(3), 301–308. https://doi.org/10.1080/01446190500435028

Leppink, M. (2017). *Op het goede spoor?* Erasmus University Rotterdam.

Lockwood, M. (2010, February 8). Solar change and climate: An update in the light of the current exceptional solar minimum. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*. https://doi.org/10.1098/rspa.2009.0519

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*(4), 251–266.

Massey, D. (2017). Five Key Challenges for Urban Policy and Planning in Europe : Retrospect and Prospect. *The Planning Review*, *3625*. https://doi.org/10.1080/02513625.2017.1341115

Matinheikki, J., Artto, K., Peltokorpi, A., & Rajala, R. (2016). Managing inter-organizational networks for value creation in the front-end of projects. *International Journal of Project Management*, *34*(7), 1226–1241. https://doi.org/10.1016/j.ijproman.2016.06.003

McKinsey Global Institute. (2017). Reinventing Construction: A Route To Higher Productivity. *McKinsey & Company*, (February), 168. Retrieved from http://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/reinventing-construction-through-a-productivity-revolution

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2009). Gedragscode openbaar bestuur | Kwaliteit en integriteit overheidsinstanties | Rijksoverheid.nl. Retrieved November 3, 2018, from https://www.rijksoverheid.nl/onderwerpen/kwaliteit-en-integriteit-overheidsinstanties/gedragscode-openbaar-bestuur

Ministerie van Infrastructuur en Milieu. (2014). *Toolkit MIRT-onderzoeken*.

Ministerie van Infrastructuur en Milieu. (2016a). Rijksstructuurvisie Amsterdam – Almere – Markermeer, (September), 12. Retrieved from https://www.rijksoverheid.nl/regering/bewindspersonen/melanie-schultz-van-haegen-maas-geesteranus/documenten/rapporten/2016/11/21/voortgangsrapportage-2016-rijksstructuurvisie-amsterdam-almere-markermeer

Ministerie van Infrastructuur en Milieu. (2016b). *Spelregels van het Meerjarenprogramma Infrastructuur, Ruimte en Transport (MIRT)*.

Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken, & Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2018). *MIRT Overzicht 2018*. Retrieved from https://www.mirtoverzicht.nl/documenten/publicaties/2017/09/19/mirt-2018

Ministerie van Infrastructuur en Waterstaat. (2007). Afsprakenlijst bestuurlijk overleg MIRT 2007.

Ministerie van Infrastructuur en Waterstaat. (2008a). Afsprakenlijst bestuurlijk overleg MIRT najaar 2008.

Ministerie van Infrastructuur en Waterstaat. (2008b). Afsprakenlijst bestuurlijk overleg MIRT voorjaar 2008.

Ministerie van Infrastructuur en Waterstaat. (2009a). Afsprakenlijst bestuurlijk overleg MIRT najaar 2009.

Ministerie van Infrastructuur en Waterstaat. (2009b). Afsprakenlijst bestuurlijk overleg MIRT voorjaar 2009.

Ministerie van Infrastructuur en Waterstaat. (2010a). Afsprakenlijst bestuurlijk overleg MIRT najaar 2010.

Ministerie van Infrastructuur en Waterstaat. (2010b). Afsprakenlijst bestuurlijk overleg MIRT voorjaar 2010.

Ministerie van Infrastructuur en Waterstaat. (2010c). Projectblad ruit Eindhoven MIRT 2010.

Ministerie van Infrastructuur en Waterstaat. (2011a). Afsprakenlijst bestuurlijk overleg MIRT najaar 2011.

Ministerie van Infrastructuur en Waterstaat. (2011b). Afsprakenlijst bestuurlijk overleg MIRT

voorjaar 2011.

Ministerie van Infrastructuur en Waterstaat. (2011c). Projectblad Rotterdamsebaan MIRT 2011.

Ministerie van Infrastructuur en Waterstaat. (2012a). Afsprakenlijst bestuurlijk overleg MIRT najaar 2012.

Ministerie van Infrastructuur en Waterstaat. (2012b). Projectblad RRAAM MIRT 2012.

Ministerie van Infrastructuur en Waterstaat. (2013a). Afsprakenlijst bestuurlijk overleg MIRT 2013.

Ministerie van Infrastructuur en Waterstaat. (2013b). Afsprakenlijst bestuurlijk overleg MIRT 2013 (Deel 2).

Ministerie van Infrastructuur en Waterstaat. (2013c). Projectblad RRAAM MIRT 2013.

Ministerie van Infrastructuur en Waterstaat. (2013d). Projectblad ruit Eindhoven MIRT 2013.

Ministerie van Infrastructuur en Waterstaat. (2014a). Afsprakenlijst bestuurlijk overleg MIRT 2014.

Ministerie van Infrastructuur en Waterstaat. (2014b). Projectblad RRAAM MIRT 2014.

Ministerie van Infrastructuur en Waterstaat. (2014c). Projectblad ruit Eindhoven MIRT 2014.

Ministerie van Infrastructuur en Waterstaat. (2015). Afsprakenlijst bestuurlijk overleg MIRT 2015.

Ministerie van Infrastructuur en Waterstaat. (2016). Afsprakenlijst bestuurlijk overleg MIRT 2016.

Ministerie van Infrastructuur en Waterstaat. (2017). Afsprakenlijst bestuurlijk overleg MIRT 2017.

Ministerie van Infrastructuur en Waterstaat. (2018). Afsprakenlijst bestuurlijk overleg MIRT voorjaar 2018.

Ministerie van Verkeer en Waterstaat. (2008). *MIRT Verkenning Zuidoostvleugel BrabantStad*.

Ministerie van Verkeer en Waterstaat, & Ministerie van Volkshuisvesting, R. O. en M. (2009). Spelregels van het meerjarenprogramma infrastructuur, ruimte en transport.

Mintrom, M., & Luetjens, J. (2016). Design Thinking in Policymaking Processes: Opportunities and Challenges. *Australian Journal of Public Administration*, *75*(3), 391–402. https://doi.org/10.1111/1467-8500.12211

Morris, J. C. (2017). Planning for Water Infrastructure: Challenges and Opportunities. *Public Works Management and Policy*, *22*(1), 24–30. https://doi.org/10.1177/1087724X16668182

Morris, P. W. G. (2013). *Reconstructing project management*. John Wiley & Sons, Ltd.

Newman, P. W. (2015). Transport infrastructure and sustainability: a new planning and assessment framework. *Smart and Sustainable Built Environment*, *4*(2), 140–153. https://doi.org/10.1108/SASBE-05-2015-0009

Newman, P. W., & Thornley, A. (1996). *Urban Planning in Europe: International Competition, National Systems and Planning Projects*. London: Routeledge.

Nicholas, J. M., & Steyn, H. (2017). *Project management for engineering business and technology* (5th ed.). Routledge.

Nieuwenhuizen, C. van. (2007). *BrabantStad Bereikbaar JJaarverslag 2007*.

Nobelius, D., & Trygg, L. (2002). Stop chasing the Front End process — management of the early phases in product development projects. *International Journal of Product Management*, *20*, 331–340. https://doi.org/10.1016/S0263-7863(01)00030-8

Oreskes, N. (2004, December 3). Beyond the Ivory Tower: The scientific consensus on climatic change. *Science*. https://doi.org/10.1126/science.1103618

Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (2007). *Engineering design: a systematic approach* (2nd ed.). https://doi.org/10.1007/978-1-84628-319-2

Pohl, K., & Rupp, C. (2015). *Requirements Engineering Fundamentals*. (M. Barabas, Ed.) (2nd ed.). Santa Barbara: Rocky Nook Inc.

Polya, G. (1957). *How to solve it: a new aspect of mathematical method* (2nd ed.). Princeton University Press.

Programmateam SmartwayZ.nl. (2017). Smartwayz.nl 1e voortgangsrapportage.

Ralph, P., & Wand, Y. (2007). A proposal for a formal definition of the design concept. In *Design requirements engineering: a ten-year perspective*. Springer Berlin Heiderberg New York.

Razaghi, M., & Finger, M. (2018). Smart Governance for Smart Cities. *Proceedings of the IEEE*, *106*(4), 680–689. https://doi.org/10.1109/JPROC.2018.2807784

Reimer, M., Getimis, P., & Blotevogel, H. (2014). *Spatial planning systems and practices in Europe: A comparitive perspective on continuity and changes*. Routeledge.

Rijksoverheid. (1993). Wet Infrastructuurfonds. Retrieved from https://wetten.overheid.nl/BWBR0006001/2018-01-01#Artikel4

Rijksoverheid. (2011). Deltawet waterveiligheid en zoetwatervoorziening. Retrieved from https://wetten.overheid.nl/BWBR0030836/2012-01-01

Rijkswaterstaat. (2010). *Handreiking MIRT-verkenning*.

Rijkswaterstaat. (2017a). Homepage English | Rijkswaterstaat. Retrieved September 8, 2018, from https://www.rijkswaterstaat.nl/english/index.aspx

Rijkswaterstaat. (2017b). *MIRT en m.e.r., verkenning en planuitwerking*.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. https://doi.org/10.1007/BF01405730

Roberts, N. (2012). SOF as Designers, 120–140.

Roberts, N. (2018). Wicked Problem Territory and the Design Strategy, 1–42.

Roggema, R., Kabat, P., & van den Dobbelsteen, A. (2012). Towards a spatial planning framework for climate adaptation. *Smart and Sustainable Built Environment*, *1*(1), 29–58. https://doi.org/10.1108/20466091211227043

Romero-Lankao, P. (2012). Governing Carbon and Climate in the Cities: An Overview of Policy and Planning Challenges and Options. *European Planning Studies*, *20*(1), 7–26. https://doi.org/10.1080/09654313.2011.638496

Samset, K. (2014). To which extent do projects explore the opportunity space? *International Journal of Managing Projects in Business*.

Samset, K., & Volden, G. H. (2016). Front-end definition of projects: Ten paradoxes and some reflections regarding project management and project governance. *International Journal of Project Management*, *34*(2), 297–313. https://doi.org/10.1016/j.ijproman.2015.01.014

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2012). *Research Methods for Business Students* (6th ed.). Retrieved from https://books.google.co.uk/books?id=u4ybBgAAQBAJ

Savelberg, F., & van Mourik, H. (2008). *Breda - Utrecht uitgerekend - Audit over de vervoerwaarde van een nieuwe spoorlijn*.

Schlattau, M. (2015). Global Competitiveness Index. Retrieved from http://reports.weforum.org/global-competitiveness-index-2017-2018/countryeconomy-profiles/#economy=NLD

Seaden, G., & Manseau, A. (2001). Public policy and construction innovation. *Building Research and Information*, *29*(3), 182–196. https://doi.org/10.1080/09613210010027701

Simatele, D. M., Dlamini, S., & Kubanza, N. S. (2017). From informality to formality: Perspectives on the challenges of integrating solid waste management into the urban development and planning policy in Johannesburg, South Africa. *Habitat International*, *63*, 122–130. https://doi.org/10.1016/j.habitatint.2017.03.018

Simon, H. A. (1996). *The sciences of the artificial* (3rd ed.). MIT press Cambridge.

Stacho, J. (2001). Introduction to Operations Research, 2001.

Storvang, P., & Clarke, A. H. (2014). How to create a space for stakeholders' involvement in construction. *Construction Management and Economics*, *32*(12), 1166–1182. https://doi.org/10.1080/01446193.2014.966732

Sui Pheng, L., & Yuquan, S. (2002). An exploratory study of Hofstede's cross-cultural dimensions in construction projects. *Management Decision*, *40*(1), 7–16. https://doi.org/10.1108/00251740210423036

Szulczewska, B., Giedych, R., & Maksymiuk, G. (2017). Can we face the challenge: how to implement a theoretical concept of green infrastructure into planning practice? Warsaw case study. *Landscape Research*, *42*(2), 176–194. https://doi.org/10.1080/01426397.2016.1240764

Tan, P. L., Bowmer, K. H., & Baldwin, C. (2012). Continued challenges in the policy and legal framework for collaborative water planning. *Journal of Hydrology*, *474*, 84–91. https://doi.org/10.1016/j.jhydrol.2012.02.021

Te Brömmelstroet, M., & Bertolini, L. (2010). Integrating land use and transport knowledge in strategy-making. *Transportation*, *37*(1), 85–104. https://doi.org/10.1007/s11116-009-9221-0

Teisman, G. R. (2000). Models for Research into Decision-Making Processes: On Phases, Streams and Decison-Making Rounds. *Public Administration*, *78*(4), 937–956. https://doi.org/10.1111/1467-9299.00238

United Nations. (2017). World Population Prospects The 2017 Revision Key Findings and Advance Tables. *World Population Prospects The 2017*, 1–46. https://doi.org/10.1017/CBO9781107415324.004

United Nations. (2018). 2018 Revision of World Urbanization Prospects | Multimedia Library - United Nations Department of Economic and Social Affairs. *2018 Revision of World Urbanization Prospects | Multimedia Library - United Nations Department of Economic and Social Affairs*. Retrieved from https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html

van Heffen, O., & Klok, P. J. (2000). Institionalism: State Models and Policy Processes. *Governance in Modern Society: Effects, Change and Formation of Government Institutions*, (1), 153–177.

van Wee, B., Annema, J. A., & Banister, D. (2012). *The Transport System and Transport Policy: An Introduction*. Edward Elgar Publishing.

Wallenius, J., Dyer, J. S., Fishburn, P. C., Steuer, R. E., Zionts, S., & Deb, K. (2008). Multiple Criteria Decision Making, Multiattribute Utility Theory: Recent Accomplishments and What Lies Ahead. *Management Science*, *54*(7), 1336–1349. https://doi.org/10.1287/mnsc.1070.0838

Walter, J., & Holbrook, C. (2015). Housing in a Federation: From Wicked Problem to Complexity Cascade? *Australian Journal of Public Administration*, *74*(4), 448–466. https://doi.org/10.1111/1467-8500.12174

Wang, Y., Monzon, A., Ciommo, F., & Kaplan, S. (2014). Integrated Transport Planning Framework Involving Combined Utility Regret Approach. *Transportation Research Record: Journal of the Transportation Research Board*, *2429*, 59–66. https://doi.org/10.3141/2429-07

Wenngren, J., Ericson, Å., & Holmqvist, J. (2014). Framing and Reframing – The Emergence of Design Constraints. *Proceedings of the Biannual NordDesign Conference (NordDesign'14)*, 500–509.

Westrik, J. (2002). *Urban Design Methods*. *Ways to study and research*.

Willems, M. (2014). Meerderheid Kamer wil geen geld voor 'Ruit om Eindhoven' - NRC. Retrieved February 19, 2019, from https://www.nrc.nl/nieuws/2014/11/27/meerderheid-kamer-wil-geen-geld-voor-ruit-om-eindhoven-a1420726

Williams, P. J., & Williams, A. M. (2016). Sustainability and planning law in Australia: achievements and challenges. *International Journal of Law in the Built Environment*, *8*(3), 226–242.

https://doi.org/10.1108/IJLBE-06-2016-0008

Williams, T., & Samset, K. (2010). Issues in Front-End Decision Making on Projects. *Project Management Institute*, *17*(1), 38–49. https://doi.org/10.1002/pmj.20160

Winter, M., & Szczepanek, T. (2008). Projects and programmes as value creation processes: A new perspective and some practical implications. *International Journal of Project Management*, *26*(1), 95–103. https://doi.org/10.1016/j.ijproman.2007.08.015

Withanaarachchi, J., & Setunge, S. (2014). Decision making on transport network planning and the impact on community, economy and the environment. *Procedia Economics and Finance*, *18*(September), 882–891. https://doi.org/10.1016/S2212-5671(14)01014-4

World Economic Forum. (2017). *The Global Competitiveness Report*. https://doi.org/92-95044-35-5

Wu, M.-Y. (2006). Hofstede's Cultural Dimensions 30 Years Later: A Study of Taiwan and the United States. *Intercultural Communication Studies*, *18*(1), 33–42. https://doi.org/10.5539/ijbm.v6n5p93

Wynn, D. C., & Clarkson, P. J. (2018). Process models in design and development. *Research in Engineering Design*, *29*(2), 161–202. https://doi.org/10.1007/s00163-017-0262-7

Wynn, D. C., & Eckert, C. M. (2017). *Perspectives on iteration in design and development*. *Research in Engineering Design* (Vol. 28). Springer London. https://doi.org/10.1007/s00163-016-0226-3

Yearworth, M. (2016). Sustainability as a 'super-wicked' problem; opportunities and limits for engineering methodology. *Intelligent Buildings International*, *8*(1), 37–47. https://doi.org/10.1080/17508975.2015.1109789

Zeitschrift, A., Link, P., Dienst, E., & Eth, E. (2014). Climate Change 2013 - The Physical Science Basis. https://doi.org/10.1017/CBO9781107415324

Zerjav, V. (2015). Design boundary dynamics in infrastructure projects: Issues of resource allocation, path dependency and problem-solving. *International Journal of Project Management*, *33*(8), 1768–1779. https://doi.org/10.1016/j.ijproman.2015.09.009