Infrastructure Interaction
Improving Regional Master Planning of Infrastructure by taking into account Infrastructure Interaction

Master Thesis Wouter K. Meyers

March 2008

FACULTY OF TECHNOLOGY, POLICY AND MANAGEMENT
ENGINEERING AND POLICY ANALYSIS MSc
DELFT UNIVERSITY OF TECHNOLOGY
Infrastructure Interaction
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Dedicated to my parents
Preface

This thesis is the product of my graduation project at the Delft University of Technology in the master of Engineering & Policy Analysis and a visiting researcher at the Queensland University of Technology in Brisbane, Australia. The research has been funded by the CIBE project under the CRC for Construction Innovation.

As a student and as a person I have always had a very broad interest, sometimes finding it difficult to make choices. In the thesis this part of my personality is reflected in the broad focus on infrastructure. Of course writing a thesis without making choices is impossible; one would end up with an encyclopedia. The choices I have made for my thesis, from delineating the scope of the project, to specifying the important concepts from the thesis and the people to interview, have coincided with important choices on where I want to take my life in the future. I like to think that the interaction between these choices has created positive effects in both end products: the thesis and my life.

I would like to take the opportunity here to thank the people that have contributed to my research in one way or another. First of all I would like to thank my main supervisors Gerard Dijkema in the Netherlands and Craig Furneaux in Australia for sharing with me their insights in how I could improve my research and for spurring me on when things seemed to stall. I would also like to thank my second supervisor in the Netherlands, Martin de Jong. His insight in how strategic planning is actually done was invaluable in the later stages of my research and has had a positive influence on the thesis. Also, many thanks to my professors Margot Weijnen in the Netherlands and Kerry Brown in Australia for their enthusiasm in getting me to the other side of the world and for their insights in making this a better work of science.

Thanks to Gejan Meyers, Adriana Diaz Arias, Asti Mardiasmo and Anish Patil for proof reading the drafts of this thesis. Without their invaluable comments the final thesis would never have reached this level of quality.

I would also like to thank CIBE, the TBM-Buitenlandfonds, the DUT CvB-Fonds and the DUT STIR-fonds for their financial help in making this project a reality.

Gejan and Margriet, thank you for all the different kinds of support you gave me during this important phase of my studies. Thank you for keeping faith while August became September, September became December and December eventually turned into April.

I would like to thank Laxman Samtani for introducing me to the nightlife of Brisbane, for being a really good friend and for sharing almost everything with me during my stay. Asti Mardiasmo introduced me to the ‘daylife’ of Brisbane, and its culinary highlights and deserves nothing but praise for that. To others it must have seemed like we couldn’t get along, but we know better! Rob Kivits was my Dutch mate in Australia. Thank you for all the good times we had, I hope your new life in Brisbane will be a grand success! To all the other people I met in Brisbane, too numerous to mention individually: thank you for making my stay worthwhile.

I would like to thank Dimos, Benny and Arnoud, my three best friends, for being just that, and for challenging and motivating me every time to be a better person.

To all my other Dutch friends and international friends: sorry for not showing my face that much for a couple of months, I’ll make it up to you, I promise!

Finally, I need to thank Aris, my new roommate, for cooking for me for 2 months while I was finishing my thesis and for good discussions and stupid shows to distract me from working on this report.

Delft, March 2008

Wouter Meyers
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Executive Summary

South East Queensland (SEQ) is the fastest growing region in Australia. To manage this growth the Queensland government has created the Office of Urban Management (OUM). The OUM delivered an infrastructure program of AUS$ 80 billion. In order to manage this it is important for the OUM to take into account the interactions that can emerge between infrastructures. Therefore the central question of the research presented in this report is: “how can the Office of Urban Management improve the infrastructure master planning process in South East Queensland to better take into account the interactions between infrastructures?”

To answer this question first a framework was created for the analysis of infrastructure interaction in the Regional Master Planning of Infrastructure. The final framework is presented in Table 1, the initial framework can be found there by disregarding the bold items. This framework was used to analyze the planning process in South East Queensland and in the Perth Metropolitan Region.

The analysis of the cases led to a few changes in the framework (bold in Table 1). The conclusion for SEQ is that the OUM needs to take an active role in engaging more stakeholders (including utilities and local government) in the planning process and involve itself more in the planning efforts of individual stakeholders to come to a truly integrated planning effort. Additional challenges for SEQ are the involvement of utilities and local government and various institutional problems. Recommendation for future research are gaining more fine grained insight in the framework and the way utilities can be involved in the master planning process.

Table 1 Framework for the analysis of Infrastructure Interaction in the Regional Master Planning of Infrastructure. Bold items were added as a result of the case study results.

<table>
<thead>
<tr>
<th>Process Requirements</th>
<th>Content Requirements</th>
</tr>
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<tbody>
<tr>
<td>• Involves the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water</td>
<td>Resource Effects of Interaction</td>
</tr>
<tr>
<td>• A focus on planning of a region with the region as a holistic entity and taking into account both public and private planning, <strong>while taking into account the local and national context</strong></td>
<td>• Save or cost space</td>
</tr>
<tr>
<td>• Sets the development objectives of a region and defines the long term program of projects to reach these goals</td>
<td>• Save or cost money</td>
</tr>
<tr>
<td>• Planning is used as strategic programming</td>
<td>• Save or cost materials</td>
</tr>
<tr>
<td>• Plans are used as a communication method and as a way to control internal and external stakeholders</td>
<td>• Save or cost time</td>
</tr>
<tr>
<td>• Planners work to find strategy, analyze strategy and are catalysts for future thinking</td>
<td>• <strong>Positive or negative social impact</strong></td>
</tr>
<tr>
<td>• The planning process takes a network approach to decision making</td>
<td>Functionality Effects of Interaction</td>
</tr>
<tr>
<td>• There is a focus on interaction in the planning process.</td>
<td>• Increase or decrease safety</td>
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<td></td>
<td>• Increase or decrease throughput</td>
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<td></td>
<td>• Increase or decrease quality</td>
</tr>
<tr>
<td></td>
<td>• Increase or decrease waste</td>
</tr>
<tr>
<td></td>
<td>Types of Interactions to take into account:</td>
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<tr>
<td></td>
<td>• Dependence interaction</td>
</tr>
<tr>
<td></td>
<td>• Environmental interaction</td>
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<td></td>
<td>• Institutional interaction</td>
</tr>
<tr>
<td></td>
<td>• Multi-actor interaction</td>
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<tr>
<td></td>
<td>• Spatial interaction</td>
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<td></td>
<td>• Technological interaction</td>
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<tr>
<td></td>
<td><strong>Spatial Interaction</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Technological Interaction</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total Resource use in a Region</strong></td>
</tr>
</tbody>
</table>
**List of Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>BCC</td>
<td>Brisbane City Council</td>
</tr>
<tr>
<td>CBD</td>
<td>Central Business District</td>
</tr>
<tr>
<td>D &amp; C</td>
<td>Design and Construct</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Planning and Infrastructure (Western Australia)</td>
</tr>
<tr>
<td>LGMS</td>
<td>Local Growth Management Strategy (Queensland)</td>
</tr>
<tr>
<td>MDP</td>
<td>Metropolitan Development Plan</td>
</tr>
<tr>
<td>MPB</td>
<td>Master Planning, Programming, Budgeting,</td>
</tr>
<tr>
<td>MRS</td>
<td>Metropolitan Region Scheme</td>
</tr>
<tr>
<td>NGI</td>
<td>Next Generation Infrastructures (Foundation)</td>
</tr>
<tr>
<td>NMR</td>
<td>New MetroRail (Western Australia)</td>
</tr>
<tr>
<td>NSBT</td>
<td>North-South Bypass Tunnel</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OUM</td>
<td>Office of Urban Management (Queensland)</td>
</tr>
<tr>
<td>PMO</td>
<td>Program Management Office (Queensland)</td>
</tr>
<tr>
<td>PPP</td>
<td>Public Private Partnership</td>
</tr>
<tr>
<td>PUP</td>
<td>Public Utility Plant</td>
</tr>
<tr>
<td>QR</td>
<td>Queensland Rail</td>
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<tr>
<td>QT</td>
<td>Queensland Transport</td>
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<tr>
<td>RCM</td>
<td>RiverCity Motorway Ltd (Queensland)</td>
</tr>
<tr>
<td>SEQ</td>
<td>South East Queensland</td>
</tr>
<tr>
<td>SEQIPP</td>
<td>South East Queensland Infrastructure Plan and Program</td>
</tr>
<tr>
<td>TBM</td>
<td>Tunnel Boring Machine</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>WAPC</td>
<td>Western Australian Planning Commission</td>
</tr>
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</table>
1 Introduction

"Why would we need a light rail station next to our hospital?", asked the project manager in charge of building the new Gold Coast hospital. "Doctor's don't take the train to work". The representative from the Office of Urban Management sighed "yes, but what about the nurses, cleaners and all the other people? They take the train to work." It was going to be a long meeting. It just seemed that the hospital people weren’t interested in an integrated infrastructure solution for their hospital. A light rail station close to the hospital would be ideal to complement the road that was planned there and would help the government to reach its public transport targets. "What’s more important", continued the hospital's project manager, "why is it that the road to our hospital is only going to be constructed in 5 years?"

This very short story introduces many of the problems that arise when taking into account the interactions between infrastructures early in the planning process. Different stakeholders have different goals. The timing of different projects does not match. How can the master planning process be structures to allow the interactions between infrastructures to be taken into account? That is a question that will be answered in this thesis.

Infrastructure is an important instrument for governments to shape and steer the development of a region. By providing infrastructure in certain places and not in others the development of a region can be directed. Infrastructure master planning of a region can help in achieving regional development goals. However, if a regional infrastructure master planning effort does not take into account the interactions between different infrastructures this can lead to increased costs and time in the delivery of the planned infrastructure. Interactions like this can range from the timing of related projects to co-locating infrastructure; they can be interactions in the physical network, the stakeholder network and the institutional framework surrounding these two subsystems. Often these mistakes have to do with parallel developments in the same region that come from different government departments. These unintentional interactions between infrastructures often cause considerable avoidable costs. It would be even more preferable if interactions between infrastructures were taken into account during the master planning process to achieve intentional interactions that save cost, resources and time, or improve the quality of the delivered infrastructures.

In this line of thinking, the South East Queensland Regional Plan (SEQ Regional Plan or Regional Plan) and South East Queensland Infrastructure Plan and Program (SEQIPP, pronounced See-kwip) have been created as two related master plans funded by the state government of Queensland, Australia to provide a growth strategy for South East Queensland and identify and plan for the needed infrastructure to achieve this strategy. What is special about the SEQIPP is that it includes all the plans for different types of infrastructure (transport, energy, water and telecommunications) in one document. The Queensland government has created the Office of Urban Management (OUM), to coordinate the creation of the SEQIPP. One of the main problems that the OUM deals with is the interactions between different infrastructures. The OUM is uncertain how to best deal with these interactions.

The central question of the research presented in this report is: “how can the Office of Urban Management improve the infrastructure master planning process in South East Queensland to better take into account the interactions between infrastructures?”

The research starts with a literature study on infrastructure master planning and infrastructure interaction to find an analytical framework from which the activities of the OUM can be assessed. The empirical part of the research focuses on three case studies, two within South East Queensland and one in Perth. While the two cases in SEQ provide a good view of the infrastructure master planning in South East Queensland, the case study in Perth shows a different form of planning that can be used as a contrast to the SEQ case studies in order to enrich the analysis. The results from the case studies are contrasted with the analytical framework to find strengths and weaknesses in the activities of the OUM, additionally the opportunities and threats
to the activities of the OUM are also identified. Finally, this analysis leads to suggested policies for the OUM to deal with the identified issues. Additionally, the case studies are used to test and refine the theoretical framework that was created to analyze these cases.

In the next chapter the background of the problem is explored in more detail, furthermore the methodology of the research is specified. Chapter 3 contains a review of relevant literature, which results in an analytical framework for the analysis of interactions between infrastructures in the master planning process. In chapters 4 the set up of the case studies is described, also the different case studies are introduced, including the rationale for choosing them. Chapter 5 and 6 present the South East Queensland and Perth Metropolitan Region case study respectively. In Chapter 7 the conclusions and recommendations from the work are presented. The results of the case studies are discussed. From that the main lessons for the framework are distilled and possible policy measures for South East Queensland are presented. The chapter also provides an evaluation of the research and closes with recommendations for future research.
2 Problem Exploration and Research Methodology

2.1 Introduction
In this chapter the problem sketched in the introduction is further explored and a methodology is specified for finding a solution to the outlined problem. First the problem description is extended in Section 2.2. This leads to a set of research questions presented in Section 2.3. Subsequently, the methodology of the research is presented. Finally, in the Section after that the relevance of the research, the scope of the research and the expected results are addressed.

2.2 Problem Description
South-East Queensland is the fastest growing region in Australia, and one of the fastest growing regions in the world, growing by "an average of 55,300 persons each year between 1986 and 2004" (Queensland Government, 2005a). That is more than 1000 people on average every week. The Queensland Government expects growth to continue at the same pace in the coming decades. This resulting growth in demand for houses, growth of industry and demand for services is expected to put strain on the availability of infrastructure in the region. For this reason the Queensland Government established the Office of Urban Management in April 2004 "to guide regional planning and infrastructure coordination in South East Queensland" (Office of Urban Management, 2007).

To reach this goal the Office of Urban Management in 2005 released the South East Queensland Regional Plan 2005-2026 and the South East Queensland Infrastructure Plan and Program 2005-2026. "The primary purpose of the Regional Plan is to provide a sustainable growth management strategy for SEQ to the year 2026" (Queensland Government, 2005b). This growth management strategy consists of a "framework for managing growth, change, land use and development" (Queensland Government, 2005b). The South East Queensland Infrastructure Plan and Program (SEQIPP) "outlines the Queensland Government’s infrastructure priorities”. It "is linked to the annual state budget and is the principal mechanism for identifying, prioritizing and delivering infrastructure projects to support the SEQ Regional Plan outcomes” (Queensland Government, 2007). The SEQIPP contains project information on a range of infrastructures, these are: transport, energy, water, information and communication technology and social and community infrastructure.

Infrastructure has a large impact on a region, it drives development and is one of the primary means for government to control and guide growth. Due to the combination of high costs, long life time and long lead time infrastructure also has specific problems. Infrastructure planning that is done now often is about infrastructure that will be completed ten years or more in the future, but a mistake in planning now can cause significant additional costs. The SEQIPP contains AUS$ 85 billion (about €52 billion) on infrastructure projects in the next 20 years. To manage the enormous size of these plans “the Program Management Office (PMO) was established in 2006 to coordinate implementation of the SEQ Infrastructure Plan, identify smart ways to help deliver the program of projects, and resolve issues that may affect delivery of key projects” (Queensland Government, 2007). One of the main problems that the Office of Urban Management deals with is the coordination between different projects. The goal is to either take advantage of opportunities to combine projects and the resulting infrastructures; or to ensure that projects and their resulting infrastructure do not have an adverse effect on each other. The OUM has experienced several problems when taking into account interaction between infrastructures. First of all, the physical and technical complexity increases, because more than one type of infrastructure is involved. This also increases the number of stakeholders and institutions involved, increasing the risk of conflicts between stakeholders and conflicting institutional arrangements. Furthermore the OUM has experienced problems that were political in
nature, where decisions on a political level hindered the ability to take interactions into account. The OUM is uncertain how to best deal with these interactions between infrastructures. An additional problem for the OUM is what infrastructure interaction entails precisely. The concept is ambiguous at best and the OUM has difficulty to focus on the type of interaction that it can have the most benefit from. The OUM hopes that by studying how to take interactions into account in the infrastructure master planning phase can help to gain a better understanding of where it can improve the way it deals with interaction at this level.

Several studies have shown that taking infrastructure interaction into account in the planning process on a project level can reduce the operational and maintenance costs of infrastructure (Franken, 2006, Schapers, 2007) and lead to a reduction in the required space for infrastructure (Dijkema et al., 2007a). The OUM wants to know what the benefits will be of taking into account interaction between infrastructures earlier on in the process; at the stages of master planning and programming infrastructure for a region as is happening in the SEQIPP. Often when interaction between infrastructures has not been taken into account intentionally in the infrastructure master planning phase unintentional interaction will occur in the design and implementation phases of specific projects leading to increased costs, time needed or resources expended. The OUM hopes that by putting more focus on integrated infrastructure master planning the effectiveness of the SEQIPP will be increased. The OUM wants to know the answer to the question how can the Office of Urban Management improve the infrastructure master planning process in South East Queensland to better take into account the interactions between infrastructures?

2.3 Research Objective

The central question of this research is as follows: how can the Office of Urban Management improve the infrastructure master planning process in South East Queensland to better take into account the interactions between infrastructures?

In order to answer this central question several sub questions will have to be answered in order to get to a complete answer of the central research question. First of all a theoretical framework is required for taking into account infrastructure interaction in the infrastructure master planning process. Secondly an overview of the infrastructure master planning process in SEQ and the role that the OUM plays in this process is required to be able to find points where the OUM can make a difference. Finally the theoretical framework and the empirical data need to be scrutinized closely to find where the OUM can improve infrastructure master planning in South East Queensland. This leads to the following research questions and sub-questions:

1. What theoretical framework can be constructed for taking into account interaction between infrastructures in the infrastructure master planning process?
   a. What definitions of interactions between infrastructures can be identified?
   b. What are the building blocks required for a theoretical framework for taking into account the interactions between infrastructures?
   c. What are the requirements for taking into account the interactions between infrastructures in the master planning process from a process perspective?
   d. What are the requirements for taking into account the interactions between infrastructures in the master planning process from a content perspective?

2. How is the OUM taking interaction between infrastructures into account in the infrastructure master planning process?
   a. What is the planning process for infrastructure in South East Queensland?
   b. What lessons can be learned from the application of our framework on the South East Queensland case?
c. What lessons can be learned for South East Queensland from the application of our framework on another master planning case in a comparable region?

3. What conclusions can be drawn from the analysis of the theoretical framework in relation to how the OUM deals with the interaction between infrastructures in the planning process?
   a. What lessons for improvement can be drawn from the case studies for our analytical framework?
   b. How can the OUM improve the planning process in South East Queensland?

2.4 Research Methodology

From the research questions above a three phase methodology for completion of the research can be formulated. The three phases are related to the theoretical, the empirical and synthesis aspects of the research. The phases are as follows:
1. Literature review and conceptual framework
2. Empirical research (the case studies)
3. Synthesis

In this section each of the three phases is described in detail. Figure 2.1 below gives a detailed overview of the entire research framework.

Figure 2.1 Research framework. The dotted lines show which box belongs to what phase.

It is important to note that this research is complex in several aspects. First of all, the field of research on infrastructure interaction is relatively young, concepts and definitions are ambiguous and relevant information is dispersed over many fields of research. If infrastructure interaction is found in literature it usually mentions that it should be taken into account, but fails to give any indication of how this should be achieved. Secondly, the research is complex because it deals with many aspects: many different forms of infrastructure, many different forms of interactions and many actors. Finally, the complexity of the research is further enhanced because the above reasons lead to methodological issues. A first issue is that delineating the scope of work is difficult, since the lack of a strong theoretical basis makes it hard to know what
is relevant and what is not. The second issue is that since definitions are ambiguous, it is hard to keep definitions the same among all interviewees, subtle differences will arise. A third issue is that it is hard to find the right people to talk to, because most agencies have no person that is responsible for ‘infrastructure interaction’. All in all, this made for a challenging research project.

2.4.1 Phase 1: Literature Review and Conceptual Framework
The first phase of the research consists of a literature study. Using literature from several disciplines the building blocks necessary for a theoretical framework on infrastructure interaction in the infrastructure master planning phase have been identified. Using these sources a clarification and definition of important concepts and an inventory of infrastructure interaction in literature have been made. Using this definition and building blocks a theoretical framework will be created that will allow us to analyze the infrastructure master planning situation in South East Queensland.

2.4.2 Phase 2: Empirical Research (The Case Studies)
In the second phase of the research two case studies have been performed in Australia; one situated around the South-East Queensland region and one in the Perth Metropolitan Region to be able to use replication logic in the case studies. The case studies have been selected to include projects that have a high potential for interaction. The case studies have been performed using document studies and interviews in which the questions are based on the analytical framework that came out of the literature review (phase 1) and are intended to test our conceptual framework for infrastructure interaction.

The case study research is arguably the best method for the study at hand. As Yin (2003) puts it: “the distinctive need for case studies arises out of a desire to understand complex social phenomena” (Yin, 2003). He also specifies three conditions for a study to be appropriate for case studies. First of all, the type of research question is important, the case study research is suitable for explanatory (how or why) questions. Secondly, the extent of control on behavioral events is important, low means of control make case studies more relevant. Finally, a focus on contemporary events is what distinguishes case studies from historical research. The type of research in phase 2 of the present study satisfies each of these criteria, making case studies the ideal way to study this field.

The setup of the case studies done in this research has been performed according to the guidelines on doing case studies in Yin (2003). Yin argues for multiple case studies since they provide more compelling evidence and therefore lead to more robust research (Yin, 2003). In addition replication logic can be employed when doing more than one case study. This means that case studies can be selected to either predict similar results or predict contrasting results but for known causes (Yin, 2003). Replication logic has been employed in this research by doing two case studies in the SEQ region and one outside it for contrast, following the same model.

2.4.3 Phase 3: Synthesis
In the third phase of the research the data found in the case studies (phase 2) have been used to make necessary changes and additions to the conceptual framework (phase 1). From this synthesis two main outcomes will emerge. First of all, an improved conceptual framework for interaction between infrastructures in the infrastructure master planning process of a region has been presented. Additionally, the South East Queensland case has been analyzed to provide options for the OUM to improve the infrastructure master planning phase to take into account interactions between infrastructures.
2.5 Relevance of the Research

The present research is relevant for academic and practical reasons. It is interesting for academic reasons, because infrastructure is an important topic in academia. Especially the problems with budget and planning overruns in infrastructure projects and infrastructure projects delivered under specifications. The present research addresses some of the issues related to these higher level problems by addressing the specific problems that occur when two or more infrastructures are interacting on one or more dimensions and in this way informs infrastructure planning more generally as well. It is also of practical relevance to the South East Queensland region in particular and regional master planners in general, because it will lead to concrete advice for improvement in South East Queensland, furthermore the framework will be a useful tool for planners to assess their own situation and improve it if necessary.

2.6 Research Scope and Expected Research Results

This research aims at understanding the implications for the process of infrastructure master planning of a region when taking into account the interactions between infrastructures. In particular the focus is on the region of South East Queensland, although it is expected that some of the conclusions from this research will be applicable to other regions as well, because of the similarities in the way planning is conducted in many regions in the world. The focus of this study is solely on infrastructure master planning, other phases of planning, like project planning are not given the primary focus, although sometimes references will be made to these other phases of infrastructure planning. The different kinds of infrastructure taken into account in the research are transport, water, energy and telecommunications infrastructure. Both the physical network as well as the stakeholder network are taken into account.

Some aspects that have explicitly not been studied are as follows. First of all national funding and planning schemes, like the Auslink program (Auslink, 2004), which is a federal infrastructure investment program, have not been taken into account. Secondly, there is no focus on the interactions between infrastructures of one region on the infrastructures of bordering regions. Third, non-physical infrastructure has not been taken into account, for example physical waste collection has not been taken into consideration in this research, since the collection of waste is done mostly with trucks that use the transport network.

The results expected from this research are twofold. First and foremost a conceptual framework for infrastructure interaction in the infrastructure master planning process will be developed by a literature study and tested and refined on the South East Queensland case. The additional result that is expected from this research is a package of recommendations for the Office of Urban Management in South East Queensland to improve the infrastructure master planning process.

2.7 Conclusion

The OUM is interested in finding ways to improve the interaction between infrastructures in South East Queensland by adopting changes in the infrastructure master planning phase. The present research attempts to find a conceptual framework to assess interaction between infrastructures in the master planning phase of infrastructure planning. The conceptual framework is tested by case study research in South East Queensland and Perth. Finally, the results of the research is a tested conceptual framework for infrastructure interaction in the infrastructure master planning phase and recommendations for the OUM on how to improve infrastructure master planning in South East Queensland by taking into account the interactions between infrastructures.
3 A Framework for the Analysis of Interaction

3.1 Introduction
In this chapter a conceptual framework is developed and presented for taking into account infrastructure interaction in regional infrastructure master planning in order to be able to analyze the South East Queensland case. The framework identifies the building blocks required for a regional infrastructure master planning process that adequately takes into account infrastructure interaction, both in the sense of the process as well as the content of the decision making. Since no such framework was available in literature a framework is constructed from a variety of research areas. The framework consists of two parts: first, taking into account interactions between infrastructures sets requirements for the process of regional infrastructure master planning. Second, taking into account interactions sets requirements for the content of decision making. The rest of this chapter is an exploration of these two elements of the framework. In Section 3.2 the process is analyzed, while Section 3.3 deals with the content of decision making. The final framework is presented in Section 3.4.

3.2 Process requirements for Regional Infrastructure Master Planning
Planning as a process can take place on many different levels of aggregation; both in time, space and the object of planning. This research is concerned with the master planning (time) done on infrastructure (object) in a region (space), or regional infrastructure master planning. To get a good grasp of what this means a few things need to be clarified.

- What infrastructure needs to be planned?
- What is regional master planning of infrastructure?
- How to deal with interaction?

From these three questions a process framework can be derived for the regional master planning of infrastructure. The final question to answer then is: how can the interactions between infrastructures be taken into account in this process?

3.2.1 Infrastructure
Before going into infrastructure planning, it is important to deal with the concept of infrastructure. The term, which literally means foundation, comes from the military world (Verhaeghe et al., 2006). There it means facilities for logistics, where logistics means the organization of all movements between military units. In civil engineering this definition is inadequate. One definition taken from Verhaeghe et al. (2006) is “large scale provisions for transport and to a lesser extent telecom, utilities and water control” [translated from Dutch]. Verheaghe et al. (2006) split infrastructure into three domains:

- Water control: originally water works and water level control, but now complete water management.
- Transport: transport of people and goods over land, water and air.
- Utilities: networks that transport basic utilities for water, waste water, energy and information.

This definition is focused heavily on water management, while the basic utilities for water, energy and telecommunications are all pushed into one category. Grigg (1988) takes a list from the American Public Works Association (APWA) and derives five categories on a subjective basis:

- Roads: roads, streets and bridges.
- Transportation: transit, rail, ports and airports.
- Water: water, wastewater, all water systems, including waterways.
- Waste management: solid waste management systems.
• Energy production and distribution: electricity and gas.

This definition completely misses the telecommunications infrastructure, which is a very important component of current infrastructure networks around the world. In the Next Generations Infrastructures (NGI) program of the Delft University of Technology five infrastructure domains have been identified (Weijnen et al., 2004). In essence the NGI splits what Verhaeghe et al. (2006) call utilities into three parts, namely energy, telecom and waste. This leads to the following five domains:

• Energy: the electricity and gas networks.
• Water: the water and waste water (sewage, sanitation) networks.
• Telecom: the telecommunication network.
• Waste: the physical waste processing network.
• Transport: the transport of people and goods over land, water and air.

In the present research we are primarily concerned with infrastructure that takes up physical space and that is used to transport people or goods (i.e. the so-called network bound infrastructures), because with these there is ample opportunity for interaction between infrastructures. This rules out the waste infrastructure identified by the NGI, as it only contains the treatment of solid waste, which does not have its own physical infrastructure network, but is transported over the transport network, which is already included in the NGI definition. Additionally, wireless telecom infrastructure and transport using the air are also ruled out. Given these requirements for our definition of infrastructure we come to the infrastructures included in our research as the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water. A criticism to this choice could be that it excludes innovative non-network bound solutions to infrastructure interaction. This might be true, however, we argue here that the moving of goods and people for the years to come will be mostly network-bound. In that respect, to keep matters to a comprehensive and more specific problem area, the non-network bound infrastructures will be excluded from this research.

Figure 3.1 Infrastructure as a physical network and a Multi-actor network component embedded in its institutional context (Source: Weijnen and Bouwmans (2006))

Besides their definition of infrastructure, the NGI additionally touches upon an important aspect of the concept of infrastructure. Namely, that while the physical network (i.e. the actual concrete, wires, nodes and links) is an important part of what constitutes an infrastructure, it does not end there; it also includes the stakeholder network of the infrastructure (i.e. the users, owners, regulators, operators, etc.) and the institutional environment in which these two subsystems are embedded. Weijnen and Bouwmans (2006) state it as follows: “The notion of ‘infrastructure’ generally refers only to the physical network that connects the suppliers and end users of an infrastructure-bound service. However, in our view, an infrastructure system includes, besides the transport and distribution network, the carriers, conversion, and storage facilities, as well as the governance, management, and control systems that are needed to make the system meet its functional specifications and its social objectives”. As we will see in Section 3.2.4 the multi-actor context is an important aspect of the focus on interaction in infrastructure master planning. Figure 3.1 shows the physical and multi-actor subsystem embedded in the institutional context.
In the notational grid shown in Figure 3.2 below the infrastructure definition of the NGI is shown with the three subsystems of infrastructure illustrated as well; the items marked with an asterisk are included in the research. This brings us to the definition of infrastructure for our framework (i.e. the infrastructures that the planning process has to be based around) as the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water.

![Figure 3.2 Notional Grid of the concept Infrastructure. Items with an * are considered in this research](image)

### 3.2.2 Regional Master Planning of Infrastructure

The concept of regional master planning of infrastructure is easiest understood when first considering regional and master planning separately and finally narrowing down to infrastructure planning.

Alden and Morgan (1974) define a region as ‘a space that is larger than any single urban area [...] and at the same time a region is contained within a nation and thus a sub national space’ (Alden and Morgan, 1974). They argue that there are three rationales for doing regional planning. First of all it provides the ability to focus on specific regional problems and solve them more directly than can be done via national planning and local (or town) planning (Alden and Morgan, 1974). The regional level allows for the coordination between local entities, but allows for finer grained and more customized planning than the national level. A good example is the coordination of growth in specific parts of the region and the accompanying infrastructure coordination. Secondly, it provides value for the planning done on local and national level. Finally, it is deemed to be a superior way of ordering societal affairs than non-planning (Alden and Morgan, 1974). There have been debates about the validity of these claims. Wadley and Smith (1998) argue that planning is about the creation, maintenance and destruction of wealth. Other authors question the value of regional planning altogether (Klosterman, 1985, Marshall, 1996). However, considering the widespread use of regional planning in contemporary planning exercises and the unending nature of this debate we will assume the premises from Alden and Morgan (1974) to be true.

Alden and Morgan (1974) further make a distinction between private and public planning. Public planning is planning done by government agencies, while private planning is done by private organizations. There is a complex interplay between these
two forms of planning. For regional planning it is important that both forms of planning are taken into account.

More recent contributions to regional planning literature focus mostly on a specific contemporary regional problem: the urban sprawl (Daniels, 2001; Janssen-Jansen, 2005). This problem is relevant for us in only a limited way, but only in the actual application of our framework. Urban sprawl in itself will not gain a place in our framework.

As we can see from the above regional planning involves the planning of a region, from a public as well as private focus, complementary to local and national planning efforts. For our framework regional planning is therefore defined as planning of a region with the region as a holistic entity and taking into account both public and private planning.

Now that we have a clear view of the concept of regional planning it is time to introduce the notion of master planning. A definition of master planning is not easily found in literature. Oppenheim (1985) comes close to a definition when he writes "master planning involves the definition of the principles which will guide the evolution of the area, towards desired objectives, in a comprehensive, long range, coordinated manner" (Oppenheim, 1985). Basically this definition means that master planning is the creation of long range plans for a region to reach established development objectives. Verhaeghe et al. (2006) introduce the notion of the cycle of Master Planning, Programming and Budgeting (MPB). In their discussion of this cycle they do not define master planning, but they state about the result of this planning that it provides a concrete plan for the future "with a maximum effective and sustainable use of the potentials at a future point in time, in line with the development objectives" (Verhaeghe et al., 2006). According to them usually a long planning horizon is taken, often 50 or more years, in order to gain a complete understanding of the potentials and limitations of the region. Additionally, they state that a master plan "provides long term targets for orientation of short term developments, [but it] provides only a static picture, further information is needed for implementation of development" (Verhaeghe et al., 2006). This additional information comes from the programming phase. This phase is also relevant for the framework developed in this paper. Programming is where, starting from the desired end situation from the master plan, a program is created to come to a realization of these goals over time (Verhaeghe et al., 2006). "Usually a cyclic programming is carried out resulting e.g. in subsequent 5-year plans" (Verhaeghe et al., 2006). These programs will contain infrastructure projects from all infrastructure types defined in the previous section on infrastructure. The final phase is the budgeting phase where an annual budget for activities stipulated in the (5-year) program is created (Verhaeghe et al., 2006). This definition is more elaborate than the Oppenheim gives. For our own definition of master planning we need to take a subset of the master planning and programming phases as defined by Verhaeghe et al. (2006). For the purpose of planning for interaction it is of importance to be able to plan concrete projects, the part of planning that the programming phase deals with. On the other hand it is also important to be able to influence the goals that are being worked towards in the region. Therefore, master planning for this framework is defined as setting the development objectives of a region and defining the long term program of projects to reach these goals.

Finally, now that we have a good idea of regional master planning it is time to narrow down our discussion to the planning of infrastructure. While the book written by Goodman and Hastak (2006) is called The Infrastructure Planning Handbook, they fail to give a concrete definition of infrastructure planning. From other sources a definition has also not been found. Maybe this is because a definition of infrastructure planning is quite straightforward: the process of analysis, design and construction of a piece of physical infrastructure. Goodman and Hastak (2006) do give an overview of the typical infrastructure planning process which looks like the following list:

1. Establishment of goals and objectives
2. Problem identification and analysis
3. Solution identification and impact assessment
4. Formulation of alternatives and analysis
5. Recommendations
6. Decisions
7. Implementation
8. Operation and Management

The first three phases in this list can be considered master planning, phases 4 to 6 are programming, while the remaining two steps are then beyond the budgeting cycle. Verhaeghe et al. (2006) also provide a good schematic overview of the infrastructure planning process, shown in Figure 3.3, which is quite similar to the process given by Goodman and Hastak (2006).

![Figure 3.3: Outline of activities to prepare, evaluate and implement an infrastructure project (Source: Verhaeghe et al. (2006))](image)

Additionally, according to Goodman and Hastak (2006), there is a programming and budgeting process for infrastructure run by public work agencies to assign money to specific programs and projects, similar to the MPB cycle from Verhaeghe et al. (2006):

1. Setting program goals and objectives.
2. Establishing program performance measures.
3. Assessing needs and identifying projects.
4. Project evaluation.
5. Priority setting and program development.
6. Program trade-offs.
7. Budgeting.
8. Program implementation and monitoring.

Goodman and Hastak (2006) mention several issues with the decision making process on infrastructure. First of all, different people hold different and constantly changing
views on current problems and solutions and are unclear on where the boundaries of their concern on these matters should be drawn. Secondly, decision makers experience constant pressure to take decisions incrementally, in stead of taking a broader, longer term perspective. Thirdly, decision makers face the constant dilemma between urgency and uncertainty. Finally, it is difficult to distinguish between the political and technical aspects of decision making, while generally the institutional structure is specifically designed to maintain this distinction (Goodman and Hastak, 2006). These issues can be attributed to two main problems with regional master planning of infrastructure. The second and third mentioned issues are related to the discrepancy between planning theory and planning practice. The first and fourth issues are related to the multi-actor setting in which decisions on planning are made nowadays. In the following two sections each of these problems will be addressed in more detail to complete the process part of our framework.

3.2.3 The Practice of Planning

According to Alden and Morgan (1974) "the rational model of decision making is the fundamental base for the majority of currently practiced planning methodologies" (Alden and Morgan, 1974). They go on to critique this approach considerably. They mention 3 criteria for rational choice:

1. All alternatives are considered.
2. All consequences of each alternative are identified and evaluated.
3. The most preferable alternative is chosen that satisfies the aims of the decision maker.

This leads to several characteristics of the planning process. First of all it is a technical exercise, problems and solutions are identified in a rational way and the best solution is chosen to be implemented. Secondly it is comprehensive, all aspects of a decision are considered. Finally the process is allocative, meaning that a solution will rule out others, due to the allocation of resources. However, Alden and Morgan (1974) see the limitations of this approach when they cite Lindblom’s analysis of the problems with the rational model. First, the “variation in values held by individuals makes agreements on ends impossible” (Alden and Morgan, 1974). According to Lindblom there can be no mathematical convergence of everyone’s values into one scale, therefore planning proposals are in accordance with political power and thus planning is a political activity, not a rational one. Secondly, the ends are not decided on first, means and ends go hand in hand. Third, adequate knowledge is assumed to take into account all means, all ends and all consequences, but ‘the consequences of any act may go on reverberating into infinity’, it is therefore impossible to consider everything. Herbert Simon (1957) coined the term bounded rationality to show that decision making is often bounded by the limited rationality of the decision makers. Instead of optimizing, decision makers often satisfice (Simon, 1981). This phenomenon is also caused by the limited information available to decision makers. Lindblom also notes that the institutional structure of governments in which planning is undertaken is not suitable for the rational model. “This structure is characterized by the division of tasks faced by an organization of government into separate predefined parts; duties are allocated to different positions, agencies are allocated to a variety of territories. Yet the rational model clearly requires that these separate divisions are overcome to in order that a comprehensive and coherent range of instruments can be developed to realize aims” (Alden and Morgan, 1974).

An important critic of the planning process as described in the previous section is Henry Mintzberg; in his book The Rise and Fall of Strategic Planning (1994) he describes why planning theory does not do justice to the actual process of strategic planning and offers an alternative form of strategic planning that more closely resembles the actual strategic planning process. After giving a considerable dose of evidence, Mintzberg presents four pitfalls of planning (Mintzberg, 1994). First of all, he argues that according to planning literature commitment to the planning process is needed by both the management of an
organization and the operational core. He then shows that commitment at the top is constantly being challenged by the pressures of the moment, further down a rigid plan does not encourage people to follow the plan, they are more likely to follow their own plans and ignore the planners plan as long as possible. Second, Mintzberg argues that plans and planning do not deal well with change. He writes "planning, as noted, is meant for coordination. And the more coordinated the plan, the less flexible it must be. Change one serious part of an integrated plan and it disintegrates" (Mintzberg, 1994). He further argues that the planning process itself "breeds a basic inflexibility in organizations, and so a resistance to significant change" (Mintzberg, 1994). Third, Mintzberg argues that politics and planning are often at odds, planning tries to drive out politics, but it always seems to come back. He argues that politics cannot be ruled out, next to the fact that politics also has functional roles to play in an organization (Mintzberg, 1994). Finally, he attacks the notion that planning can exert any control on the environment; something he claims that is implicit in conventional planners' ethos. From these pitfalls he derives three fallacies. First of all, he argues that planning cannot predict the future. The fallacy of determination is that forecasts and scenarios are used to plan for a future that is likely to never arrive. Secondly, he attacks the notion that to be able to plan one needs to be detached from the daily treadmill of everyday life. He argues that the fallacy of detachment is that planning cannot be done from an ivory tower, because in that way it cannot react to emergent strategy. Finally, the third fallacy of strategic planning is that of formalization. He argues that it is impossible to formalize the planning process, because it is by definition a partly analytical, partly intuitive activity, of which only the analytical part can be formalized (Mintzberg, 1994).

Mintzberg concludes that planning as it is normally done can never achieve the goals it sets for itself. He then goes on to find roles for planning and plans that are achievable (Mintzberg, 1994). He argues that the only role of planning is strategic programming: "organizations engage in formal planning, not to create strategies, but to program the strategies they already have, that is, to elaborate and operationalize their consequences formally" (Mintzberg, 1994). Plans, he argues, are to be used in two ways: 1) as communication media for strategies: "plans, as they emerge from strategic programming as programs, schedules, budgets, and so on, can be prime media to communicate not just strategic intentions, but also what each individual within the organizations must do to realize them" (Mintzberg, 1994) and 2) as control devices "specifying what behaviors are expected of particular units and individuals in order to realize strategy, and then being available to feed back into the strategy making process comparisons of these expectations with actual performance" (Mintzberg, 1994). Finally, Mintzberg argues that there are three roles for planners in the planning process. First there is the role of finders of strategy. Planners can help to find strategies as a first step in strategic programming and find realized patterns to achieve broader strategic control (Mintzberg, 1994). The second role of planners is that of analysts. "Every one of the intense probes into what planners actually do suggests that the effective ones spend a good deal of time not so much doing or even encouraging planning, as carrying out analyses of specific issues to be fed into the strategy making process on an ad hoc basis" (Mintzberg, 1994). Finally, the third role of planners according to Mintzberg is that of catalysts. Basically, planners should promote future thinking its broadest sense (Mintzberg, 1994).

We can do nothing but to accept Mintzberg’s convincing criticism of the conventional planning method. For the framework this means that planning is a form of strategic programming, to elaborate and operationalize their consequences formally. Plans should are as a communication method and as a way to control internal and external stakeholders. Finally, planners work to find strategy, analyze strategy and are catalysts for future thinking.

3.2.4 Planning in a Multi-Actor Context

The second problem with the rational approach to regional master planning of infrastructure is the many stakeholders involved. For this reason De Bruijn and Ten
Heuvelhof (2000) also criticize the rational approach to planning for two important reasons:

1. Decision makers do not make a planning on their own, but in cooperation with many other stakeholders.
2. Between these parties there is no agreement over norms and values or facts and figures.

This means that a single decision maker can not impose his own goals and objectives on other stakeholders.

According to De Bruijn and ten Heuvelhof (2000) most decision making these days is no longer done in hierarchies, but in networks. Networks have several characteristics that set them apart from hierarchies. First of all a network is characterized by pluriformity: there are many different actors, perceptions, interests, means of power, etc. Secondly, in a network actors are interdependent. This means that actors need each other in order to function properly. Finally, a network is characterized by closedness, which means that actors are not necessarily sensitive to an intervention by another actor. These characteristics lead to a network being dynamic in nature. The primary effects upon the decision making process are as follows:

- Infrequent and no clear sequence of component activities
- Decision making in rounds, instead of phases
- Actors enter and exit and behave strategically
- Often winners and losers in problem formulation
- No isolated clear beginning and end
- The nature of the problem shifts over time
- The solution does not necessarily follow the problem

Several problems occur when an attempt is made to manage decisions like these in an hierarchal (i.e. traditional) way. First, some stakeholders may feel left out of the decision making process and ignore, resist or distort decisions being made (they are said to have blocking power). Secondly, in a network strategic behavior of actors is a way of life. The network management approach limits the impact that strategic behavior has on the decision making process.

This description of decision making is also valid for infrastructure planning, especially in the master planning phase of decision making. In this form of Multi-Actor decision making De Bruijn and Den Heuvelhof (2000) advise to use a process approach to planning and decision making. This means that instead of focusing on the content of a decision focus is put on the process of decision making, to find a way to keep all actors satisfied with the decision through a process of 'wheeling and dealing'. The process approach will often lead to decisions being made, but there is no guarantee that the decision made will be substantial. This means that additional expert knowledge on the content of decision making should be added into the process. They give the following design requirements for a process approach to decision making, which are important to the planning process: first of all, a sense of urgency is needed for stakeholders to commit to the decision making process. Furthermore, the process should be based on openness and integrity to create trust between stakeholders. Third, incentives for progress are needed, otherwise the decision making process might stall. Finally, process agreements are necessary to keep the substance of the decisions made in order. This means that expert opinion needs to be included in the process at an appropriate level.

Since the regional master planning of infrastructure has the characteristics of a network, for the analytical framework this means that the planning process takes a network approach to decision making.

### 3.2.5 A focus on Interaction

Now that we have discussed the requirements of the regional master planning of infrastructure process it is time to consider how the interactions between infrastructures can be considered in this process.
In literature often only lip service is paid to interactions between infrastructures. Many sources just mention it and claim that it should be taken into account, not specifying how this should be accomplished. For example, the OECD in their outlook on infrastructure in the next 30 years recognizes the “interdependencies and synergies” among infrastructures as an important development that will gain prominence in time (OECD, 2006), but gives no answer to the question on how this should be accomplished. Some sources in literature deal specifically with infrastructure interaction. The Next Generations Infrastructures (NGI) Foundation acknowledges that the interaction between infrastructures is an important factor in the reliability and serviceability of infrastructures. Weijnen and Bouwmans (2006) ask the question “how do interdependencies, interconnectedness and convergence affect the [infrastructures] network development and it’s functioning?”. Grava (1985) argues for the coordinated infrastructure planning, “because it is necessary to assure that “adequate services will be available, all systems are in proper balance, the cross-linkages are considered, substitutability is accounted for and future changes can be accommodated [italics added]” (Grava, 1985). I would like to add the costs that can be avoided by taking into account these interactions between infrastructures. Goodman and Hastak (2006) also note that the different infrastructure systems need to be integrated. They give the following example: “Within a highway right of way, a physical facility carries automobiles, public transit vehicles, goods movement vehicles, emergency vehicles, pedestrians and bicyclists. And within the same right of way are water and waste distribution systems, power and telecommunications systems, and storm water distribution systems” (Goodman and Hastak, 2006). Oppenheim (1985) sees interactions between infrastructures and other components of the urban system. However, some of his analysis is also applicable on the interaction between infrastructures. He identifies three effects of interaction: systemic, dynamic and interactive. With the systemic nature of interaction he means that infrastructure will have many effects other than the primary effect is it trying to achieve. The dynamic character of interaction means that the effects will change over time. Finally, the interactive character of interaction means that the relationship between infrastructure planning and other planning is not one-way, but that the other planning elements also have an effect on infrastructure planning (Oppenheim, 1985).

![Figure 3.4 Schematic representation of interaction (1 way)](image-url)

Still, it is hard to find a concrete definition of the interactions between infrastructures in literature. Even the dictionary definition of interaction does not give us much to work with: a “mutual or reciprocal action or influence” (Merriam-Webster, 2007). However, Cozby (2003) provides a definition that makes logical sense and is usable in
our research. He defines interaction as “the differing effect of one independent variable on the dependent variable, depending on the particular level of another independent variable” (Cozby, 2003). An example can be seen in Figure 3.4, where the total cost of two infrastructure projects is influenced by the cost of project 1 and the cost of project 2. However, the size of project 2 is influencing the cost of project 1 (in this case the direction of change is unknown) and this will of course also influence the total cost. Of course it would be possible for project 1 to influence the cost of project 2 at the same time, this might even be likely as we will see below, in that case there would be a two-way interaction between project 1 and 2. Of course the Figure above is highly simplified. In reality there could be many interactions between the different infrastructures, with different effects. One interaction might save space, but lead to other interactions that cause more costs. In reality there will always be tradeoffs and it will be difficult to say which interaction is causing what effect.

Taking the diagram from Figure 3.1 on page 17 and expanding it to include infrastructure interaction is straightforward; in Figure 3.5 two of the diagrams are shown together with arrows displaying how interactions can take place. Imagining what interaction between three different infrastructures looks like is not hard to imagine. It is also obvious that the number of possible interactions increases fast with each infrastructure that is added.

An important distinction to make in infrastructure interaction is the difference between planned (intentional) and unplanned (unintentional) interaction. Unplanned interactions have the potential to remain unseen until they lead to negative effects. They are generally associated with crisis management. On the other hand the proactive management of interactions leads to planned interactions. This makes it possible to mitigate the effects of negative interactions, while capitalizing on positive interactions. Unplanned interactions between infrastructures will mostly materialize during the detailed design or even the implementation or operation phase of the infrastructure lifecycle. It is then too late to properly take into account these unintentional interactions and they will most likely lead to added monetary costs, time and/or lowered safety or functionality. On the other hand, if the interaction between infrastructures is taken into account earlier in the process (i.e. in the master planning
or the programming phase) the interactions between infrastructures can be planned to maximize the benefits of this interaction. Unplanned interactions between infrastructures will mostly materialize during the detailed design or even the implementation or operation phase of the infrastructure lifecycle. It is then too late to properly account for these unintentional interactions and they will most likely lead to added costs, time and/or lowered safety or functionality (see Figure 3.6). On the other hand, if interaction between infrastructures is taken into account earlier in the process, i.e. in the master planning or early in the programming phase the interactions between infrastructures can be planned to maximize the benefits of this interaction (see Figure 3.7 on the next page). This does not mean to say that when interactions are taken into account early in the process they will always be beneficial, but it does mean that when there are negative interactions these can be spotted and treated.

Figure 3.6 Unplanned, unintentional interaction between infrastructures

For this research two cases of infrastructure planning are of importance: planning of new infrastructure which will likely interact with existing infrastructure, or two or more infrastructures being planned that will likely interact with each other. The case where infrastructure is planned that might interact with future infrastructure (not yet being planned) is a very interesting situation, but this is not the focus of this research. Of course in order to take interactions between infrastructures into account there needs to be a focus on this in the decision making process. This focus can be added by putting it on the agenda. Additionally, the planning process needs to allow for interaction to be taken into account. As we have seen in the previous section the multi-actor context is an important factor in this. The institutional context can in some cases also be a barrier to interaction and is equally important to make interaction possible. There are many ways that infrastructure can be taken into account in the process. Since our framework attempts to be flexible, this means that we will suffice here with the notion that there needs to be a focus on interaction in the planning process.
3.3 Content Requirements to plan for Interaction between Infrastructures

In the previous section the process of master planning for interaction has been described, in this section the content of master planning for interaction will be explored. First, the effects of interaction between infrastructures are presented. Then, a provisional overview of different categories of interaction is given that has been extracted from literature.

3.3.1 The Effects of Interactions between Infrastructures

What can be the effects of positive or negative interactions? Two types of effects can be identified: resource effects and functionality effects. On the resource side interactions can cause increases and decreases in monetary cost, time needed for implementation, materials needed and space requirements.

On the functionality side De Boer (2001) gives five types of problems with infrastructure. Each of these problems may be caused by many different things, but all of them can also be caused by interactions between infrastructures. The five problems are as follows:

- Technical problems
- Capacity (or throughput) problems
- User Experience (Quality) problems
- Safety problems
- Environmental problems

The technical problems will mostly be actual interactions, while the other four problems always have an associated effect. In Figure 3.8 below all these effects have been summarized schematically. Infrastructure interaction can be negative or positive and split up either in functionally based interaction or in resource based interaction. Additionally, interaction can cause an effect as a one-off event, usually during construction, but also at the end of life of an infrastructure, or as a permanent effect. For example, putting a railway and a road in the same corridor might save construction costs (i.e. a one-off cost), because earthworks and reclamation of land can be combined, but it might cause a permanent safety effect on the users of the road and the railway.
3.3.2 A provisional list of categories of interactions between infrastructures

In the following paragraph a provisional attempt will be made to list interactions that could be derived from literature, logic and other sources. These interactions form the basis of the content of master planning for interactions. This list can not be guaranteed to be comprehensive (we would even argue that it is guaranteed to be incomplete), but it will be the initial starting point for the empirical case study research in South East Queensland and the developed planning model for interaction between infrastructures. An important basis of this list is framework developed by Dijkema et al. (2007b); this paper presents a framework for the physical combination of

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Figure 3.8 Notational grid for the concept infrastructure interaction. In the research the focus is on all forms of interaction.
infrastructure. Dijkema et al (2007b) finds three classes of infrastructure characteristics that determine whether infrastructures can be combined. These are: safety, spatial effects and regulatory and organizational characteristics.

**Dependence Interaction**
An infrastructure is dependent on another one when it needs the other infrastructure to function. For example, the desalination of sea water for drinking water purposes needs a lot of energy. If in Australia desalination of water will be used in the future the energy infrastructure will need to be made so that it can support this. Another form of dependence is a railway needing more fine grained public transport to move people from the main stations to close to people’s destinations (Westerduin, 1999).

**Environmental Interaction**
There are two ways in which infrastructures have environmental interactions. First, when two or more infrastructures are located spatially close together and environmental problems, like emissions, of all these infrastructures are added together. This is a recurring problem in the Netherlands where the norms for air quality are exceeded because of densely packed infrastructure corridors (Buijsman et al., 2005). The other way of interaction on environmental characteristics is when a waste product of one infrastructure is used as an input for another. An example here is heat cascading, where waste heat from energy plants or industry is used to heat residential homes (Dincer, 2002).

**Institutional Interaction**
Laws and regulations might influence the interactions between infrastructures. One infrastructure might be highly regulated while another one might be free to the market. In some ways these infrastructures might be unable to interact with each other favorably because of this barrier. An example is the different track widths of railways in Queensland and New South Wales, which makes interaction between these two systems difficult, of course this is also a technological interaction (Australian Rail Track Corporation Ltd, 2004).

Another form of institutional barriers to interactions are the way in which decision making processes are sometimes organized. The requirements for economic impact assessments and business cases for individual projects causes the focus on interaction to be lessened. Institutional interaction closely corresponds with the Regulatory and Organizational characteristic of Dijkema et al. (2007b). They identify four key features: ownership, sector regulation, competition and permitting regime.

**Multi-actor Interaction**
It is important that actors use the same demographical forecasts when planning infrastructure. If two councils in one region both assume that the forecasted growth will be in their council area and they both plan the infrastructure accordingly they might both be disappointed later. A concrete example of where this went wrong is with the telecommunications in Europe, where many parties were building infrastructure to serve the same customers (Lemstra, 2006).

**Spatial Interaction**
By combining two infrastructures in a clever way spatially a lot of space can be saved. A classic example is the telecommunications line going through a gas or sewer pipe. Another common example is a road with a railway running alongside it in a shared corridor (Willems, 2001). By employing a shared corridor in this way the spatial separation of a region by infrastructure cutting through it is minimized. This kind of combination can lead to issues with safety, costs, time and environment. Dijkema et al. (2007b) identify four characteristics of spatial combinations: 1) suitability for horizontal bundling, 2) suitability for vertical stapling, 3) the footprint, 4) fostering segmentation spatial barrier.

The safety aspects of infrastructure when two infrastructures are interacting in a shared corridor have been studied extensively by several authors (Rosmuller, 1996,
Rosmuller, 2001, Van der Heijden and Van der Vlies, 2005). Stoop (1993) advices the use of a safety impact assessment for big infrastructure projects in the same sense as the environmental impact assessment that in many countries is already mandatory, including the Netherlands (Dutch Government, 1987, Dutch Government, 1994) and Australia (Australian Government, 1999). Dijkema et al. (2007b) finds six characteristics of safety interactions when combining infrastructure. Five of these are related to the possibility of liberation of 1) kinetic energy, 2) heat, smoke or heat radiation, 3) dangerous substances, 4) water, 5) electricity or electromagnetic radiation. The sixth characteristic is the possible likelihood of functional interference.

**Technological Interaction**

Technological characteristics come into play when one infrastructures technology can be used to influence another. A typical example is the ICT infrastructure which is nowadays interacting with practically all other infrastructures. A more concrete example is the integration of voice and data transfer over telecom and television cables using the TCP/IP protocol.

### 3.4 Conclusion: A Framework for Analysis of Interactions

From the above review of available literature the requirements for taking into account the interactions between infrastructures in the regional master planning of infrastructure have been distilled. In this Section the framework is presented in its entirety.

From the analysis of infrastructure the infrastructures that need to be involved have been found. A discussion of regional master planning of infrastructure further uncovered the requirements from a regional and master planning perspective. It also showed two main problems with the theory on these subjects. The multi-actor setting and the practice of planning therefore also introduced their own requirements. Finally, taking into account the interactions between infrastructures puts a final requirement on the planning process.

By analyzing the content of decision making on interaction we found the effects of interaction and a tentative list of all the interactions that can occur. The total framework has been schematized in Table 3.1 on the next page.
Table 3.1 Analytical framework for the analysis of interactions between infrastructures in the regional master planning process

<table>
<thead>
<tr>
<th>Process Requirements</th>
<th>Content Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Involves the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water</td>
<td>Resource Effects of Interaction</td>
</tr>
<tr>
<td>• A focus on planning of a region with the region as a holistic entity and taking into account both public and private planning</td>
<td>• Save or cost space</td>
</tr>
<tr>
<td>• Sets the development objectives of a region and defines the long term program of projects to reach these goals</td>
<td>• Save or cost money</td>
</tr>
<tr>
<td>• Planning is used as strategic programming</td>
<td>• Save or cost materials</td>
</tr>
<tr>
<td>• Plans are used as a communication method and as a way to control internal and external stakeholders</td>
<td>• Save or cost time</td>
</tr>
<tr>
<td>• Planners work to find strategy, analyze strategy and are catalysts for future thinking</td>
<td>Functionality Effects of Interaction</td>
</tr>
<tr>
<td>• The planning process takes a network approach to decision making</td>
<td>• Increase or decrease safety</td>
</tr>
<tr>
<td>• There is a focus on interaction in the planning process.</td>
<td>• Increase or decrease throughput</td>
</tr>
<tr>
<td></td>
<td>• Increase or decrease quality</td>
</tr>
<tr>
<td></td>
<td>• Increase or decrease waste</td>
</tr>
<tr>
<td>Types of Interactions to take into account:</td>
<td></td>
</tr>
<tr>
<td>• Dependence interaction</td>
<td></td>
</tr>
<tr>
<td>• Environmental interaction</td>
<td></td>
</tr>
<tr>
<td>• Institutional interaction</td>
<td></td>
</tr>
<tr>
<td>• Multi-actor interaction</td>
<td></td>
</tr>
<tr>
<td>• Spatial interaction</td>
<td></td>
</tr>
<tr>
<td>• Technological interaction</td>
<td></td>
</tr>
</tbody>
</table>
4 Introduction to the Case Studies

4.1 Introduction
In order to test the quality of the analytical framework presented in the previous chapter, two planning areas were studied in depth. Case studies were chosen as the preferred way to study these planning areas, because case studies allow for in-depth descriptions, interpretations and explanations of the object of analysis like no other method, something that is needed for this complex research. In this chapter the set-up and selection of the case studies is presented. In Section 4.2 the set-up of the case studies is explained. Section 4.3 justifies the selection of the case studies. The data collection methods used for each of the case studies is given in Section 4.4. Finally, in Section 4.5 the way the case studies have been analyzed is presented.

4.2 Case Study Set Up
According to Yin “the distinctive need for case studies arises out of a desire to understand complex social phenomena” (Yin, 2003). The strength of case study research is theory generation. Case studies can be used to test a theory and enrich it. Yin gives four conditions related to the quality of case study research (Yin, 2003):
1. Construct validity
2. Internal validity
3. External validity
4. Reliability

Construct validity of the research can be achieved by using multiple sources of evidence, using chains of evidence and having key informants check the case study report for accuracy. In this research multiple sources of evidence have been used. First of all, multiple case studies have been used. Within the case studies both document studies and multiple interviews were used. Additionally, in one of the case studies two projects have been studied. A chain of evidence is using multiple sources to complement each other and find a conclusion that follows from the chain of evidence, rather than from a single piece of evidence. Finally, allowing key informants to check the case study for accuracy is a good way to achieve construct validity within the research (Yin, 2003). Both case studies have been sent for review to all interviewees, any comments have been incorporated in the case studies.

Internal validity of a case study can be achieved by pattern matching, addressing rival explanations, explanation building, using logic modules and member checks (Yin, 2003). In this research pattern matching and member checks have been used primarily to achieve internal validity.

External validity of a case study can be achieved by using replication logic. With the use of multiple case studies the cases can be matched to predict similar or contrasting results. Additionally, the use of multiple cases leads to more compelling evidence and thus to more robustness of the research. It is also good to note that case studies do not use statistical generalization, but analytical generalization. Case studies generalize a particular set of results to a broader theory (Yin, 2003).

Reliability can be achieved by making sure that it is clear how the research has been performed and documenting steps taken (Yin, 2003). The way that this has been achieved is keeping an extensive bibliography of all documents used in the research. Additionally, where possible all interviews have been taped. A list of interviewees can be found in Appendix A.

4.3 Selection of case studies
The OUM wants to improve master planning in the South East Queensland region; this makes the choice for a case study on the SEQ regional planning process a straightforward choice. Additionally, in order to be able to use replication logic in the research a second case study was selected. The Perth Metropolitan Region is a region
similar to South East Queensland, but the planning processes there have been in place for decades. It will be interesting to contrast the differences in planning between these two similar, but distinctly different cases.

In order to make sure that talking about interaction was not going to be a guessing exercise it was decided to not only focus on the master planning process, but also look at specific infrastructure projects from the respective programs and see the effects of the master planning on the interactions within these projects. Two criteria were important for the selection of these projects. First of all, the projects had to be past the planning phase, this to ensure that talking about interactions was going to lead to concrete results. The second criterion was the potential for interaction. This means that the projects studied should have a certain potential for interaction. The way this has been assessed is by studying publicly available information on projects on the internet and assessing the potential interaction from these documents. The goal of studying the separate projects was to be able to analyze concrete interactions between infrastructures, no attempts have been made to assess whether these projects were making the right choices.

It was quickly found that the major projects in the SEQIPP and in Perth were related to transport. It was decided to continue with the broad setup of the research and focus specifically on how other infrastructure types and their interactions were incorporated in these projects.

These criteria and the limitation of available projects led to the choice of three projects to be used in the case studies: two in South East Queensland and one in Perth. The Darra to Springfield Transport Corridor and the North-South Bypass Tunnel were selected for South East Queensland. The last project selected was the New MetroRail Southern Suburbs Railway line in the Perth Metropolitan Region. Table 4.1 gives an overview of the criteria and the selected cases.

Table 4.1 Criteria for selecting cases

<table>
<thead>
<tr>
<th>Criteria</th>
<th>SEQ</th>
<th>Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Master Plan</td>
<td>Darra to Springfield</td>
<td>North-South Bypass Tunnel</td>
</tr>
<tr>
<td></td>
<td>Transport Corridor</td>
<td></td>
</tr>
<tr>
<td>Past Master Planning phase</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Significant potential interaction with other</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>infrastructure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3.1 South East Queensland

The South Eastern corner of Queensland is appropriately called South East Queensland (SEQ). South East Queensland is heavily urbanized with the south eastern tip of South East Queensland containing the three largest urban population centers of South East Queensland: Brisbane, the Gold Coast and the Sunshine Coast, which account for 90 percent of the region’s population (Queensland Government, 2005b). Regional planning in SEQ focuses around the SEQ Regional Plan and SEQ Infrastructure Plan and Program (SEQIPP). The SEQ Regional plan is the plan that sets targets for land use and development in the region for the coming 20 years. The SEQIPP is an infrastructure planning document presenting an infrastructure program of AUS$80 billion for the coming 20 years to meet growth in SEQ.

The Darra to Springfield Transport Corridor

The south western suburbs in Brisbane are being connected to the Centenary Highway at Darra by Boundary Road. The project has been selected because it met the criteria of being past the planning phase and significant potential interaction. The interaction is
especially obvious when looking at the railway link from Darra to Springfield that is still in planning stages at the moment, but has been taken into account in the planning of the highway upgrade.

**The North-South Bypass Tunnel**
The North-South Bypass Tunnel is a 5 km dual road tunnel being built from the north of Brisbane to the South, which will allow travelers to circumvent the busy Central Business District (CBD, the city center) of Brisbane, which is now impossible in a timely manner because of congestion problems. The project has been chosen because it meets all the criteria listed above. It is part of the South-East Queensland Infrastructure Plan and Program. The project is past the master planning phase and construction of the tunnel has begun in late August 2006. The potential for interaction is high: there are several ventilation ducts that have raised questions about air quality problems. Furthermore, the project is pushed by the Brisbane City Council (BCC) which leads to interesting interactions with the state government. Additionally, the project interacts with the Boggo Road Busway that is being constructed in the same area. Finally, the project will lead to significant changes in the traffic flows to the city and around the entry points of the tunnels.

### 4.3.2 Perth Metropolitan Region
Perth is the capital city of Western Australia (WA). About 75 percent of the approximately 2.1 million people living in WA live in the Perth Metropolitan Region. The Perth region is heavily urbanized. It is one of the most sprawling and car oriented cities in Australia, because of the explicit corridor forming since the 1960’s (Hill, 2005). The metropolitan region has around 1.5 million people, the region is growing rapidly, and is expected to reach 2.4 million people in 2031 (Western Australian Planning Commission, 2004).

**The Southern Suburbs Railway**
The New MetroRail Southern Suburbs Railway in Perth is a railway project from the Perth CBD to Mandurrah 76 km away from central Perth that for the first 26 km of its length runs in a freeway median. Additionally the part of the project running through the city center runs through a bored tunnel. The project was opened at the end of 2007, and is thus long past the planning phase. The interactions with other infrastructure are significant. First of all there is of course the interaction with the road. Additionally there are overpasses, utilities, the Rockingham Transit System and many other interactions.

### 4.4 Data Collection Methods
The case study in South East Queensland is based mainly on interviews, selected through the snowballing method. Seven interviews have been conducted with people involved in the master planning of the region. Furthermore, for the two projects respectively 6 and 4 people have been interviewed. The data from the case studies has been enriched using a document study of relevant policy material. The case study in Perth is based more on document study on the regional infrastructure master planning. For the project 10 interviews have been conducted, selected using the snowballing method. Where relevant the interviews have been used to enrich the study on the regional planning effort. A list of interviewees can be found in Appendix A, together with a justification of the selection method for interviewees.

### 4.5 Analysis of the cases
The main purpose of the case studies is to assess whether the framework developed in Chapter 3 is suitable for the analysis of interactions between infrastructures in the master planning process of a region. This means that no information about this topic should fall outside of the framework, while no superfluous information should enter the
framework as well. The next 2 chapters analyze the case studies using the framework, after which it will be evaluated and improved in Chapter 7. The structure of the case studies in the next chapters is dictated by the framework and partly by the need to understand the background and context of the planning efforts under consideration. The requirements that came out of the literature study in Chapter 3 (summarized in Table 3.1 on page 31) have been mapped to the case studies as follows. First of all, the process requirements of the framework are tested by analyzing the planning efforts in each region. Following that the content requirements are tested by analyzing the case study results from the projects within each region. In both these parts the background of the planning process and the individual projects are described before going into the analysis. The concrete structure of the case studies chapter looks like this (items in italics refer directly to the framework):
1 Introduction
2 Background of the planning effort
3 Analyzing the case master planning with the framework
   3.1 A Focus on Infrastructure
      Criterion under consideration: ‘Involves the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water’.
   3.2 A Focus on Regional Master Planning
      Criteria under consideration: ‘A focus on planning of a region with the region as a holistic entity and taking into account both public and private planning’ and ‘Sets the development objectives of a region and defines the long term program of projects to reach these goals’.
   3.3 The Practice of Planning
      Criteria under consideration: ‘Planning is used as strategic programming’, ‘Plans are used as a communication method and as a way to control internal and external stakeholders’ and ‘Planners work to find strategy, analyze strategy and are catalysts for future thinking’.
   3.4 The multi-actor setting
      Criterion under consideration: ‘The planning process takes a network approach to decision making’.
   3.5 A focus on Interaction
      Criterion under consideration: ‘There is a focus on interaction in the planning process’.
   3.6 Conclusion
4 The project case 1
   4.1 Background to the project
   4.2 Stakeholders
   4.3 Resource Effects of Interaction
   4.4 Functionality Effects of Interaction
   4.5 Dependence interaction
   4.6 Environmental interaction
   4.7 Institutional interaction
   4.8 Multi-actor interaction
   4.9 Spatial interaction
   4.10 Technological interaction
   4.11 Conclusion
5 The project case 2 (contents same as under 4)
6 Improvements for the Framework
7 Improvements for the case
8 Conclusion on the case study
5 Case Study 1: South East Queensland

5.1 Introduction
In this chapter the framework from chapter 3 will be tested against the regional planning undertaken in South East Queensland (SEQ). Regional planning in SEQ focuses around the SEQ Regional Plan and SEQ Infrastructure Plan and Program (or SEQIPP, pronounced seekwip). The SEQ Regional plan is the plan that sets targets for land use and development in the region for the coming 20 years. The SEQIPP is an infrastructure planning document presenting an infrastructure program of AUS$80 billion for the coming 20 years to meet growth in SEQ. The SEQIPP tries to drive land use by putting infrastructure where growth is wanted to occur. The case is interesting, because the SEQIPP contains a program for investment for transport, water, energy and telecommunications infrastructure.

The case Study has been set up with overarching interviews and a document study on the SEQ Regional Plan and the SEQ Infrastructure Plan and Program, which primarily focuses on the process of the planning for interaction. Additionally, to analyze the content of the planning for interaction two individual projects within the SEQIPP have been studied. The first project is the Darra to Springfield Transport Corridor which will contain a highway and a railway line in the same corridor. The second project is the North-South Bypass Tunnel (NSBT), a tunnel intended for commuters to bypass the Central Business District (CBD) of Brisbane when traveling north to south (or south to north). These projects have been studied to get an idea of the effects of master planning on an actual project level, since this is where the costs and benefits of interaction really surface.

There were seven overarching interviews conducted with people involved in the Regional Plan and Infrastructure Plans. For the two projects respectively six and four interviews were conducted. Statements from the interviewees that were relevant for another part of the case study have been reported in the relevant section.

The case study has been set up as detailed in Section 4.5. In Section 5.2 the background to the case study is explored. Then in Section 5.3 the framework is tested using the overarching interviews that were conducted on the master planning process and an analysis of the relevant documents. This section focuses specifically on the process side of the framework. Sections 5.4 and 5.5 focus on the content side of the framework and deal specifically with the two concrete projects from the SEQIPP. In Section 5.6 the found improvements to the framework are addressed. Section 5.7 presents the opportunities and barriers to infrastructure planning for interaction in SEQ. Finally, in Section 5.8 the necessary conclusions will be drawn about the case study.

5.2 Background: SEQ, SEQ Regional Plan and SEQIPP
Queensland is a state of Australia, occupying the north-eastern corner of the mainland continent. The South Eastern corner of Queensland is appropriately called South East Queensland (see Figure 5.1 below). The SEQ region covers 22,420 square kilometers (SEQ Council of Mayors, 2008), extending 240 km from Noosa in the north to the Gold Coast and New South Wales border in the south, and 140 km west to Toowoomba. South East Queensland is heavily urbanized with the south eastern tip of South East Queensland containing the three largest urban population centers of South East Queensland: Brisbane, the Gold Coast and the Sunshine Coast, which account for 90 percent of the region’s population (Queensland Government, 2005b). While heavily urbanized, the urban density is low, which is regarded as an inhibitor of the adoption of public transport (Queensland Government, 2005b). South-East Queensland is the fastest growing region in Australia, and one of the fastest growing regions in the world, growing by “an average of 55,300 persons each year between 1986 and 2004” (Queensland Government, 2005b). The Queensland Government predicts growth to continue at the same pace in the coming decades, bringing the population size up to between 3,46 million and 3,97 million people in 2026 (Queensland Government,
This growth is expected to lead to a demand of 575,000 new houses and 425,000 new jobs up to 2026. It will also require a "wide variety of supporting infrastructures, ranging from arterial roads, public transport and water storages to local parks, shops and community facilities" (Queensland Government, 2005b). For this reason the Queensland Government established the Office of Urban Management in April 2004 "to guide regional planning and infrastructure coordination in South East Queensland" (Office of Urban Management, 2007). The Office of Urban Management resides within the Department of Infrastructure. To reach its goal the Office of Urban Management in 2005 released the South East Queensland Regional Plan 2005-2026 (Queensland Government, 2005b) and the South East Queensland Infrastructure Plan and Program 2005-2026 (Queensland Government, 2005a). "The primary purpose of the Regional Plan is to provide a sustainable growth management strategy for SEQ to the year 2026" (Queensland Government, 2005b).

Figure 5.1 Queensland and South East Queensland (Source: Central Queensland Regional Information System and ourbrisbane.com)

5.3 Analyzing SEQ Master Planning with the Framework

In this Section the process side of the analytical framework is analyzed. In Section 4.5 the structure of the case studies was described in detail. First the focus on all infrastructure types is assessed. Then the focus on regional master planning is analyzed. After that the two major problems with regional master planning are addressed: the practice of planning and the multi-actor setting. Finally, the focus on interaction in the planning process is addressed.

5.3.1 Focus on infrastructure

The Regional Plan identifies infrastructure as a key mechanism to lead growth in a desired direction, "it is intended that, wherever possible, that infrastructure will lead major development, rather than follow it" (Queensland Government, 2005b). The main
goal for infrastructure is to "lead and support desired regional growth" (Queensland Government, 2005b). For this “the Queensland Government has made a commitment to long-term infrastructure planning through the Infrastructure Plan”, officially called the South East Queensland Infrastructure Plan, which "outlines the Queensland Government’s infrastructure priorities" (Queensland Government, 2005b). It is the first time in South East Queensland that there is an infrastructure plan associated with a regional plan. An interviewee: "the difference with this plan in comparison to other plans is that this plan really couples together targets for growth with the infrastructure needed to underpin that growth". The SEQIPP “is linked to the annual state budget and is the principal mechanism for identifying, prioritizing and delivering infrastructure projects to support the SEQ Regional Plan outcomes” (Queensland Government, 2007). This means that the SEQIPP is updated each year in order to match the budget and deal with new developments in the region. The SEQIPP contains project information on several types of infrastructure, these are: transport, energy, water, information and communication technology and social and community infrastructure. The total government investment in the 2007 version of SEQIPP is AUS$82 billion (about EUR 50 billion) over the next 20 years, "including AUS$35 billion in road, rail and public transport project, AUS$78 million to investigate another possible AUS$15 billion worth of road and public transport projects, AUS$ 8 billion in social and community infrastructure, an expected AUS$7,5 billion in water infrastructure projects, AUS$5 billion spending on energy networks (over five years), and AUS$11 billion in expected outlays on energy networks (beyond the first five years)” (Queensland Government, 2007).

In the SEQIPP private investment in electricity, gas and telecommunication technology is not included, because these are competitive markets, for which private sector investments cannot be forecast (Queensland Government, 2007). However, the SEQIPP does contain some initiatives in these areas, mainly from Queensland’s government-owned corporations, like Energex, for which a 5 year planning horizon is included. This means that the telecommunications and energy infrastructure is only marginally represented, as most of this infrastructure is privately owned. The SEQIPP is focused primarily on major state infrastructure, some local projects are included (like the North-South Bypass Tunnel), but there seems to be little consideration for smaller local infrastructure. As one of the interviewees said: “there has been criticism of the plan to say: ‘how can you put together an infrastructure plan without talking to [local government] [...]’? And that’s a valid comment”. Of the state infrastructure the main focus of the SEQIPP is transport, more than half of the forecasted investment goes to transport infrastructure. In the newest version of the SEQIPP there is an additional focus on water infrastructure, because of the draught experienced in Queensland.

From the above analysis using our framework we conclude that the plan only partly meets the criterion of must ‘Involve the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water’. This is primarily caused by a lack of focus on private and local infrastructure. This will lead to lack of attention for interactions between these infrastructures in the master planning phase. Thus, although the SEQIPP includes all types of infrastructure, this critical issue for dealing effectively with infrastructure interaction is not sufficiently addressed in the program.

5.3.2 Focus on Regional Master Planning

"The primary purpose of the Regional Plan is to provide a sustainable growth management strategy for SEQ to the year 2026" (Queensland Government, 2005b). The SEQ Regional Plan aims to do this by “determining appropriate developable land to meet future population growth, providing timely and cost-effective infrastructure and services” and “establishing sound urban development principles that support a compact, well serviced and efficient urban form” (Queensland Government, 2005b). The plan aims to protect the regional environment and biodiversity, maintaining and enhancing the quality of life in the region and supporting economic development in the
region. Another main goal of the Regional Plan is to promote growth in what is called the Western Corridor. This region, including Ipswich and Springfield, is supposed to take a large share of the growth in order to relieve the growth that is occurring especially on the coastline (Queensland Government, 2005b). The Regional Plan is not the first regional planning exercise undertaken by South East Queensland. In 1990 the SEQ 2001 (later renamed to SEQ 2021) was released. This led to three non-statutory regional plans in 1995, 1998 and 2000. However, after 15 years of experience with the voluntary mechanisms in those plans the State realized that more effective mechanisms were required (Hughes and Niven, 2005). As one interviewee stated his opinion on the SEQ 2021 regional plan: “it basically just talked about a range of objectives and goals, but there was no commitment to funding it. So, for ten years we had a regional plan that was riding on nothing more than the goodwill of infrastructure providers to deliver these plans”. The Regional Plan has a lot of weight as a planning document: “the Regional Plan prevails where there is any inconsistency with any other plan, document or code, including any other planning instrument made under state legislation” (Queensland Government, 2005b). Furthermore the Regional Plan is required to be taken into account in other planning and development decision-making, including Queensland Government plans and policies, local government planning schemes. “Where local government planning schemes materially contradict the Regional Plan, the planning scheme must be amended to ensure alignment” (Queensland Government, 2005b). By many of the interviewees this is seen as a strong point in the objective to guide development. As one interviewee put it “we really needed to plan on how to accommodate that kind of growth in a coordinated way, rather than just the councils dealing with it”.

The Regional Plan allocates an urban footprint in the region (see Figure 5.2 on page 40), determining where urban development is allowed, “it protects more than 80 percent of all land in South East Queensland from urban development” (Queensland Government, 2005b). The use of an urban footprint is considered to be a good way to limit growth outside of the boundaries set by government. As one interviewee said: “there is now a boundary around future development, so unless you’re in that pink area you can’t develop. That means that infrastructure can be planned to support a known land use pattern”.

The Regional Plan will be reviewed formally every 5 years in order to be able to respond to future changes in circumstances or preferences (Queensland Government, 2005b). The State furthermore has the possibility to amend the Regional Plan whenever it sees fit, this has already happened once in October 2006 (Queensland Government, 2006). Strangely enough, the Regional Plan and Infrastructure Plan are State initiatives. However, considering that two thirds of the Queensland population lives in South East Queensland (Queensland Government, 2005b), the lack of a strong regional authority and the high growth in the region, it becomes understandable that the Queensland Government steps in to manage growth, instead of leaving it to individual councils. However, as said before, it does seem that the regional focus taken by the SEQ Infrastructure Plan lacks a focus on the local level.

A main issue that was addressed by several interviewees is the robustness and flexibility of the plan. “We have got a problem if you have a twenty year master plan strategy there is a very high likelihood that your regional development strategy might change in that period”. “There’ll always be factors which you can’t foresee now. Particularly if you are looking at a 20 to 30 year horizon, it really is hard to know how said development will occur”. One interviewee gave a concrete example of this: “even with that [traffic and transport modeling] you are going to have your anomalies; even during our study there was a major development application that came in for quite a large parcel of land out there, which could potentially influence the development of traffic flows in that area. So, you start from a strategic planning area and hope that sets it all in place and you can handle what the future is going to be and you can make your predictions of what kind of infrastructure is needed”.

The use of our framework leads to the conclusion that the Regional Plan meets the criterion of having ‘a focus on planning of a region with the region as a holistic entity
and taking into account both public and private planning'. However, as we have seen in the previous section the focus on private planning is minimal. In the plan, the region is clearly defined and objectives are set for its development. Additionally, the plan meets the criterion that it 'sets the development objectives of a region and defines the long term program of projects to reach these goals'. Again the only problem here is that private infrastructure is not taken into account in the program of projects.

Figure 5.2 Urban footprint in South East Queensland (pink area) as established by OUM (Source: Queensland Government (2006))
5.3.3 The Practice of Planning

From the interviews it became clear that the SEQIPP is in itself not a planning effort per se. The plan focuses mainly on major State infrastructure that is planned by the individual agencies. As an interviewee put it: "it does tend to be more major projects and separate functions e.g. energy, water, telecom and transport; they tend to be separate planning entities, because they are trying to feed a need, they don't necessarily fit together to say: 'well, we've got a transport corridor, so let's take a water main as well'". Especially in the first iteration of the plan, the agencies involved delivered their own program for the coming years to the Office of Urban Management (OUM). The OUM in that respect was only involved in reprioritizing certain projects if that was beneficial to the objectives set out in the Regional Plan. As one interviewee put it: "currently OUM sees itself as pulling stuff together from agencies […], picking the obvious stuff and making some sense of it. They would have to move well beyond that to a much more directive and planning role". The primary intentions of the Infrastructure Plan seem to be communication to and control of stakeholders and the community as a whole, to show the direction that infrastructure development is going and gaining commitment. One interviewee, when asked about the primary goals of the plan, made the following remark: "there are a couple of important objectives in SEQIPP. […] One is to make it clear what was happening in South East Queensland, but also, because of the size of the program, to give some comfort to industry, that if they build capacity to deliver it, then there will be projects there for them to deliver. […] the other was to help government better coordinate infrastructure. I think we didn't do that in terms of right things at the right time in the right place and avoid digging up the road ten times for ten different reasons". It is interesting to see how the first goal of the plan is clearly communication, while the second is concerned with control and coordination. Another interviewee from within the OUM said "the plan […] is making sure that all agencies are planning using the same sort of assumptions. It sounds pretty simple, but across the eight to ten delivery agencies, we found that quite a few were using different population forecasts or making different fundamental assumptions about what was going to happen in different parts of the region". Also here, the plan is communicating a chosen strategy.

The conclusion for our framework is that the planning itself is a form of strategic programming, where chosen strategies are codified and made concrete. It therefore meets the criterion of 'planning is used as strategic programming'. The master plan itself is an excellent way to communicate the chosen strategy and the strategic program. Therefore it meets the criterion of 'plans are used as a communication method and as a way to control internal and external stakeholders'. What is lacking in this sense is the planners as the finders of strategy and catalysts for future thinking. The OUM does this only to a limited extent and could do a lot more in this area. Therefore we conclude that the criterion of 'Planners work to find strategy, analyze strategy and are catalysts for future thinking' is not met appropriately.

5.3.4 The Multi-Actor Setting

"To ensure coordination with local governments in SEQ, Queensland Government representatives meet regularly with infrastructure planners and local government sub-regional coordinators" (Queensland Government, 2007). In order to successfully implement the SEQIPP, the Queensland Government has implemented several strategies:

• "Creating the Department of Infrastructure that brings together the planning, facilitation and coordination capabilities of the Coordinator General and the Office of Urban Management […]"
• Establishing the Program Management Office to oversee implementation of the SEQ Infrastructure Plan projects; […]
• Preparing precinct master plans to ensure infrastructure investment is coordinated across delivery agencies and reflects desired regional outcomes; for example ensuring new hospitals are integrated with public transport and other community facilities" (Queensland Government, 2007).
Another goal of the SEQIPP is to encourage construction industry investment in workforce and materials in order to be able to deliver the projects identified in the plan. The SEQIPP does this by ramping up infrastructure spending and trying to keep it stable throughout the life of the program (see Figure 5.3).

An important reason for interaction being hard to take into account is the many stakeholders involved in the planning process and the different, and often conflicting, interests these stakeholders have. Stakeholders that were involved in the planning process were Queensland Transport, Department of Main Roads, government owned energy corporations like Energex and Powerlink, Queensland Health, Queensland Education, Department of Sports and Education, TAFE, the water planning agencies and Treasury. Other involved stakeholders were local government, the construction industry, the community. One interviewee exclaimed: “it is always the case that individual agencies have their own set of priorities and I think that is inevitable, I don’t know how you change that […], the fact that you have silo’s of responsibility”. The interviewees were split between feeling that the most important stakeholders had enough input in the decision making process on the Regional Plan and SEQ Infrastructure Plan and feeling that some important stakeholders were missed, as one interviewee with the first opinion put it, the level of stakeholder involvement was “very comprehensive. Anyone that had any sort of interest in infrastructure in the region, were in land use planning, or […] the community, had the opportunity to provide input into the [SEQIPP and Regional Plan]”. Parties feeling left outside of the decision making process were the local governments ("It was pretty secretive actually, there wasn’t much involvement [from local government], the State pretty much did it and said: ‘here you go’. […] I don’t think there is a lot of coordination between State and Local level") and primary, public infrastructure providers, like the water associations ("They wanted to know the impact of the SEQIPP on the water and waste water network after the Regional Plan had been made, the costs came out to be extremely high, but then it was too late to change. There is no consultation of infrastructure owners, except for transport. Primary infrastructure never gets consulted"). Other interviewees, primarily from the private utilities, did not expect to be given a chance to give input, as building infrastructure is their expertise, not planning it.

A few interviewees addressed the unbalanced focus on transport infrastructure, both in terms of budget and involvement. One thing that was mentioned several times was that both Main Roads and Queensland Transport had an employee seconded to the Office of Urban Management to manage the transport infrastructure planning. This also meant that Main Roads and Queensland Transport proved most content with the planning outcome.
During the creation of the first plans there was a certain sense of urgency: “the initial SEQ Regional Plan was put together very quickly, on a sort of hot house environment, where people were given a very short period of time to put together a regional plan. [...] That way they avoided the forever cycle of bureaucracy, trying to get it a 100% right”. Another interviewee clearly described the advantages and disadvantages of this approach: “the advantage of a short timeframe is that it focuses and forces you to deliver something as good as you can get by a certain time [...]. The advantage of a longer timeframe is that you can potentially address issues like integration and a range of other funding issues more successfully [...]. The disadvantage of that is that you might not end up with a plan, you just keep negotiating and arguing and integrating and you never make a decision”.

One of the problems that a private sector interviewee had was the interface with government, since there are so many different departments involved in planning and infrastructure and they all have their own requirements: “another phrase we’ve got here is that ‘someone let the octopus out of the box’: there’s so many tentacles that when you’ve talked to one government department and got one tentacle into the box, another one flops out at the other side and you’ve got to drag it back in”. Another problem was mentioned by another interviewee: “there are some agencies who prefer the good old days, when they didn’t have to coordinate with anyone else. Some agencies have the tendency, if left to their own devices they’ll gladly return to their old ways and just do it themselves and not take into account a lot of other factors”.

The main insights gained from applying the multi-actor context part of the analysis framework to the SEQIPP case is that not all relevant stakeholders are involved sufficiently in the decision making. This may develop into a barrier to including infrastructure interaction in the planning process. Especially local councils and private infrastructure providers need to be more involved. In that respect the criterion of ‘takes a network approach to decision making’ is not met sufficiently.

5.3.5 Focus on interaction

The Regional Plan aims to “coordinate, prioritize and sequence infrastructure through strategic plans, programs, budgets and statutory planning” and to “align and coordinate infrastructure plans, priorities and budgets of state agencies with the Regional Plan and the Infrastructure Plan” (Queensland Government, 2005b). They signal that “to remain effective [...] this relies on sharing information amongst state agencies and local government to identify, fund and deliver significant infrastructure ahead of time” (Queensland Government, 2005b). For this cross government coordination during implementation the Program Management Office has been set up in 2006 within the Department of Infrastructure, which “is coordinating infrastructure delivery sequenced with the pace and pattern of development planned for the region” (Queensland Government, 2007). Finally, the Regional Plan states that “co-locating infrastructure has the potential to reduce the need for new infrastructure sites and corridors, thereby reducing the overall cost to the community” (Queensland Government, 2005b).

However, from the interviews conducted it was found that the actual focus on interaction in the planning process proves to be lacking. A reason for this is the lack of time, since the planning documents had to be produced in what one interviewee described as a “hothouse environment”, where there was very tight deadline and thus no time to take interactions into account in the actual planning process. Another reason for this was described by an interviewee from the Office of Urban Management: “In some cases some agencies were proposing to do some work that conflicted with the plans in a way, so then we worked with the agencies to reprioritize their program, which was a bit difficult, because agencies are developing plans that are efficient for them, but don’t necessarily work well with things that other agencies are doing or the whole of government priorities. It’s all too easy for agencies to just go off and deliver their own infrastructure without paying much attention to what another department is doing”. Other interviewees questioned the ability to take into account interactions at an appropriate level in the master planning phase: “when you started the master plan you are at a pretty high level, you don’t have much detail so you might look at very
coarse benefits. [...] In the master plan it’s a matter of getting the infrastructure in the right locations and you might be thinking of the interactions, but you probably wouldn’t do that too much. [...] When you move from planning into detailed design that’s where you’re going to be very exact and know where interaction is going to be and design to solve the problems that might arise”. Another problem was illustrated by another interviewee when he said: “When I was working with Brisbane City Council I was very much focused on transport. That was what I did. I didn’t worry about what anyone else was doing, because I was focused on transport”. One interviewee took the position that having more interaction could lead to potentially more interesting results: “the more interaction you have then potentially the better compromise you are going to be able to arrive at”. One interviewee was quite sure that for that a lot needs to change in the process, since “the whole development [of SEQIPP] was focused [only] on transport corridors”. Some interviewees saw positives in just having the plan. As one interviewee put it: “it is just valuable having all the projects in the same report on the same plan so that you can start thinking about the synergies that exist between the various pieces of infrastructure”. Another interviewee said that “the fact that agencies now have to, in their own document, put their major stuff together, anybody can look at it and say ‘hang on, you are planning the hospital then, but the road is not planned until then, so it makes it a lot more obvious, so it certainly helps’. The interviewee from OUM recounted a good example of this when the timing of a hospital, a road and a light rail connection were all brought together in the Sunshine Coast. At first all agencies were against this, but after negotiations with the OUM finally everybody saw the benefit in having a hospital that was accessible via a proper road and a light rail connection, for which a new, unplanned stop was needed near the hospital.

Some interviewees who were skeptical about the focus on interaction saw possibilities for the future, either because there would be more time for it now, or because a change in the process could make it more likely. “I don’t think there was much focus on coordination in the development of the first SEQIPP. I think there is more focus on that now in terms of delivery, but in the actual planning and development of the plan, I don’t believe there was much thought on interaction”. “Now can SEQIPP do that [planning for interaction]? It could if it was a better planned process, but it would require a lot more effort than people are putting in at the moment, because that sort of integration is hard”. Another interviewee mentioned the support that is needed for integration at the highest levels of government.

Even though from the above we can conclude that the focus on interaction is lacking there have been several important changes in the way infrastructure is planned and delivered in SEQ since the plans have been released. An important change is the legislative imperatives that are related to, especially the Regional Plan. This has driven changes in many of the main stakeholder organizations. Main Roads and Queensland Transport have established a Major Projects Office that works on delivering joint projects, Queensland Rail has created a SEQIPRAIL project office that deals with delivering the projects related to railway lines. Since 2006 several organizations have been combined into the Department of Infrastructure, primarily charged with the coordination of infrastructure in the region. This department contains the Office of Urban Management, the Program Management Office and the Coordinator General. Another new aspect is the way projects are contracted. Alliance style contracting is used to institutionalize the coordinated way of delivering projects.

The impact of the plan on the regional objectives is being monitored by the OUM. “Some other process have been put into place around the Regional Plan, sort of development monitoring type processes, so that we’re getting better data in terms of ‘this is where we thought we were going to be, this is where we are now’”. At a local level the plan hasn’t missed its impact. The legislative requirements of the plan force local councils to show how they intend to implement the Regional Plan on a local scale using Local Growth Management Strategies (LGMS’s). The LGMS’s will be used as input for the next version of the SEQIPP in May 2008. Another impact of the plan is the way communication between state agencies and local government is going. As an interviewee from a local government states: “it has been a significant advance,
because historically, we just would not know. [...] There are no new surprises in there [the SEQIPP], but we are just much more informed, I think the State is much more open now”. At local government level the information provided in this way might be the most valuable: “the sequencing, the timing of it is the most significant for us [local government], [...] a lot of the individual projects and investigations we were aware of, or knew that they needed to happen, but it is about when it happens, so that we can bring our planning, particularly our land use infrastructure, on to either follow or influence that”.

A final impact of the plan is that upfront spending on infrastructure planning has gone up. With the hope of getting a better outcome in the end. As an interviewee from OUM put it: “it’s more resource intensive in the planning phases and getting the coordination right, but we’re pretty confident that this will save a lot of resources at the backend of the process”.

In conclusion: the Regional Plan and SEQIPP have led to a change of the infrastructure development process, which also induced taking into account interactions between infrastructures more. The analysis clearly demonstrates, however, that anticipating and leveraging interactions is done at a relatively superficial level. At the programming/planning stage more can be done. This means that the requirement of having 'a focus on interaction in the planning process' is only met partly by the current planning process.

5.3.6 Conclusion
Concluding this section we have seen that the focus on interaction in the planning process in South East Queensland has improved with the introduction of the Regional Plan and the SEQIPP. However, the focus on interaction is still limited in scope and can be improved. We have seen that the almost exclusive focus on public infrastructure has a negative impact on the interactions taken into account in the regional master planning. The regional planning effort additionally has trouble taking into account the local level of planning, which again puts less focus on interaction. The master planning process itself seems very good, the program of infrastructure is a very good asset in the planning. This is also seen in the way the planning process deals with the practice of planning. The planning process is a form of strategic planning and the plan itself is an excellent communicator of chosen strategy and a way to control stakeholders. On the other hand, the planners of the OUM could focus more on finding strategy for interaction and being catalysts for future change. Looking at the stakeholder network we conclude that not all relevant stakeholders are included in the planning process. Local government and public parties should be involved more in the network of decision making in order to make sure that they will not block decisions further down the line. Finally, we have seen that the focus on interaction has improved in the planning process, but that it is still only taken into account to a limited extent.

5.4 The Darra to Springfield Transport Corridor Project
In this section the content side of the framework is tested on the Darra to Springfield Transport Corridor Project. As we have seen in Chapter 3 the effects of interactions are saving or costing space, costs, materials and time in the resource based effects. In the functionality based effects it can increase or decrease safety, throughput, quality and waste. The categories of interactions that can be taken into account are dependence interactions, environmental interactions, institutional interactions, multi-actor interactions, spatial interactions and technological interactions. Each of these effects and categories will be addressed in separate Paragraphs. Drawing conclusions on individual Paragraphs is not appropriate here, so conclusions can be found in a separate Paragraph at the end of the section (Paragraph 5.4.11)

5.4.1 Background
The Darra to Springfield Transport Corridor is a collection of projects intended to upgrade the whole corridor leading from Darra down to Springfield. The SEQ Regional Plan identifies Springfield as a principal activity center, as part of the strategy to
encourage growth in the Western Corridor. The SEQ Infrastructure Plan backs this up by providing new infrastructure from Brisbane to Springfield. The project is to improve the infrastructure linkage between the existing Centenary Highway north of Ipswich Motorway through to the new residential growth area called Springfield. The Centenary Highway is already running down to Springfield, but it’s only a 2 lane highway road. The project upgrades this to 4 lanes, with the possibility to upgrade to 6 lanes in the future. It also includes a railway line from Darra down to Springfield. Figure 5.4 shows the Western Corridor (the pink area). The Darra to Springfield Transport Corridor are the numbers 1.2, 2.5 and 2.6.

Figure 5.4 Projects in the Western Corridor. Darra to Springfield Railway line (1.2), Centenary Highway Upgrade (2.6) and Kelliher Road - Boundary Road Upgrade project (2.5). (Source: Queensland Government (2007))

It is interesting to note here that once you get down to detailed design, suddenly the level of aggregation shifts. This leads to an increase in the number of infrastructures that can be distinguished, which also leads to an increase in the number of interactions that can be identified. One of the interviewees made this clear when he mentioned a shared access path for the full length of the project. This shared access path is a path for pedestrians and bicycles next to the road. One can be sure that this piece of infrastructure wasn’t considered in a lot of detail in the master planning of the project. Not taking these infrastructures often causes problems in detailed design, because these infrastructures bring additional requirements and interactions to the table that were barely considered. An important question is whether there are positive effects of master planning on project results. Without even discussing interaction yet, when going down to more detailed project planning, one always seems to run in problems that weren’t foreseen in the master planning stages. One of the interviewees put this nicely: “as always when you do planning and you come to actually build something you find out that your corridors are too narrow, or tight anyway”. The same is true for the timing of projects: “to me it seems more luck than integrated planning that Ipswich Motorway is happening at a similar time, because it has been difficult to coordinate
some of the timings of when they are going to hand over their formation and we are to have our trackwork through there. The reason I say that is that we are only working through our timing now, if it would have been master planned someone would have aligned that time in previous [planning] and it wouldn’t be quite as hard as it has been. Also there wouldn’t be issues as to who had scope”.

**The Centenary Highway Upgrade Project and Darra to Springfield Railway Line (Horizon Alliance)**

As part of the objective in the Regional Plan to encourage growth in the Western Corridor the Queensland Government plans to upgrade the transport infrastructure from Darra to Springfield. The project includes a new passenger railway line from Darra to Springfield and an upgrade and four lanning of the current 2-lane Centenary Highway. “The project is the first large-scale integrated road and rail project for South East Queensland” (SEQIPRAIL, 2007). Two stations are planned along the railway line and a further two are proposed to be built in the future.

The project is being delivered by the Horizon Alliance: a collaboration between Queensland Rail, Main Roads, John Holland Pty Ltd, GHD Pty Ltd and Kellogg Brown & Root (KBR) Pty Ltd (SEQIPRAIL, 2007).

While in the SEQIPP the road and the rail infrastructure are separate projects, the planning of the two projects has been combined. The remaining 3 km of road will be constructed by the Boundary Road – Kelliher Road Upgrade Project.

**Boundary Road – Kelliher Road Upgrade Project (Centenary Link Alliance)**

Historically, the Centenary Highway was split in the middle by Kelliher Road, a local road (owned by Brisbane City Council), that took all the traffic from both sides of the highway. Main Roads wanted to upgrade this piece of road to highway standard, but was waiting for Council’s financial contribution to these works. Planning for the upgrade started in the 1990’s by BCC, but was put on hold in 1998 because of a study by Main Roads on upgrading the Ipswich Motorway. When this was completed the project was restarted in 2004 with Main Roads support. In 2005 the SEQIPP was released; this plan brought forward in the planning a railway line from Darra down to Springfield that had previously been identified as not needed for another 20 years. This makes it likely that the railway line will precede the construction of the road. This also had an impact on the project and some planning had to be redone, which cost an additional 12 to 18 months, also because of the involvement of Main Roads and, now also, Queensland Rail in the planning. The goal of the project was to provide the missing piece of the Centenary Highway, delivering it as a four-lane highway, while providing for the Darra to Springfield railway line that is being planned. The project was run as an alliance style contract, with Brisbane City Council being the lead agent, with the involvement of Main Roads (as stakeholder and funder of the project), Queensland Rail (as alliance partner) and Bielby Holdings, JF Hull Holdings and Bornhorst + Ward (Centenary Link Alliance, 2006). The AUS$ 40 million project, while led by Brisbane City Council, was mostly paid for by Main Roads (the rough split being 25% Council, 25% Queensland Rail and 50% Main Roads), most of the road infrastructure (the highway) was handed over to Main Roads. The work done on the railway line in this section saves the Horizon Alliance around AUS$ 5 million, since it only requires the laying of the tracks, without having to do groundwork under heavy traffic conditions. According to an interviewee the project was completed and opened on the 17th of August 2007, ahead of time and under cost.

**5.4.2 Stakeholders**

Essentially the planning was done by the Integrated Transport Planning department of the Department of Planning and Department of Main Roads of the Queensland State Government. Queensland Rail was also involved in the planning. Other stakeholders that were consulted were local government, local communities, the Environmental Protection Agency, the Department of Natural Reserves, the Federal Government, the
Springfield Land Development Corporation, Translink, the Horizon Alliance, emergency services, traditional groups, developers in the area, transport companies, potentially affected land owners and finally Treasury.

The main challenge, according to one interviewee, for this project, is integrating the requirements of Main Roads and Queensland Rail. One of the ways to do that, according to many interviewees, is alliance style contracting, or Public Private Partnerships. These PPP’s often include one or more agencies and industry partners. Especially the alliances where Main Roads and Queensland Rail were both given a role in decision making were experienced by many people to be very beneficial. A selection of quotes from several interviewees can be found in Box 5.1.

On the utilities front there were interactions, but most were not planned for. In some ways utilities were accommodated: "if you can plan your work appropriately you can get Telstra and Energex to share the same trenches, so we did some of that", but most of the time people tried to stay out of each other’s way: “we have got a road and a rail, that is great, we have got one corridor and there are some benefits in that already, but as far as the rest of the utilities and services to this, they are all being done independently so far”. As one interviewee stated: “if you have electricity tails, the lead time for getting major tails raised is quite important. In that respect we talked with them a lot and the service providers would let us know what their future planning is and what their requirements are. You also try to involve them in your planning to try to make sure that you’ve got synergies there and making sure that they’re not blocking what you’re trying to achieve and making sure that we’re not blocking what they are trying to achieve". Overall, the sentiment seems to be that utilities are a necessary evil that have to be moved for the project to be able to progress.

Box 5.1 Selected interviewee quotes on alliance style contracting

“It is early days for us here, delivering big infrastructure projects on an alliance type program, but we have found that when taking on an inclusive type thing like that, that you get better advantages and innovation, because you have got the people who have got to live with it at the other end in the decision making upfront”.

“The benefits that we can see from an alliance structure and getting those people together, are that you can address issues of integration right through the whole spectrum of design, construct and maintain better”.

“[about alliance style contracting] Here we have Main Roads on board with Queensland Rail, previously we would have been at loggerheads about this. Here we are working side by side, trying to get a public transport outcome”.

“It has been an opportunity for Queensland Rail and Main Roads to cooperate. [...] Traditionally, cooperation probably hasn’t been as good as it could have been. Culturally, they are different organizations, but certainly the cooperation to date is working well [...] and the memorandum of understanding has firmed up into a joint project delivery agreement”.

“There is a cross-fertilization of people, both Main Roads and Queensland Rail are seconding people to the alliance and that is at the working level and at the board level there are both QR and MR representatives on the Alliance Board”.

5.4.3 Resource Effects of Interaction

When coming down to project level the benefits and costs of interaction are starting to become blurred, depending on who you talk to the project will be either beneficial, or not beneficial to cost, time and resources. The main lessons to learn are that benefits are dependent on the perception of the stakeholder and there are tradeoffs between interactions. Box 5.2 below gives a summary of important quotes on benefits and costs.
One of the interviewees presented planning for interaction as a dilemma: "if it is master planned you could try and make sure those linkages are there without too much cost being incurred, whereas if you are doing it later in the development stage, typically the solutions you come up with are more costly, because you have locked in certain parts of the project. [...] The sooner you deal with the big issues, there are potentially bigger savings”. This means that taking interactions into account earlier has the potential for big savings, but lacks depth and detail, while doing it later provides the detail to be able to do it, but at much higher cost.

An important point was made by an interviewee from Main Roads. He said: "you’re going to have joint drainage, because that’s the logical and economical way of handling it”. Most interactions are not that logical, but once stakeholders see the economic value of taking into account an interaction it becomes a ‘no-brainer’. This might be a key to taking into account interactions in the master planning and programming phases. When asked whether the co-location of road and rail in one corridor was good or bad the same interviewee said: “I think in the end it would be beneficial. It’s a pretty big question that one, but if you would have to acquire a new corridor that would be hugely expensive. So based on the assumption that you have a corridor there which can accommodate both road and rail you wouldn’t go off and purchase a new corridor. [...] So, in terms of social cost as well as dollar cost it’s definitely worth putting it into one corridor when you have that one corridor sitting there. If that wasn’t a problem, if for example it was a very rural area, or undeveloped land, meaning that the social and dollar cost would be lower you probably would separate them, because certainly where we have an interchange the road has to go over the railway line and that’s an added cost”. This illustrates the same point from a slightly different perspective: interaction cannot be a goal in itself, if not interacting (in this case by using separate corridors for example) is more beneficial than interacting, interaction should not be done. An additional question to ask here is to who it is more beneficial, but we’ll get to that point later.

Box 5.2 Resource based costs and benefits to taking into account interaction in the Darra to Springfield Transport Corridor

**Costs, resources and/or time – Positive**

“The benefit is that we don’t have to come back into the future, and build a road next to an operating railway, which is extremely difficult. [...] If we had to build that after the railway was finished it would take much longer and cost more, because you can only build them in the middle of the night, and the longer it takes you, the more its going to cost”.

“There were significant cost savings by involving Queensland Rail in the [Boundary Road – Kelliher Road Upgrade] project, and in doing their works in the order of around AUS$5 million for us doing our project”.

“Obviously there are cost savings to be made with that, no re-work hopefully, allowing for future services connections saves money. We could easily do it as part of our project [Boundary Road – Kelliher Road Upgrade], whereas later on it would be very difficult [...] and probably the opportunity lost, because the disruption would be too great”.

“There will be obviously economies of scale in that the equipment we need for the earthworks for the rail is the same as the equipment we need for the road so we only have one set of establishment”.

“As far as costs are concerned, there are opportunities for saving costs by constructing things together. [...] You can also save money and better utilization of your earthworks so you are able to get a more economical earthworks solution by being able to shift spoil to borrow, borrow to spoil between the corridor elements rather than just along the corridor”.
Costs and/or resources – Negative
"It will increase the cost of the road to an extent because the rail vertical alignment is much more stringent than the road vertical alignment".

“There may be some additional materials costs involved because having two pieces of infrastructure side by side makes intersection interchange arrangements more complicated and so you will get a more complex and expensive interchange, because you have to not only connect into your road, but you also have to span the adjacent railway line so that results in more expensive ramp costs etc”.

Space – Positive
"If these were two separate projects you would require more land to construct”.

"We will save space because just by running both the rail and the road down together, there are common batters so it should be narrower than it would be otherwise”.

"The telecommunication lines for road and rail, you can share there, even if its just the trench for it”.

5.4.4 Functionality Effects of Interaction
The safety and throughput aspects of interaction are detailed in Section 5.4.9. The basic conclusion there is that extra costs were required to keep safety at an acceptable level for both the road and the railway. On the throughput aspects the railway might suffer from the road because its catchment area is reduced. On the other hand, the railway has a good potential to reduce congestion on the road.
It became apparent from the interviewees that any adverse quality of service effects of interaction had to be mitigated. In this way the cost and time of building the infrastructure went up, but the quality remained the same.
The waste effects of interaction have been detailed in Section 5.4.6. Additionally, the shared corridor caused less waste in the earthworks as has been described in Section 5.4.3 above.

5.4.5 Dependence Interaction
No dependence interaction was mentioned in the interviews.

5.4.6 Environmental interaction
One interviewee mentioned the advantage of having road and rail in one corridor made the containment of noise easier.

5.4.7 Institutional interaction
Maybe the most complex aspect of co-locating infrastructure is the institutional side of things. Interviewees raised very diverse issues and advantages to the institutional aspect of interaction.
One of the interviewees mentioned that there was plenty of time to consider interactions between infrastructures for the Boundary Road – Kelliher Road Upgrade project, because this project was in the planning stages for a number of years, while it was being held up by various institutional barriers. Here the institutional interactions between the road and the railway, which caused many of these delays, made it easier for the planners to plan more thoroughly.
The access to sites can be shared, with agreement that multiple agencies can use that access. On the other hand, communication lines can not be shared, because it is a mission critical asset to Queensland Rail; the trench for the communication lines, on the other hand, will be shared by the two parties.
Another aspect of institutional interaction is the differing construction and engineering standards that the two agencies use. "Wherever we had differences in our standards we had to take the harshest standard".

One of the institutional problems that is encountered often is the difference in organizational culture and conduct between Main Roads and Queensland Rail. "Main Roads is a full government body and Queensland Rail is a self-governed government entity. This often leads to problems in the interaction". From a legal perspective this is also a potential issue in the future: "you also need to consider your future when you're operating it, because the rail is operated by a different authority to what the road is operated by. [...] So, it's important to look at the legal aspects between two different entities in the same corridor". Solutions to the legal aspects are being looked at in the way of common area agreements and co-location agreements.

Finally, when you get really deep into the institutional aspects of interaction the difference between reserves for railways and roads starts to make a difference as well. "We normally just designate our corridors as road reserve and railways have their own sort of designation. We need to work out whether we just create a new type of transport corridor and what that means then".

5.4.8 Multi-actor Interaction

No multi-actor interaction was mentioned in the interviews.

5.4.9 Spatial interaction

Obviously, with the co-location of infrastructure, on the spatial interaction side there are a lot of interactions.

Safety

From an operational safety perspective, various measures had to be taken to ensure an acceptable level of safety on both the road and the railway. These measures include keeping the railway slightly higher than the motorway, in order to keep errant vehicles from going onto the railway, in places where this is not possible retaining walls will be constructed. Furthermore, emergency services often access calamities from the other side of the motorway, for this reason the choice was made to make sure the railway would not run through the middle of the two road halves. This again shows the tradeoffs between various sorts of interactions, since these measures caused the cost of the projects to go up to keep safety to an acceptable level. From a construction safety perspective "building two elements at the same time puts them all under the same safety plan for construction which means to say you have got one safety plan that you are trying to manage, rather than two separate ones".

Throughput

In different interviews two interviewees mentioned the effects that having a road and rail together might have on the throughput on both. The first interviewee pointed out that having the rail might cause less people to use the road (which would possibly not be a bad thing because of the congestion). A very different thing is happening on the rail side: "if you have got a rail station that isn't constrained by road, you are able to get 360 degrees of access from the adjacent community, you can build that in, whereas sitting beside a major highway you lose a percentage of that accessibility".

Utilities

The interaction in this project with utility services was basically to relocate or rebuild them when they were in the way. No specific effort seems to have been made to get them on board and share the same corridor. "Most services can be managed. It is just a matter of how you manage it, sometimes you have to relocate it, if you need to widen a corridor. Sometimes you need to reconstruct a gas line or a storm water drainage, because what used to be the verge of your road is now going to be road, so you need to build a new services corridor to the side. If that needs to be done it will
5.4.10 Technological interaction

Technological interaction is interesting, because it is tightly related to spatial interaction and the resource based interactions in this case. "From an engineering perspective, especially the grades, or slopes, of a railway line is a lot more restricted than a road is [...] Your railway line can't move up and down with the terrain, so you're building a lot of fills and cuts through hills to try and keep it quite level. With your road you could do the same, but then your earthworks costs will blow out, so then you're forced to have retaining walls between the road and the rail where the levels are different".

Another aspect that was mentioned is the fact that some infrastructures don't interact very well with other infrastructures. The example was given of water and electricity, but many more examples are available. Dijkema et al. (2007a) also deals with this aspect of interaction.

5.4.11 Conclusion

To conclude the section above we have found a lot of interactions in different categories. The only categories of interactions that have not been found are the multi-actor and dependence interactions. Overall we can conclude that, while interactions are being taken into account in the design of the project, indeed the focus in the master planning on interaction was limited to combining the two projects together. Other interactions have also been found, these will be addressed in Section 5.6 below.

5.5 The North-South Bypass Tunnel Project

In this section the content side of the framework is tested on the North-south Bypass Project. As we have seen in Chapter 3 the effects of interactions are saving or costing space, costs, materials and time in the resource based effects. In the functionality based effects it can increase or decrease safety, throughput, quality and waste. The categories of interactions that can be taken into account are dependence interactions, environmental interactions, institutional interactions, multi-actor interactions, spatial interactions and technological interactions. Each of these effects and categories will be addressed in separate Paragraphs. Drawing conclusions on individual Paragraphs is not appropriate here, so conclusions can be found in a separate Paragraph at the end of the section (Paragraph 5.5.11).
Baulderstone Hornibrook and also the tunnelling experience of Bilfinger Berger. Leighton Services and Bilfinger Berger Services will maintain the North-South Bypass Tunnel during the concession period” (RiverCity Motorway, 2007).

One of the interviewees alluded to the actual reason for building the NSBT as “the real reason Brisbane City wants to get less cars in the CBD, is because during peaks we can’t get enough buses in the center of town, because its saturated. The idea is to get those cars out and promote buslanes in the center of town, so we can actually improve public transport to get people into town. And that theoretically should reduce the number of cars. It’s strange to do more roads to get them out, but that’s hopefully [the result] at the end of the day”.

It needs to be mentioned here that it was very difficult to get a sufficient number of interviewees for this project. Many people were unwilling to be interviewed, even under explicit guarantees of privacy. From various sources I heard that some political turmoil caused this problem, but in the interviews I did do, there was no evidence of this.

![Figure 5.5 The North-South Bypass Tunnel and Airport Link projects (Source: http://www.brisbaneairportlink.com.au)](image)

5.5.2 Stakeholders

There are three levels of stakeholders that could be identified in this project. On state government level the involved agencies are Main Roads, the Department of Infrastructure, the Departments of Health, Natural Resources, Emergency Services, Police and Queensland Transport. Because of the extensive number of government agencies involved the Department of Infrastructure has a key role in helping to coordinate with the state departments. At a local government level Brisbane City Council is involved, since its the initiator of the project, but also because it runs the
water services and sewer services. In that respect Council is interacting with itself at that level, however inside Council there is a division traffic and transport, which had to be integrated with RiverCity Motorway’s stakeholders. Since the project is contained in the Brisbane Council there is no need to interface with other Councils. Then on the level of utilities the following stakeholders are involved: Energex, the gas suppliers and telecom operators, like Telstra and Optus. And then there were the major industrial players like Queensland Rail. Additional to that there are “20 banks who finance the deal, so any changes that have to be made to the project, for example adding a busway, have to go through the banks and that takes time. It constrains adding things that might be of benefit, which makes it very important that when the deal is struck, there is full visibility of anything around the project that’s going to affect it”.

The project interfaces with Main Roads on the South East Freeway, with BCC assets in the north, which means that design and connection details in the south need sign-off by Main Roads, while it needs sign-off by BCC in the north. An interviewee from Main Roads is very happy the way this interface is set up: “Another example is the North-South Bypass Tunnel and the interface with our network being done as a joint project and also how it hooks into the South East Freeway. All the work that needs to be done on our network is being done as part of the tunnel, which didn’t necessarily happen before”.

Dealing with State government has been difficult in this project. An interviewee remarked: “the state government has lots of tentacles and they have a lot of different departments; you’ve got to interface with all of them and that makes life very difficult, that’s why the Coordinator General [Department of Infrastructure] is there to help in its role as coordinating the state departments. But that doesn’t mean to say that you don’t get low level problems, because you’ll be dealing with a department and they don’t like to be overridden by a coordinator general, so they try to get a consensus type setup. And we’re here with a hard dollar cost and a timeline, so they’re not necessarily conducive to the right outcome we’re looking for”. An interviewee from Main Roads asserted that for this project there “is a focus on the whole of government outcome’. For this “there is a quarterly meeting of senior managers of the different stakeholders involved. These meetings are done in good honor”. Other ways to resolve issues are: “weekly meetings are being held in an informal setting” and “conflict resolution is handled in the deed, with the possibility to go to an expert witness”.

5.5.3 Resource Effects of Interaction

The Boggo Road busway is the main interaction that was mentioned in the interviews, this busway is being built in the same area at the same time that the NSBT is doing construction. This was beneficial for several reasons. First of all, it minimized the disruption for road users. Secondly, it saved the construction of part of the structure that would later be demolished when Boggo Road Busway would come in and do their work. For the NSBT project this meant additional cost and time, because this interaction was not scheduled, however, the State payed the extra money, because it saved community impact to do the interaction. This also meant that it saved the Boggo Road Busway money, they didn’t have to do the traffic control arrangement again.

On a detailed planning level interactions are looked at from a project management perspective: “they [interactions] were looked at on a risk basis and a dollar basis. So, if there was a direct cost, they obviously had direct effect on the outcome dollar value. If they had a risk factor [...] and if that risk is sufficiently high then we put it in the contract terms to either transfer that risk or accept it by Council”.

Again, in this case study an interviewee mentioned the different perceptions on cost and benefits. “There are many sides to interaction and benefits, and what’s perceived by one party as benefit may not really be seen in the contractual light or be different things by others. [...] What might be a benefit to me, might not really be a benefit to the Design and Construct contractor”.

5.5.4 Functionality Effects of Interaction

No safety effects of interaction were found in this project.
On the throughput side the effect on the throughput in the CBD is intended to relieve congestion there and make the CBD more accessible for buses. In this study the only quality effect found was the expected increase in level of service of the CBD road network because of the reduced congestion.

The waste effects of interaction are treated in Section 5.5.6. The basic conclusion there is that it is undecided whether the tunnel will have a positive or a negative on waste.

### 5.5.5 Dependence interaction

It may seem obvious, but one of the interviewees pointed out that during construction, in order to be able to construct the infrastructure, the people are dependent on other forms of infrastructure: "communications, water, energy, they are all things that we use to varying degrees over the various phases of the project. We had a strong energy requirement for developing the project, the tunnel boring machines (TBM's) and road hitters are all run by electricity, and temporary ventilation systems during construction, temporary lighting systems, all powered by electricity". This may seem like no real issue, nothing to consider, but the same interviewee pointed out that the draught in Brisbane is causing some serious problems, because a lot of water is needed for the TBM’s and this is costing additional money.

### 5.5.6 Environmental interaction

The project has received some criticism to the use of two ventilation stacks, which would according to the protesters cause a high amount of toxics to be released in a concentrated area (The Rivermouth Action Group Inc, 2008). However, one of the interviewees asserted that these stacks will be high up in the air stream and so might be even beneficial, since the tunnel will likely remove some cars from the CBD that would release their fumes on ground level over there. An additional thought, wholly my assertion, is that given the right filtering technology these stacks could also be used to clean the air of toxic materials.

### 5.5.7 Institutional interaction

One of the institutional problems associated with the NSBT project is that the other TransApex projects are not yet confirmed. The capital and resources requirements are too great for these projects to be run parallel. The other projects also still have to pass the Environmental Impact Assessment (EIA) and business case. “On the northern end of the tunnel we interface with the airport link project, it links with this project. If these projects had been integrated and build together, there could have been a saving in money, but because of the size of both projects and the resources required for both projects you can’t build them at once. So we’re going to have two years where we’re operating with infrastructure that’s going to be demolished, so that will be a cost that’s lost to the community at the end of the day”.

### 5.5.8 Multi-actor Interaction

No multi-actor interaction was mentioned in the interviews.

### 5.5.9 Spatial interaction

**Boggo Road Busway**

Even with a tunnel project there was a lot of spatial interaction. The most significant of these being the Boggo Road busway. This interaction came in rather late, when the project was already well underway in the construction stage did the Boggo Road Busway turn up. "We have interactions with a busway, called the Boggo Road busway, on the southern end that has some positives and negatives in it. Its costing additional money, we’re adding costs, however, we’re saving the community time and community cost. The tunnel and the busway cross, so if they wait until we finish, they’ll just dig the road up and cause more congestion cost. The state has agreed to pay some additional money to allow that work to happen at the same time, so that
that future disruption cost goes away”. Of course this meant that “it is a little more complicated, having two constructors in the one work zone, there are some coordination issues”.

Utilities
In the NSBT project the attitude towards utilities is simple: “electricity, communications, water, [...] they are not the primary interface, but a secondary one. We call them PUP’s, Public Utility Plants, which have to be moved in order to build for us what we want to build”. There seems to be little focus on creating added value by interacting with these infrastructures in a smart way. There is some thought about it though: “one of the problems we’ve got is that we move them once for us and once for airport link, otherwise they’re going to have to pay to get them moved again. And they’re not designed yet, so we’re having a bit of a coordination problem”. And some issues as well: “on southern end we’re working with the Boggo Road busway to coordinate the moving of the services, so that we don’t have to do that twice. But that is a major part of that works, we’ve been at it now for 9 months, moving services in that area”. On the other hand, some utilities are being added in the tunnel: “we’re putting some communication lines in for future perceived needs”. And if other people want to add more there would be no problem: “there’s no reason why, if someone had a need to put a water main or a gas main, well the gas main is a problem because of the explosive content, or an electricity cable through the tunnel as long as they would be willing to make a commitment in time and meet the design schedule so not to hold up delivery”. One was considered, but was deemed to risky: “we were looking at putting a water main next to the tunnel, but the risk and the potential level of that risk, we decided to do otherwise. We are at some point 50 meters under the ground and its not easy to maintain things in the tunnel”.

A philosophical perspective on tunneling
One of the interviewees provided a rather philosophical approach to tunneling. He said: “trying to find space, time, availability in the network to do things on the network is a major problem now. [...] Building a tunnel takes more time and it costs more money that is a fact, but you save destroying the city and probably if you had to destroy the city you wouldn’t be doing it”. When asked about interactions this lead him to the following remark: “most of our space is subterranean. [...] If you take it another way and say ‘look because of all the infrastructure that is already developed in Brisbane’, the most efficient way through that is not to disturb it but to go somewhere else which is underneath”. In that respect tunneling by itself is a form of spatial interaction.

5.5.10 Technological interaction
No concrete technological interactions were mentioned during the interviews, but one interviewee said the following: “with these kinds of projects, the complexities in the physical structure are really at the very, very low level of detail”, indicating that some technological interactions will only surface during detailed design, not in the master planning or programming stages of the planning process.

5.5.11 Conclusion
In this section we have also found a lot of interactions in different categories. Also in this project the only categories of interactions that have not been found are the multi-actor and dependence interactions. Overall we can conclude that this project hasn’t been planned for interaction. The interactions that are being dealt with right now are emergent interactions, not planned. An interesting perspective is that tunneling is a good way to avoid spatial interactions, which in itself is a way of mitigating the effect of the infrastructure on other infrastructures. Other interactions have also been found, these will be addressed in Section 5.6 below.
5.6 Improving the Framework
Not only can the planning for interaction in SEQ be improved, the framework for analysis presented in Chapter 3 has been tested using the SEQ case study. From this, the following improvements can be extracted.

5.6.1 A program leader or champion
Several interviewees mentioned the fact that there needs to be a strong leader for a planning effort like the SEQ Regional Plan and Infrastructure Plan. "We had a very strong minister who was keen to address the issues, that was minister Mackenroth, who was in charge of the planning area". It seems that without a good planning effort, there will be no good planning on interaction as well. As one interviewee put it: "we need leadership in planning, get the planning wrong and nothing else matters". This champion does not fit in the framework as presented in Chapter 3.

5.6.2 Other types of interaction
During the interviews, several new types of interaction were found that were not in the initial framework. These were either directly stated by the interviewees as lacking in the framework, or were found implicitly by analyzing the interviews.

The timing of interaction
The SEQIPP caused the Darra to Springfield Railway Line to be moved forward in the planning. This brought the timing together of the two projects, which enabled most of the interaction to take place in the first place. This is an important example of the timing of interaction, there is a specific window of opportunity for interaction, if that window is missed the beneficial interaction could be lost. Another example of this was mentioned by an interviewee from Queensland Rail: "there is an opportunity to run utility services out along the line, so optical cable and things like that to Springfield, although we are potentially a little bit late, they are building a big data centre out at Springfield, if we had been a little bit earlier, we could have run optical cable out to them, and rented them cable space on the QR optical cable network, but time might beat us on that one". Here the timing is focused on interaction with a private partner, the benefits here are potentially much smaller, but even these sort of interactions are interesting. Another interviewee mentioned an issue with the relocation of a utility cable that could have been moved only once if the timing was better: "we knew that the Energex cable that we were relocating was going to have to be relocated by someone else as well, [...] if we had more time we could have relocated it into its final position. [...] So, we could save them time and money in the future when they started their road works for the project".

The timing of the Boggo Road Busway is an example where earlier planning could have saved time and money by taking this interaction into account earlier. The way the interaction was handled, because it was too late, meant that it cost some extra money and time. If it had been considered earlier in the planning these extra costs could have been avoided by optimizing the timing of these projects.

The total resource use in a region
The Centenary Link Alliance was started about two years earlier than most other alliances. The cause for this was the "resources shortage" in SEQ, which makes it hard to find good skilled workers for construction work. Queensland Rail saw an opportunity to start early to make sure it didn’t lack the needed resources. Part of the resource shortage problem can be attributed to the boom in infrastructure projects caused by the SEQIPP. This points to another interaction that a program of projects needs to take into account: the ability of the construction sector to deliver the work. A program of projects should not cause a resources shortage like this, which is a kind of overarching interaction that was not in the initial framework, but is very relevant in the programming phase of regional planning.
Community impact
Something that was mentioned by a lot of interviewees is the impact of construction work and new infrastructure on the community. Community impact is a thing, which all interviewees agreed upon, is something to keep low. There are several ways where planned interaction can reduce community impact. Having two infrastructures in one corridor means that you are only dealing with the community once, instead of twice. The same goes for the relocation of utilities that can be coordinated in such a way that the community is only disrupted twice. Road works can also be coordinated together, making sure that there is congestion only once, in stead of twice. This is the main reasons why the Boggo Road Busway and North-South Bypass Tunnel are having their interaction.

Box 5.3 Selected interviewee quotes on community impact

"During the construction we are interfering with the road network, so in providing the infrastructure, we’re affecting the network and there is a cost to some of that”.

"There are other things like community impact, in that obviously having the two major transport in one corridor you are not dealing with the community twice”

"You are only modifying it and disrupting the community with service relocations once as opposed to twice for two separate projects”.

5.7 Improving planning for interaction in SEQ
Of course one of the main themes in the interviews conducted was the question how master planning for interaction can be done better. In this section the main comments from interviewees has been grouped. Several of the interviewees pointed to the fact that the master plan is only 2 years old, expressing trust in the ability of government to start taking into account interaction more as the plan matures over time.

5.7.1 The problems
Several problems can be identified in taking into account interactions in the programming and master planning phase. First and foremost is that it is no priority; agencies do not have the time or the resources and the focus lies mostly on getting the best outcome for the individual agency. For some stakeholders there is no incentive to cooperate with planning for interaction, sometimes there even is an incentive to not cooperate (that will be discussed in the next Paragraph)! Secondly, a problem is that taking into account interactions at this stage of planning is difficult, as one interviewee put it "thinking about those things upfront would be very good, but we are not in Utopia". It is just hard to think thoroughly about positive and negative interactions, when nothing about interacting projects is certain; no budget, no timeframe, no team. What also does not help here is that planning in Brisbane is, as it is in most other places, not as rational as most literature would want it to be. One interviewee said: "the whole infrastructure planning in Queensland does tend to be, ‘oh foot to the accelerator’, oh no costing us more’, then the foot goes on the brakes, so it is not quite as orderly as it should be”. In that respect, even if it is in the program, emergent strategy, or the budget cycle, might make a project obsolete. Does spending money on planning for interaction in that uncertain phase make sense then? A third problem is that not all stakeholders are involved to a sufficient extent to be able to take into account interactions in the planning process. Local councils felt as if they had no input in the plan and yet, a lot of local infrastructure is interacting with the State infrastructure. The same is true for public and private utilities, that for various reasons are not involved in the planning process sufficiently (more on utilities in Paragraph 5.7.3). A final problem is that not all costs are measured equally in planning decisions. The cost of traffic interruption and infrastructure relocation isn’t taken into account sufficiently in most decisions; yet these costs can be very high. This
kind of interaction between infrastructures is exactly what we argue should be taken into account more. Box 5.4 summarizes the main quotes that have been used to draw up this list of problems.

Box 5.4 Selected interviewee quotes on problems with planning for interaction

**Stakeholder Commitment**

"People either haven’t got the time or the resources, or agencies are unwilling to cooperate”.

"The telecoms can go anywhere they want to and they do”.

**Uncertainty in planning**

"The whole infrastructure planning in Queensland does tend to be, ‘oh foot to the accelerator’, oh no costing us more’, then the foot goes on the brakes, so it is not quite as orderly as it should be. [...] You wish when there was some money in the coffers, that they only did two-thirds of the things they thought of and that spending on infrastructure was the peaks and troughs were taken out of it".

"The devil is in the detail and you have only got a certain amount of information to start off”.

"The fact that these projects are in a master plan does not mean that they have been approved by government. Until you get a tender in and negotiate that tender and get it signed and ticked by the government you don’t actually know if you’ve got a project. [...] We still don’t know [...] if it will happen, if the finance doesn’t work or no one wants to build it or do a PPP for it, it just won’t be build. So, you can’t necessarily rely on what is in the plan”.

**Stakeholder involvement**

"To engage a bit more and even seek feedback if they are bringing this out annually, to get our [local government] input before they release it instead of saying: ‘here it is’”.

**Taking into account all variables**

"In Brisbane, the social cost of traffic interruption and capital cost of infrastructure relocating isn’t taken into account in most planning decisions, and is high”.

5.7.2 The Solutions

Many of the interviewees also gave solutions to the problems that they mentioned above. In this paragraph the solutions that interviewees gave on the problems above will be presented.

**Stakeholder focus**

To get stakeholder focus, some interviewees suggest completely changing the way that government plans infrastructure, by creating a kind of super planning department, that does all the infrastructure for the whole of government. Some interviewees also see weaknesses in this approach: "while you might create some efficiencies in terms of integration of infrastructure, you might lose some efficiencies because of lack of integration with other government core business”. Another idea that was given is to give the Department of Infrastructure a more coordinating role in infrastructure planning, as one interviewee put it: "a stronger Coordinator General department [now Department of Infrastructure], where it has a recognized role in coordinating and it is accepted that certain projects will have to be delayed or brought forward to better suit a whole of government outcome". The same interviewee also saw a problem in this: "while people would accept that face to face, in practical terms they will ignore it for as long as they could, because it detracts from their focus on their project". One
interviewee gave a long quote, but very balanced on this topic: “what is needed is an integrated planning program that overarches the responsibilities of each of the delivery agencies that gives them the opportunity to put some of that together. Now the SEQIPP is the start of that process, but it won’t be successful of and in itself, because the infrastructure plan and programming doesn’t actually do the planning, it demonstrates the results of the planning. The planning needs to be done upstream and the need for integration between elements and co-location of infrastructure elements if that’s required needs to be identified early by a central body rather than individual delivery bodies tripping over the opportunity at some stage, which is exactly what happened here [...] The Department of Infrastructure has a role to ensure that they get the best value out of the infrastructure budget that is available and if there are cost savings to be had through infrastructure and interaction with each other, I think they have a role in that”.

Uncertainty in planning
As a solution to resolve the uncertainty in planning, several interviewees advised to “stick to the plan”. However, this same interviewee saw that this “is a problem for governments because they like to change things to generate political attractiveness for a particular government, it happens on a regular basis due to elections. [...] The horizon that is set is never struck to”. Another interviewee took a slightly different perspective, giving the hypothetical situation that “if government was prepared to say: “this is going to happen”, people would be able to take a slightly different risk profile. For instance you could integrate some of the other infrastructures with that, if rather than just a plan it was a confirmed plan. The problem is that a master plan to a degree needs to be flexible until you get into the environmental impact statement you don’t know if the plan is going to fly, until you get into the business case you don’t whether it’s going to fly. So, you’ve got those uncertainties, so if you had a government with pots and pots of money and they said: “we’re going to do this” then you could coordinate and integrate all of this, and maybe you could save us lots of money by doing this which will make it worth our while and make it worth our investment. But without that, you’re left with a master plan that only says what we would like to do, not what we’re going to do”. To draw us back to reality, one of the interviewees mentioned that he thinks the SEQIPP will reach the end of the budget, before the end of the program: “the plan for what it is spends the budget, but my prediction is that you will reach the budget in five years. Most of the projects that are happening at the moment are at least double the estimated cost [...] I suspect the SEQIPP plan to be very successful, but not all of it is going to be built”.

A final problem with committing to a plan rigorously is that it does create an additional dilemma, because there is another requirement of planning, namely flexibility. Two interviewee quotes illustrate this dilemma adequately: “there should be flexible ways to change plans if the situation changes, but it should be transparent” and “whilst its good to have a 20, or 30 or 40 year target, you still need the ability to reflect and to see if your original assumptions are still accurate”. Given the uncertainty of the future, fixing a plan to complete rigidness is probably not the best solution. Could there be a different way to manage uncertainty?

Stakeholder involvement
Obviously, to involve stakeholders more, they should be allowed input in the decision making. There should be appropriate process mechanisms in place to make sure that all relevant stakeholders get their say.
It has been mentioned in the paragraphs above before, but one thing that a lot of people are very happy with is the alliance style contracting, which is also a measure to involve people in the decision making process in a constructive way. “One of the big advantages of doing these things together is that its much easier to deliver the things much friendlier; you don’t have to argue with everybody, you can just do it. The way that this [the alliance style contracting] is set up makes that easier”. One stakeholder that does not normally get involved in the planning process is the constructor. On the Horizon Alliance, because the alliance was started so early, the
business case for the project was created with input from the constructor. One of the interviewees expressed that this was a great thing, because "there is a lot more history in infrastructure projects where the business case is done in isolation from constructor input and as soon as the cost comes in [from the constructor] it is about as twice as the business case, and there is a rude shock". In the case of the Horizon alliance, they "are very comfortable that the planning top figure in the project is achievable".

Miscellaneous
A final solution, to a problem that wasn’t mentioned above, is the suggestion of one of the interviewees that "when a water main goes under the ground, put the electricity wires under the ground at the same time, so that our grandchildren won’t have these ugly overhead wires".

5.7.3 Including the Utilities
During the interviews it became clear that the utilities, the underground cables and wires, are planned and dealt with in a very different way from transport infrastructure. Most of the time the interaction with utilities is seen as a necessary evil, something that just needs to be dealt with. However, as we’ve seen in the case study the cost of infrastructure relocating is often high, taking a lot of time and resources. There seem to be several reasons why utilities aren’t taken into account in a different, more proactive way. First of all, there is attitude; the way utilities are handled has been like this forever, so why change it? The general feeling that many interviewees seemed to have this resignation to the way utilities are handled. A second reason is the fact that many of the utilities have been privatized over the years. “They might not want to co-locate or coordinate with Main Roads, which is a state run department”. An interviewee from Energex said about alliance contracting: “Energex never takes part in these alliances directly, but works on a contractual basis with them”. The privatization has also led to institutional problems. A company like Energex is not allowed to plan more than 5 years ahead and must always implement the cheapest solution due to monopoly regulation. A third reason is the technical complexity of locating all utilities in one corridor: “they all have their own technical requirements on what pipes need to be in the ground, what pipes can be around them, near them or what can drive over the top of them”. Box 5.5 gives an overview of selected interviewee quotes on the problems mentioned above. Especially due to the attitude about utilities most people have only mentioned problems around the utilities, no solutions to those problems. We’ll get back to possible solutions in Chapter 7.

Box 5.5 Selected interviewee quotes on specific problems with the utilities

Privatization
“Effectively some of these [infrastructures] are privatized, like electricity, they might not want to co-locate or coordinate with Main Roads, which is a state run department”.

“Energex never takes part in these alliances directly, but works on a contractual basis with them”.

“A lot of these utilities [...] are presently government owned and there are opportunities for infrastructures to be managed in a coordinated way, however over the last 19 or 20 years in Australia and certainly in Queensland, the competition policy has kicked in and a number of these infrastructures are now privatized, and I suppose that is the tension where in fact there is greater movement towards segregation rather than integration”.

Technical difficulty
“It would be lovely if the services, like the water, the energy and the telecom could all use the same corridor, but it doesn’t normally work that way, because they all have their own technical requirements on what pipes need to be in the ground, what pipes
can be around them, near them or what can drive over the top of them. We have tried to put in place memorandums of understanding with parties like Powerlink and Energex, which would basically outline how we work with them and we’ll let them know in advance when we want to move some of their infrastructure around and they’ll agree to respond and we’ll supply them whatever they need to know to be able to do it, but that has only been done one on one, with only a particular service authority”.

5.8 Conclusion

In this chapter we have analyzed the regional master planning in South East Queensland using the analytical framework presented in Chapter 3. From this analysis we can conclude that the Regional Plan and Infrastructure Plan are not really the planning, they are the result of a planning effort, that is mostly not integrated. The SEQIPP also does not contain as much of the infrastructure planning as it seems to do, since the energy and telecommunications categories are relatively empty. The coordination of planning that the Office of Urban Management does at the moment is too limited to really take into account interactions in the programming phase of infrastructure planning, except for some specific examples where the Office has created some planned interactions. The main problems for taking into account interaction seem to be the limited focus of stakeholders on interaction, the uncertainty in the early phases of planning, the lack of stakeholder involvement and the way in which some costs are not taken into account in the decision making process. The good news is that there seem to be solutions for these problems. To get higher stakeholder focus it is important that there is more coordination in the planning process. A body like the Program Management Office or Office of Urban Management could take this role. However, more is needed, because some stakeholders have no incentive to participate in planning for interaction. Solutions for this problem will be presented in Chapter 7. The uncertainty is a problem with no easy solutions. It seems that any measure implemented to take into account the interactions between infrastructures in the master planning process needs to be flexible enough to deal with these uncertainties. The solution to stakeholder involvement seems to be simple: involve them more. Organizations like the local councils need to be given a stronger voice in the planning process. Of course, the institutions for this need to be organized appropriately. Finally, the solution to not all variables being taken into account in the decision making process is straightforward: use the framework presented in this thesis to organize master planning for interaction. In Chapter 7 additional solutions will be presented in more detail, also based on the case study in Perth that is presented in the next chapter.

Despite the problems in SEQ the impact that the plans have had on delivering agents is quite substantial. Many agencies have restructured in order to be better able to deliver the infrastructure contained in the SEQIPP, including the setting up of joint project offices. Additionally, the use of alliance style contracting is proving to be a good way to manage interaction in the detailed design and construction phases of projects.

For the analytical framework used to analyze the case some improvements have also been found. First of all, the strong leader that led the development of the SEQ Regional Plan and SEQIPP is lacking from the framework. Additionally, several new forms of interaction have been identified: the timing of interaction, the total resources used in the area and finally the community impact.
6 Case Study 2: The Perth Metropolitan Region

6.1 Introduction

In this chapter the framework presented in Chapter 3 will be tested against the regional planning undertaken in the Perth Metropolitan Region. Perth is, just like Brisbane, a region in growth. Additionally, Perth has the 3rd highest amount of car ownership per capita in the world (Martinovich, 2006).

The case Study has been set up with a document study on the planning practices in the Perth Metropolitan Region, focusing primarily on the process of planning for interaction, and interviews on the Southern Suburbs Railway, focusing primarily on the content. Ten interviews have been conducted for the Southern Suburbs Railway, where relevant the results from the interviews have been used to enrich the document study on the planning practices in Perth. This case study is conducted to enrich the analysis of the South East Queensland case study. It is intended to draw lessons for the South East Queensland situation. As a second consideration conclusion are drawn on the Perth situation.

There were ten interviews conducted with people involved in the Regional Plan and the New MetroRail project. The case study has been set up as detailed in Section 4.5 on page 34. In Section 6.2 the background to the case study is explored. Then in Section 6.3 the framework is tested using the overarching interviews that were conducted on the master planning process and an analysis of the relevant documents. This section focuses specifically on the process side of the framework. Sections 6.4 and 6.5 focus on the content side of the framework and deal specifically with the New MetroRail Project and the Rockingham Busway project. In Section 6.6 the found improvements to the framework are addressed. Section 6.7 presents the opportunities and barriers to infrastructure planning for interaction in Perth. Finally, in Section 6.8 the necessary conclusions will be drawn about the case study.

![Map of Western Australia and the Perth Metropolitan Region](image)

Figure 6.1 Western Australia and the Perth Metropolitan Region (Source: WA Police and the Perth Tourist Center).
6.2 Background of Regional Master Planning in Perth

Perth is the capital city of Western Australia (WA). About 75 percent of the approximately 2.1 million people living in WA live in the Perth Metropolitan Region (see Figure 6.1 above). The Perth region is heavily urbanized. It is one of the most sprawling and car oriented cities in Australia, because of the explicit corridor forming from the 1960’s (Hill, 2005). The metropolitan region contains around 1.5 million people, the region is growing rapidly, and is expected to reach 2.4 million people in 2031 (Western Australian Planning Commission, 2004). In the coming years this growth is expected to lead to a need of more than 400,000 new homes, of which about “370,000 new homes are being projected for the Perth, Mandurah and Murray areas” (Western Australian Planning Commission, 2004). In 2001, the local economy in the Perth region supported around 624,000 jobs. In 2031 this is expected to have increased to 975,000 jobs (Western Australian Planning Commission, 2004). Perth has known a quite elaborate form of regional planning, starting in 1955 with the first corridor planning document, leading up to the newest regional planning effort called, Network City, in 2004. A constant during this time has been the Metropolitan Region Scheme. This is the statutory institution that all the planning efforts in Perth work to. The Metropolitan Region Scheme identifies where in the area what development can and will take place.

6.3 Analyzing Master Planning in Perth using the Framework

In this Section the process side of the analytical framework is analyzed. In Section 4.5 the structure of the case studies was described in detail. First the focus on all infrastructure types is assessed. Then the focus on regional master planning is analyzed. After that the two major problems with regional master planning are addressed: the practice of planning and the multi-actor setting. Finally, the focus on interaction in the planning process is addressed.

6.3.1 Focus on infrastructure

The Metropolitan Development Plan (MDP), a document released by the Infrastructure Coordinating Committee of the Western Australian Planning Commission (WAPC) contains a 5 year program for investment in electricity, gas, water, transport and social infrastructure. From the document we see that this is mainly major public infrastructure projects. However, the report also contains “an overview of how agencies such as the Water Corporation and Western Power provide the essential services and community infrastructure required by the growing population” (Western Australian Planning Commission, 2006). Furthermore, “the report examines the demand for and supply of residential land and housing. It provides regional or sector summaries of strategic plans, major residential development projects at the planning stage and the State Government’s capital works investments”. Normally the MDP is released every year; however, in 2007 no MDP was released because of the developments flowing from the release of Network City. In the 2006 version of the planning the following is said about Network City: “Network city highlights the need for the MDP to expand and refocus to a more strategic level so it can advise government and service providers more effectively on land supply, staging requirements and infrastructure capacity in Brownfield and Greenfield areas” (Western Australian Planning Commission, 2006). The Network City plan provides several actions associated with updating the MDP, including “identify transport and infrastructure timing and land requirements” and “broaden its scope to influence and justify capital works programs and major service commitments of government agencies” (Western Australian Planning Commission, 2004). Since no newer version of the MDP is available at this time it is impossible to say what these recommendations will entail for the MDP. From the application of our framework we conclude that the planning process in Perth meets the criterion that it ‘involves the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water’.
6.3.2 Focus on Regional Master Planning

Perth has quite an intricate regional planning process. The final result of this process being the Metropolitan Region Scheme (MRS), which is the statutory basis for the planning of the Perth metropolitan region. It is basically a map showing all the land zones and reservations for the region. These land zones and reservations are broad zones designating what is currently on them or will be on them in the future by designating these zones for urban, future urban, agricultural or road reserve for example. Reservations are used to denote land that the government is intending to acquire. The MRS follows from corridor or district structure planning. The structure plans detail land requirements for specific parts of the Perth Metropolitan Area. They are compiled interactively with major infrastructure projects, like New MetroRail. They are used as an important input for the MRS and to guide more detailed planning, typically called local structure plans or outline development plans. Finally, the local councils within the metropolitan area are required to fill in the detail of the MRS with their local government town planning schemes, which are required by law to be consistent with the MRS. See Box 6.1 for a specific example of the regional planning in the Perth Metropolitan Region.

Box 6.1 The planning of Marmion Avenue

"In the northern corridor for example, once we designed where Marmion Avenue was going to go, the utility authorities then designed their infrastructure to align with the road, and then we had to look at how we were going to fit them under the road, so it was interactive. That scheme had to go through Parliament and was finalised in July. Equally, those utility authorities, particularly transport and water were involved in the concept plans that led to the district structure plan. They fed their plans in, it was then worked-up with all the other issues: geography, environment, urban design, capacity of the urban area, and so on. From the concept plan we did the re-zoning, the district designs were then done in more detail and the corridor plan review happened at the same time".

The master planning process in Perth essentially focuses around land use, but is very elaborate in this respect. The infrastructure master planning process is essentially the same as the structure planning process. Corridor structure plans are done based on the metropolitan region strategy, called Network City (Western Australian Planning Commission, 2004), under this there are structure plans for the whole city. One level below that are corridor structure plans (see 6.3.2) bringing in a big area of around 40km by 20km in the case of the northern corridors. The corridors are then broken up into districts based on land owners, geography, infrastructure, road routes etc. Finally, there are logical district areas generally in the order of 50,000 people. This is also the way that infrastructure is coordinated through the process. Network City is a community planning strategy for Perth and Peel, it "provides a new planning strategy for the future of Perth, Mandurah and Murray" (Western Australian Planning Commission, 2006). The strategy contains strategies to guide planning in Perth from 2005 to 2030. "It aims, among other things, to counter the economic, social and environmental externalities or social costs attributable to urban sprawl or poorly managed suburban growth. It is about making more efficient use of urban land, natural resources and public infrastructure. At the centre of this new policy direction is a greater emphasis on growth management, in a bid to contain urban sprawl and increase opportunities for urban renewal in the existing urban area" (Western Australian Planning Commission, 2006).

Some interviewees are positive about this way of planning. One of the interviewees mention that having the master plan "reduces the ability for individuals to make changes, because every time someone makes a change it has a flow on effect [...] If you have got the large plan you can see the bigger picture and say well, you know, it is not possible for these reasons". Many objections to the master planning are voiced as well. One of the most poignant is that without some form of detailed design it is
hard to take into account interactions": "at master plan stage, you have got a line on a piece of paper and a bridge over it". Another is that "the budget always gets in the way of good planning". Other interviewees are unhappy with the ways that collaboration between stakeholders comes about: "everyone looks after their own little area and not too fussed about whatever else is happening. It may even happen internally, between rail and buses. The more you can achieve in that direction the easier life is, the better". Another interviewee notices the discrepancy between doing planning and actually going out there to build the structure: "when you have the interaction between different infrastructures and you are doing your planning, you can do your planning quite well, but the reality is when you get out to actually build something, [...] you are putting together two Government Departments that have different aims and objectives [...] and in many instances there are conflicting aims, and in many instances they don't understand what the other is trying to achieve. [...] It sounds good, planning it all, but I found that when you actually come to do the work, there are always these interface problems".

It seems that even though the planning in Perth is more elaborate, there still are plenty of problems with taking into account the interactions between different types of infrastructure. At the moment it seems that the 5 year horizon of the MDP is too narrow to be able to really take into account the interactions between infrastructures sufficiently. The recommendations from Network City seem to undersign this conclusion (Western Australian Planning Commission, 2004).

Applying our framework we conclude that there clearly is ‘a focus on planning of a region with the region as a holistic entity and taking into account both public and private planning’, although the focus is primarily on public planning. The corridor plans and the MRS clearly focus on the region as a holistic entity. The master planning also ‘sets the development objectives of a region and defines the long term program of projects to reach these goals’. However, the long term focus seems to be a weak point. The five year focus of the MDP is not long enough to really leverage on the interactions between interactions in the programming phase of master planning.

6.3.3 The Practice of Planning

The plethora of plans in Perth gives a bit of a confusing picture of the actual practice of planning. It never becomes entirely clear which planning effort follows another and which document is intended to inform the others. This seems to be the biggest problem in the planning situation in Perth. The planning effort itself is very good and thorough, but because of this the communication about the whole process becomes difficult and dense. It is questionable whether the planning effort in Perth meets the criterion that the ‘planning is used as strategic programming’. On the one hand the planning effort codifies chosen strategy, but on the other hand also seems to be a way to formulate new strategy. The main problem with the planning process in Perth is that the criterion that ‘planners work to find strategy, analyze strategy and are catalysts for future thinking’ is met well in Perth. The Western Australian Planning Commission as well as the Department of Planning and Infrastructure are committed to the three roles of planning as defined in our framework.

6.3.4 Multi-actor decision making

In Perth multi-actor decision making is institutionalized in the system. The Western Australian Planning Commission (WAPC), which is supported by the Department of Planning and Infrastructure (DPI), is the body that integrates planning throughout the state of Western Australia. It has committees with members representing important stakeholders, both from government agencies and private organizations. “The Director Generals, CEO’s etc. of the various utility and transport agencies sit on that [the WAPC]." The WAPC has standard processes in place to assure interaction between
stakeholders. A proposal for a new development has to be submitted to the DPI to be assessed and then be reported to the WAPC for approval or refusal. The DPI, in preparing its report will send out all information to relevant stakeholders and comments and issues will be fed back to the constituent of the proposal.

One of the interviewees believes that the WAPC’s Infrastructure Coordinating Committee should be restructured and refocused, because "the CEO’s are not dealing with the bigger policy issues, they are dealing with smaller stuff that gets fed up to them, and they are not satisfied that it is a good use of their time. Equally, you have got an agenda where you are trying to do transport infrastructure stuff, utility infrastructure stuff on the same agenda, and not having community or recreation infrastructure stuff dealt with very well, or at all".

Western Australia also has a Utility Providers Code of Conduct, subject to review and amendment by the Utility Providers Services Committee that sets out the way that utilities get dealt with in Western Australia.

One of the interviewees, who also had experience with decision making in Sydney and overseas, said that decision making in Perth is much more collaborative. "Very rarely do I see heated arguments, very rarely do I see people refusing to work with other people or undermine them, it is much more common for people get together in a room, talk it through, and resolve the issue". Another interviewee mentioned that, even though there is a lot of collaboration, the way to improve planning and decision making would be "larger degrees of collaboration" and "a multi-disciplinary approach". He continues: "we have historically been separated, the railway engineers, road engineers work in separate offices, and the designers, and it does separate us".

The above leads us to conclude that the planning process in Perth meets the requirement that ‘the planning process takes a network approach to decision making’.

6.3.5 Focus on interaction

As said above, there are quite a few measures in WA that force stakeholders to account for interaction. “There is never ever a choice not to have any interaction. They are not allowed to, it would not be permitted in Western Australia. They have to work in accordance with the law, and the law is for interaction between different organizations, including private organizations, is covered by the Western Australian Planning Commission laws, and that are State laws actually, and it is the major umbrella organization, which says to all different organizations, you have to interact and resolve your issues with each other. A significant number are infrastructure issues, but there is no way we could ignore anything, even if we are setting up our own master plan, we have to, at every stage, involve all of the other stakeholders”. There are several things that help this focus on interaction. First of all there is a “very comprehensive” GIS system and a Dial-Before-You-Dig telephone number that everyone that wants to dig is required to call “and within a couple of days we have got plans of the area and if there is major infrastructure like the optic fiber cables connecting Australia to the world, Telstra people will be ringing you personally to remind you”. One interviewee also mentioned a barrier: ‘when you have got a $1.6 billion project, anything outside the project just gets in your way’.

The advantages of taking into account interaction that were mentioned is large: people know what other organizations are doing, organizations know what effects it has on their assets, they can advise other agencies what cost and risks are associated with their own projects, organizations can tell other agencies what they can do and cannot do in relation to a particular asset or planning scheme, which then means that they might have to take an alternative route, organizations can object. An interviewee: “the benefits are better economy, better efficiencies, communication, timing, understanding of timing with other stakeholders”.

From applying our framework we conclude that the master planning process in Perth scores nicely on the criterion of 'there is a focus on interaction in the planning process'.
6.3.6 Conclusion

From the above we can conclude that the master planning process in Perth is poised very well to take into account the interactions between infrastructures. There are however several problems with the planning process that keep it from achieving its full potential. The first problem is the limited horizon of programming done in the regional master planning of infrastructure. This causes the interactions between infrastructures to be invisible until five years before, when it gets into the program. A second problem is the way the plans are used. They are not the best forms of communication of strategy and therefore will have a hard time to control all stakeholders. This causes the planning process to rely heavily on the process of decision making. This will have the tendency to lead to more strategic behavior then is necessary. In this respect the planning process is also very technocratic, causing the planning to not be very flexible.

Figure 6.2 The Southern Suburbs Railway Line (New MetroRail) (Source: (Western Australian Department of Planning and Infrastructure - Perth Urban Rail Development Office (2002)))
6.4 The Southern Suburbs Railway Line

6.4.1 Background

On the 23rd of December 2007 the Perth to Mandurah railway line, or Southern Suburbs Railway Line, was opened. The railway line is expected to have more than 50,000 boardings each day and remove 21,000 cars off the freeway. The AUS$ 1.6 billion project is special because the railway runs down the median of the Kwinana Freeway for a large part of its length. Additionally, a tunnel has been bored under the city center for the last 2 kilometers. These features make the project interesting to study in this research because of the unavoidable interaction. Figure 6.2 above shows a map of Perth with the Perth to Mandurah railway line in red.

In August 2002 a supplement (Western Australian Department of Planning and Infrastructure - Perth Urban Rail Development Office, 2002) to South West Metropolitan Railway line master plan was released (Western Australian Department of Transport - Urban Rail Planning Group, 2000), both master plans provided a detailed plan for the implementation of a railway from Perth down to Mandurah. The major difference was the route of the railway, because the supplementary master plan suggested a new route to Mandurah, called the Direct Route, down the Kwinana freeway (see Figure 6.2). Before the shift in government in 2001 the Southern Suburbs Railway line was going via the so called Kenwick route (for a comparison of the routes see Figure 6.3 below). From the interviews it became obvious that going down the freeway (the direct route that was implemented) was a political choice. It is interesting to analyze this debate from an interaction perspective.

Figure 6.3 Kenwick and Direct Route (Source: adapted from Western Australian Department of Planning and Infrastructure - Perth Urban Rail Development Office (2002))

The reasons to change the route were twofold. The official reason was to improve the travel time from Mandurah and Rockingham. The direct route accomplishes this by improving travel time from Mandurah by 20% and from Rockingham by 26%. A
related benefit was that this decrease in travel time allowed the decrease of railcars used on the railway by 20%. A few of the interviewees mentioned another reason to send the railway down the freeway and that is to increase the visibility of the railway, it is meant to encourage road users to make the modal change from car to public transport.

The significant interactions on the Kenwick route are as follows. First of all, the project budget did not include the grade separation of road and rail, which would have caused a safety interaction to both road and rail users, additionally this would have caused a doubling of the downtime for motorists at these crossings. Another safety impact would have been the use of older rail infrastructure.

The Direct route, as mentioned above reduces travel time and requires fewer trains to operate. Furthermore, it uses new rail infrastructure and is fully grade separated, improving safety and downtime for motorists. On the other hand, the Direct route caused a significant dollar and social cost because of the realignment of the freeway, the necessary strengthening and duplication of the Narrows and Mount Henry bridges and the associated construction works. Additionally, the Direct route does not allow for future upgrades of the railway to four tracks, which would be necessary to allow for express trains when the railway is upgraded beyond Mandurah.

One interviewee said that, while it might have been a correct decision to put the railway down the freeway corridor, “but because it came in as an eleventh hour, last minute decision there just hadn’t been that planning work done. So a few dollars invested a few years prior would have more than recouped itself in later years”.

The delivery of the project has not been entirely without problems. The railway line was supposed to be delivered in July 2007 and the project has sustained an AUS$ 250 million cost overrun (Phillips, 2007). One interviewee mentioned that, while these cost and budget overruns happened “the new government came on board basically saying that they could build the same railway for the same cost but a more efficient railway coming up the freeway and that wasn’t a totally realistic claim”.

Making concluding remarks here is difficult. As one interviewee put it: “you are not comparing apples with apples”, because of the higher quality of the Direct Route. On the other hand, the future upgradeability of the Direct Route might bring a high future cost if this is ever needed. In that respect, only time will tell what was the better option. This is also an important lessen from this case study: future uncertainty and especially the uncertainty of the choices that weren’t made makes it very hard to comment definitely on what would have been the better choice.

It is interesting to note that these master plans are based only on the railway and are not the kind of regional master plans that we discuss in this research. The master plan quantifies the demand patronage and develops what services are required to satisfy that demand; it identifies the infrastructure required for this and it aims to integrate these needs with land use. Of course the master plan had to conform with all regulatory requirements and other parties’ services. Finally, the master planning process and resulting master plan aimed to “engage with the community and engender stakeholder ownership” (Western Australian Department of Planning and Infrastructure - Perth Urban Rail Development Office, 2002). From the early planning done in 1994 there had already been a corridor for the Kenwick route, this was later changed in 2002 to the Direct Route (Western Australian Department of Planning and Infrastructure - Perth Urban Rail Development Office, 2002).

One of the interviewees believes that the choice for the new, direct route, was a political choice. Because of this the master planning process for the new route had to get fast tracked. Here opportunities were lost to account for interaction: “If we had ten years to plan it properly, we would have got a better result. But if we had ten years to plan it, it probably wouldn’t have got built because the governments would have swapped over”. Another interviewee identified master planning as a “very critical step” to take into account interaction: “it is important to close out all of those key areas at that stage if you can”. The question is if the tight timeframe allowed for this. According to one of the interviewees involved in the creation of the master plan the focus in the master plan was on identifying risks and making sure these could be treated, the way to do this basically was “no major risk analysis in the master planning stage;
experience and judgment that’s what it was”. This experience and judgment did not just come from the project, but was also brought in from consultants and experts. For example, when there was talk about buildings in the CBD collapsing because of the tunnel boring "the minister came and said: ‘[…] is this true? Are these buildings going to fall down?’ No. ‘Why?’ ‘Because we went and saw the best geologists we could, we went and saw the best tunnel borers we could’. We actually had, and this is all part of the master plan”. The four major questions to answer were: is there sufficient demand? Is it going to be safe? Is it environmentally friendly? And is it Economically feasible? The major benefit of the master planning was to be able to have a foresight into the breadth and scope of what had to be done as part of the implementation. When asked whether interactions should be taken into account in the master planning phase one of the main planners of the railway said: “there is a whole lot of politics involved here, and if you want to kill this project do all those things at the master planning stage. The master planning stage has to look at the risk and say is this manageable? Yes it is, we will develop the protocols, but I could kill this railway at a master planning stage if I was smart enough, by mounting legitimate arguments and not giving people enough time to do the risk analysis and the treatments”. One way the focus on interaction was ensured was by taking the core people from the master planning stage into the project team in charge of the final project. Some interviewees see the master plan as a political document that was "just proving up the feasibility of this concept of pushing it down the freeway". An interviewee from Main Roads felt that the railway authorities were "coming in and forcing their railway down mostly Main Roads road reserve". On the other hand, given the constraint that the railway was going to go down the freeway, most interviewees thought that "New MetroRail worked extremely hard to try and meet everyone’s needs". One of the aims of the master plan was to set a common ground for forecasts and assumptions about the project. But of course “there are some very pessimistic views on how many people will use the new train, and there are some very optimistic views on how many people will use the new train”. Also in this project, when going down from master planning to detailed design the level of aggregation shifted, as can be seen from the following quote: "our project involved structures, bridges, roadworks, drainage, there is a bit of electrical with lighting and signals, but mainly civil type structure works, […] a heavy component of electrical […] with communications and electrified rail and overheads […], as well as […] track laying”.

6.4.2 Stakeholders
During the master planning and construction stages there were many stakeholders involved. From the State government there was involvement from the State Treasury, The Department of Planning and Infrastructure, Main Roads, the Public Transport Authority, the Water Corporation. At local government level the railway went through seven local councils, who were of course all involved: Perth Council, South Perth, Melville, Cockburn, Kwinana, Rockingham and Mandurah. From the utilities and services side Western Power, AlintaGas, Telstra, Optus and “bundles of others” were involved. Also involved were local communities, schools, disabled, aged people, developers. According to an interviewee from New MetroRail there was “a lot of consultation with stakeholders […] on our own master plan for the railway”. Not everyone agreed however, one interviewee said that, especially on the supplementary master plan, there wasn’t enough consultation, because of the hurry in creating the plan. The consultation with services was, according to one interviewee, “on a basis of what is the impact, rather than getting them to join in and say how can we both get what’s best and needed out of this”. This also meant that after these impacts had been determined the utilities were not represented very well in the construction of the project. Early in the process a Steering Committee was set up for the project. This committee was made up of the CEO’s from the Public Transport Authority, Main Roads, the Department of Planning and Infrastructure, the Treasury and the director of the New
MetroRail project team. The Steering Committee had a role in solving any conflicts that could not be solved on a lower level. It was mentioned by several interviewees that the Steering Committee was critical to the success of the project by allowing for a way for conflicts to be solved.

According to most interviewees the differences in perception of stakeholders were around details, the principle of having the railway line was broadly accepted. Differences were settled in a lot of different ways, many times it was done through negotiations or convincing, either through argument or through detailed and elaborate proofs. In this way the consultation as part of the Master Plan also helped to settle differences early on.

Also, a lot of conflicts were solved by political willpower, for example with budget or time frame issues, at some points the minister was involved in settling conflicts. But mostly conflicts were settled at a high level within organizations, with the project director or chief engineer speaking to their counterparts. Interaction with the community was done by actually going door to door on occasions and when there were specific issues organizing ways for people to give feedback and possible feeding it back to the engineers to solve. The way the consultation with the community was set up for the master planning also helped in settling differences: "they got to know about the project, they got to like it, understand it, they got ownership of it". According to one interviewee the process for this was as follows: "you go out there and confront the community openly, honestly and show them your plans, receive feedback, modify your proposals and then you display it, and by so doing, you will get understanding, enthusiasm and ownership.

Another way to settle differences was through giving key organizations, like Main Roads, the designs of the railway for review. This way comments could be provided and this “free flow” of information improved the relationship between stakeholders a lot. "You build up a relationship with these guys because you have to work with them, and while you don't always understand what they're doing you have got the opportunity to talk it through". The utilities all provided contact points within their organizations, which was helpful in terms of having a point of contact, but it also gave the project recognition within those organizations as an important project.

6.4.3 Resource Effects of Interaction

Some interviewees reffered to cost and time as being a trade-off. A trade-off between construction and operating costs, a trade-off between the Direct and Kenwick route or a trade-off between costs, time and resources. In that respect a clear answer can not be given to whether the actual resource costs of going down the freeway were significantly higher than the other solution.

Most interviewees agree that the way down the freeway is definitely saving space. As well as reducing the severance of the land by another corridor, mostly because of shared barriers and the narrow corridor.

Time is interesting, since the construction of the railway is by many interviewees considered to be more time consuming, the actual travel time for travelers is less. See Box 6.2 for a collection of interviewee quotes on resource effects.

Box 6.2 Selected interviewee quotes on resource based effects

**Cost – Trade-off**

"The alternative of retro fitting into a freeway is lots of reclaimed land and/or upgrading other rail infrastructure or a worse route, so it is a bit difficult to comment on those".

"It cost them a fair bit of money to meet our requirements and probably with Western Power and Telstra and all of those as well, but that is part of any engineering project, and if you don’t do that then there are significant future costs. When you look at the cost it is not just the capital cost, you have done your analysis, it is the NPV, the cost analysis over the life of the project. What we are doing here is significantly reducing the costs, because we are protecting assets now, and if we didn’t do that and we had a
major failure, the railway would stop, you would have all sorts of accidents and hazards occurring and then they would be up for the costs of doing it then”.

**Cost – Positive**

“I also see a cost advantage that when you are building your freeway you have got to build the freeway with a median, you’ve got to build the bridges to span over that medium, putting your railway there is a logical use of the bridge structure that you generally do not have to have very much bigger to get the railway along there”.

“There is a lot more you can do to minimize costs when you have got more to work with. When you are dealing with freeway modifications as well as the railway, there is more opportunities to save that money”.

**Cost – Negative**

“There are potential infrastructure savings, if it is all planned well in advance. If you are trying to retrofit this sort of thing afterwards, I would query whether there are savings, in fact, certainly to bring the railway up the Kwinana Freeway was a lot more expensive than it was to go out via the Kenwick route, mainly because you are dealing with almost Greenfield sites out there, whereas you have got an existing expensive piece of infrastructure, and you are trying to relocate that”.

**Space – Positive**

“Running the railway line down the freeway had the tendency to save space, because you were doing your earthworks once, for the railway and the freeway”.

“Going down the centre of the freeway saved some space”.

**Time – Trade-off**

“If you’ve got green fields than it saves time, by building a reserve that can handle those needs, retrofitting costs a lot of time”.

“Saving space, time and materials and costs by running the railway down the freeway. It wouldn’t have saved construction time though”.

### 6.4.4 Functionality Effects of Interaction

The added cost of the railway down the freeway is, according to some interviewees, offset by the increased functionality. According to one interviewee the high speed railway will attract a lot of patronage, which will take cars off the road, preventing a lot of safety incidents and providing “huge environmental benefits”. The throughput of the whole system will likely increase, because of the reduced pressure on the road system, causing less congestion. “Road and rail operators in this State have actually come to an agreement on this, where we are both very comfortable with it, because they know that the biggest benefit to their road use is our railway”. On the other hand, the throughput of walk on patronage to the stations is seemingly causing some problems, “it appeared to fall a bit short sighted there”.

On the waste side the interviewees are unanimous: the interaction is positive, because there is less waste and because it could be reused in another part of the project: “we had 1.3 million cubic meters of spoil on this Package A project, but because it was one big project, they could take the spoil, they could use it on the road works as well”.

### 6.4.5 Dependence interaction

The railway system is dependent on supporting infrastructure, like electricity and telecommunication systems: “we have an electrified railway, so we have got the overhead system, [...] a traction power system, we run a 25 kilovolt AC system, [...]
the signaling system, communications systems, [...] a main communications fiber, [...] telephone systems, [...] microwave systems”. Furthermore, the railway is dependent on roads to bring commuters to the train stations. Especially, since the railway line is located within a freeway median the feeder roads are important for the railway (also see Section 6.4.9 on Spatial Interaction). "The other advantage with combining the infrastructure is that you have all your arterial feeder roads coming into your freeway so it is just a natural area for buses to come in which would then feeding onto the highway, they can now feed into a railway station".

6.4.6 Environmental interaction

The main environmental interaction mentioned by several interviewees is the increase in local air quality due to the reduced emissions by less people using the cars. As one interviewee mentioned “local air quality in Perth some days apparently rivals San Francisco”. The energy produced for the railway is produced 200 km away from the city, where the social cost of CO2 emissions and other harmful substances is much lower than in the middle of the city. In this respect the railway going down to Mandurah has a positive effect on the environment in the corridor. Another environmental impact that was lowered was noise, because it was contained in one corridor. "The impacts from the freeway are there already, the railway doesn’t substantially add to those impacts. The freeway creates noise, the railway doesn’t add a lot more noise, if you are building noise walls for the freeway, then you have already build them for the railway”.

6.4.7 Institutional interaction

In the New MetroRail project there have been many forms of institutional interaction. Something that was essential for the success of the project is the political support that was given to the project. As one interviewee put it: “how do you get road and rail people to talk to each other? This Act of Parliament says, ‘this is it boys, this is what you are going to do’”. This meant that other stakeholders were operating under the constraint that they knew that this railway was going down the freeway. Related to that was the institutional power that the master plan had. A normal project goes up the organizational hierarchy of the Planning and Transport Authority (PTA) to the Treasury on their list of rankings of projects to the Expenditure Review Committee and then finally to the State Government. Because of the Master Plan the NMR project could directly go to the State Government, so most of these steps were skipped (see Figure 6.4). As one interviewee put it: “the fact that you have got total government commitment, ‘this is going to happen’, you could see that being pushed down the line in different organizations, ‘this project you can’t hold it up’".

![Figure 6.4 The institutional impact of a Master Plan (as sketched by one of the interviewees)](image-url)
Of course working with different organizations creates some institutional interactions. One interviewee mentioned that there is unfamiliarity with the processes that other organizations use. Another interviewee said that some organizations are not very clear in what their requirements are: "you can think you are doing the right thing, and still not achieve their objectives". Another interviewee mentioned that Western Power was split up in four different entities, causing all kinds of interface problems: "who are you dealing with now? Do they even know about the project? Are they going to want something completely different to what the last person has agreed with us?". Another issue that was mentioned related with this is the fact that people change jobs or retire and this also changes the way organizations interact.

Meeting standards is more important for some agencies than it is for others. But standards change. An interviewee remembered that agreements were reached with Main Roads on the standards to use for the road design, however, these had to be changed later on, because Australian standards had changed and the designs were no longer acceptable. On the other hand, standards had to be shifted or changed with the New MetroRail project. An interviewee from New MetroRail mentioned that risk analysis was used to see if standards could be changed, in stead of rigidly keeping to standards. Standards can in fact be detrimental to project outcome. The interviewee from New MetroRail encountered one instance where adopting the standard of putting concrete barriers on the whole length of the project, as the Rail Safety Regulator wanted, in stead of only where necessary would have caused AUS $100 million in damages on death and trauma of road users over a 30 year lifetime of the project.

The project was split up in 7 work packages; this caused some interface problems between the different packages. An example of this is the walk on path towards the station; it was split between different packages and one interviewee at one point thought that "the thinking about how you walk into the railway station was slipping through the cracks". Overall people were very happy with the work packages, where one contractor was doing all the works in one area, the part where things went wrong "is where we have had different contractors interacting doing their own infrastructure". The relationship with Main Roads in this respect is special, because in the early planning it was decided that the freeway works were so extensive and complex that it would be best if Main Roads would execute that part of the project. The project was paid by NMR, but it was executed by Main Roads as a joint agent. The added benefit was that it "gives Main Roads confidence that [...] they are getting a quality job, they have got to look after the asset at the end of the project, they know their staff have been involved in the construction and they are very happy with that". Another part of the project that was special in this respect was the tunnel boring under the city, for that a special sub-group was formed under a separate contract because "it was so completely different to the rest of the project, different risks, different style". The other packages were put out for design and construct contracts, they contained blocks of three stations, the railway formation, the drainage, the power for the overhead system, the communications system “and even some of the smaller structures, we said this is just basically railway works”. "We got a sort of functionality, a sort of commonality throughout a function, and said okay, we should be able to get a contractor who is expert in that sort of area".

One of the barriers to interaction was the fixed budget. "At a fairly late stage, we looked at the possibility of running a cycle facility down parts of the southwest railway line which would have been great if we had done it, however, because we were only able to address that issue late in the project, budgets had been set, so we didn’t succeed in doing that".

Another institutional problem is that some organizations have more power than others. A good example is Telstra, which has a Federal Government act overriding any State legislation. This means that, as one interviewee put it "you don’t have much argument about it, because they pull out their Act and say ‘sorry, you will do this’. "Where we had to relocate fiber optic cable they really took every opportunity they could to get us to pay for fiber optic cable which they would have had to install. Cable which was only six months old, we weren’t allowed to cut off 1km, brand new cable, and re-use it, so they would argue, no sorry you have got to give us brand new cable".
This also points to another problem that is a real barrier to planned interaction: the fact that projects that happen above ground need to pay for the relocations of services under ground. This can make it an advantage for utilities to enable planned interaction, because they would miss out on a beautiful new asset. "They [the NMR project] have to accommodate existing infrastructure and they cannot do something that puts at risk the infrastructure of another government organization without authority of that organization [...], we can authorize them to have it all pulled up and re-located, or they can pay for the cost of modifying our infrastructure, to remove the risks that they put on it". He continues: "we don’t say ‘no you can’t do it’, we say ‘yes you can do it, if you do this’".

An important question for the future is: what will be the institutional status of the corridor? Related questions are who owns and maintains the assets and how the corridor is managed. Instead of a railway and a freeway the corridor is a "Combined Transport Corridor".

### 6.4.8 Multi-actor Interaction

No multi-actor interaction was mentioned in the interviews.

### 6.4.9 Spatial Interaction

The heaviest component of interaction in the NMR project is the spatial interaction between the Kwinana Freeway and the railway. However, there also is significant interaction with utilities along the 72km long railway line and a lot of potential spatial interaction was avoided with the decision to tunnel bore under the CBD, instead of constructing a cut and cover tunnel.

#### Kwinana Freeway interaction

The main spatial interaction in this project was with the railway being located in the median of the Kwinana freeway. There are some advantages and some disadvantages in this set up, which will be discussed here, starting with the advantages. First of all, the amount of land used for the two infrastructures is minimized. In this case it is certainly true, because "ideally they would like the railway corridor 25m, we squashed the rail corridor down to 12m in places". Second, the land is not divided even more and it also means that all environmental impacts are all centralized in one corridor. Another advantage is that the connector roads to the freeway are also good feeders to the station. Also, the alignment and profile of a freeway generally suit a railway (compare this to the Centenary Highway). They are also a good security against vandalism, because they are highly visible. Another advantage that was mentioned by someone from New MetroRail was the visibility of the railway: "the people who are using the road network go: ‘gee look at this thing going past us’", which would be an advantage to the road network if it reduced congestion. Finally, compared to the older railway line (as well as the proposed Kenwick Route), the railway does not have any level interchanges anymore, which is a safety benefit.

There are several main disadvantages to putting the railway in the freeway. One of them is that about 30% of the freeway had to be shifted outward by about half a meter to 3.5 meters to make room for the railway, since the median was never planned to contain a railway. Additionally, several bridges had to be duplicated to be able to carry both the road and the railway. Because of this, both the safety requirements for road and for rail have had to be adjusted downwards. Main Roads likes to have an emergency lane on both sides of the freeway, which was impossible. On the bridges there is no room for emergency lanes at all anymore. Some freeway interchanges had to be realigned, sometimes in quite complex ways because of the railway.

Another major disadvantage is the safety on both the rail and the road. One of the interviewees illustrated the issue nicely: "we have done quite a number of risk assessments to determine what sort of protection we need to keep the railway safe, and in the end we decided to put up concrete barriers for most of the route [italics added]". Concrete barriers are a lot less forgiving to road users than wire rope
barriers. In order to keep the railway safe road users are exposed to more dangerous barriers. However, in reality the NMR project team employed risk analysis to find the best type of barrier for each part of the freeway, in that way, where wire rope was effective this was used in stead of concrete barriers. For 20km of freeway the wire rope barriers are used, which from the risk analysis was AUS$ 100 million cheaper, mainly due to extra trauma and death of road users crashing into the concrete barrier. “Road design is about complying, what are the standards of a particular traffic set, build it and that is okay, there is little operational control, whereas railways are all about risk analysis and all risks have to be put into the category of as low as reasonably possible. I think there is a fundamental here on mass transit, it doesn’t matter whether you are talking about aviation, if you are taking about railways or if you are talking about seaways. There is always the chance of an accident, and the risk of an accident is catastrophic”. In the risk analysis there were “two major risks, one is a derailed train impacting on the traffic or oncoming trains or vehicles or debris entering the path of a train. […] If you are going to say the first one is a major risk then you would stop train operations everywhere in the world, so we said that is not really a risk we managed that routinely. […] This next risk though, is a killer for us: vehicles or debris entering the path of a train. That is the risk that we have to address. […] Our big worry is that while we are very controlled in the centre, on either side of us there is this mayhem going on”. In addition to being an extra hazard to road users, the concrete barriers also cause, especially in curves, the lack of necessary sight distance, which also necessitated realignment of the freeway in some places. Another safety problem with the railway in the middle of the freeway is that emergency services can’t duck across the median to the other side anymore, which used to be common practice on the Kwinana Freeway. However, to put the safety discussion more in perspective, one of the interviewees said: “if you have got plenty of land and space is not an issue, then it is probably preferable to separate from a safety point of view. Separate your freeways from your railways. You want to separate northbound traffic from southbound traffic and get as much distance between them. You want to get as much distance from the freeway and surrounding houses, as much distance between freeway and shared paths, as much distance as possible from a railway to adjacent houses or roadway. […] If you had an ideal world then you would separate them. We don’t have an ideal world, land costs a lot of money, so even if you do separate them it is questionable how much extra safety you would get from separating the infrastructure”.

Another problem with the combined infrastructure is the catchment areas of the train stations, “if you bring the rail line into the suburbs, then you are into a grid street system straight away and of your 400, 800 and 1000 meter catchments you are getting much better effect, and a more pleasant walk than walking across a bridge over a freeway”. Finally, in some instances, one in particular, the combination of the road and rail caused additional congestion on the road network (see Box 6.3).

Box 6.3 South Street Interchange

“At the South Street interchange, we actually added a third set of signals, so we actually made the congestion potentially even worse, and that is why Main Roads had to add on a widening to the South Street bridge because our traffic modeling was saying this whole South Street area is going to fall over if we do what the railway authority is wanting us to do. So they did some modeling to make it work without widening the South Street bridge, and that was really complex stuff, they spent weeks and weeks and weeks trying to get it to work, and they finally managed to tweak it so that it just worked with all the traffic, but you put 1% more traffic on there, and bang it just grid-locked. That was so complex that we never got agreement between Main Roads and the rail authority, such that in the end Main Roads said we are not going to take the risk, we will separately fund the widening of South Street, because we recognize you have done this modeling which shows it won’t be a problem, but it is just too sensitive and we can’t afford that risk, because if it doesn’t work then Main Roads and the Rail Authority will look bad. So there were cases like that, that were
just too complex to work out what the actual impact is so you then go back to looking at the risk of not doing something, but also an opportunity, so we got that widening done cheaper than a stand alone contract, because the contractor was already there in the area doing other works, but it is still questionable as to whether the joint infrastructure needed it. The Railway authority would stick to their guns if it wasn’t needed, also on the basis of ‘wow, if we can get gridlock, that will only help more people to use the train’”.

Utility interaction
The project has a spatial interaction with a lot of utilities located near the corridor. Basically, these had to be relocated at the cost of the NMR project. Interviewees mentioned a plethora of services that needed to be relocated, street lighting, including high and low voltage power, telecommunication services, fiber optic services, gas, resource pipelines, oil pipelines, a slurry pipeline, fire services and Water Corporation assets like water and sewerage services. The way these infrastructures were dealt with was clearly described by an interviewee: “if our works required their diversion we had to plan it with the […] infrastructure owner and arrange its’ mutually acceptable solution to relocate it or make it go deeper into the ground so we had cover over the top of it; and we paid for that”. Most of the services were moved outward, away from the transport corridor, in many places because the corridor was widened and “we don’t like anything left under the freeway”. Another type of interaction that was related to the utilities near the corridor was the potential interference the overhead power system of the railway had with these. The overhead power system of the railway consists of a 25.000 volt system at 4.7 meters above the ground. "If you have got a major water service running parallel to that over a distance of more than 1km or so within 500m, the induced electro-magnetic field can have effects on that water service to the detriment of public safety. The net result is that I could turn on the tap and I could be killed […] because of electric shock”. This means that services that were vulnerable to this interaction had to be immunized. The same happened when NMR “went through the exercise of actually determining and acquiring land, putting planning controls on for a new power feed station which had to be next to the railway line, next to a 132KV power line from Western Power and it could not be under the big power towers on account of interference”.

CBD interaction
Initially, the part of the railway going through the CBD of Perth was going to be a cut-and-cover type tunnel. This means the tunnel would be dug out from the ground down and then covered with concrete slabs later. This would have meant that William Street, a main street in the center of Perth, would have to be closed for traffic for 2 years. This proved to lead to a lot of resistance from businesses and the community in general. As one interviewee mentioned: “there was a lot of opposition to the route, and if we hadn’t sorted out those issues, it possibly wouldn’t have been built”.

6.4.10 Technological interaction
A technological interaction between the road and the railway is that when a work train has to go over the bridge it will need a permit from Main Roads, this is because the bridge cannot support a maximum train and maximum road load. One area where both technological and institutional reasons proved to be a barrier to interaction was the Intelligent Transport System, or monitoring and communications of both road and rail “we have got the railways, the railway line, communications for rail, and they have their requirements for monitoring and […], emergency response, and we have ours. There is nothing bringing everything together that says ‘this is our kind of overall strategy for ITS or for monitoring systems’ […], but that is an evolving type of industry”.
6.4.11 Conclusion

In this section we have found a list of interactions. In this project the only category of interactions that has not been found is the multi-actor interaction. The project was planned outside of the regular regional master planning process because of the political decision to change the route of the railway so late in the planning process. Therefore, we can conclude that with this project the necessity to plan for interaction was high. This was accomplished by risk assessment and expert judgement. Because of this decision the interactions between infrastructures has only been taken into account in a limited way in the master planning process.

6.5 The Rockingham Transit System

During the interviews for the New MetroRail project another project came up several times: the Rockingham Transit System. It was decided to give this project its own Section in this chapter, but because of the limited amount of data available a complete analysis of the case has not been made. The following information should therefore be seen as indicative of a full analysis using our framework.

One of the most hotly debated issues that came from the New MetroRail project was the route of the railway through Rockingham. In the end the station was placed outside of the city center, against the wishes of the Rockingham City Council. As part of the negotiations a new master plan was launched for the Rockingham City Center Transit System. This transit system is a partly dedicated busway from the station to the center of Rockingham, with the future possibility of upgrading to a light rail facility. The planning for the system was done as a separate entity with a number of government agencies, including the Department of Planning and Infrastructure and Main Roads. Other involved stakeholders were the local council, a shopping mall owner and the community. The whole system has been built by the Public Transport Authority, but Rockingham City has gained ownership of the assets. One of the interviewees felt that the PTA and local government had gained a closer working relationship because of this project.

One of the advantages of being associated with the New MetroRail project is that it is possible to leverage off it weight. Since the project itself was rather small it would have been difficult to get people moving for it. However, dropping the New MetroRail name usually got people moving for this project as well.

That the ‘Dial Before You Dig’ service does not always work has been proven in this project, when a piece of vacant land was dug up for the project and turned out to be full of undocumented utilities, going from anywhere to nowhere. “Every time you digged [sic], there was something else, and you didn’t even know what it connected to, you didn’t know where it connected to and whether it was a live service or wasn’t”. One of the problems that was encountered with the master planning process in this project was the fact that once community consultation was over it took a couple of months to get the project to the construction phase. For the people who were at the consultation this came as quite a surprise, because of the time in between, they had either forgotten, or didn’t live there at the time. The lesson to learn is to communicate well with all stakeholders throughout the life of the project.

An institutional problem that the project ran into was the small size of the project compared to other projects of the organization. The contract said that the contractor had to be paid within 32 days upon receipt of the invoice, however, the internal processes said that nobody gets paid until at least 30 days after receipt of the invoice. This meant that the project was in breach of contract and some internal processes had to be changed.

6.6 Improving the framework

6.6.1 Other Effects of Interaction

Community Impact

A lot of interviewees commented on the community impact in a region. This can be both positive and negative. The main negative impact was mentioned to be the
freeway modifications. On the positive side of community impact was the fact that the railway development is causing a housing boom along the corridor of the railway. Also mentioned was the fact that combining the road and rail in the same corridor decreased the negative impact on the surrounding neighborhoods. Another form of community impact is urban severance. "If you severed the place by the freeway, putting the railway down the freeway doesn’t create another severance". This interaction causes both social and environmental impacts. See Box 6.4 for selected interviewee quotes.

Box 6.4 Selected interviewee quotes on Community Impact

"People don’t really like living next to the railway, also the social impacts of parking and I guess these carparks near stations can attract burglars and the burglars and car thieves if they don’t get what they want in the station it then has a negative impact on the surrounding community. [...] By combining the infrastructure you are bringing those noise issues and undesirable element issues into one area, so you have halved that problem".

"The other thing that has been very dramatic, has been the development in the corridor where the railway is going, since I have started, has just been phenomenal, I mean we have got a housing boom in Western Australia as you are aware, but in that corridor there are just estates going up everywhere, it has been where once there was a green field site, there are now 1,000 houses, and the developers are looking at bringing forward the long term station locations and in fact marketing that there is a future station planned to go near their estate, even though it might be twenty years away".

6.6.2 Other Categories of Interaction

Timing Interaction

A main interaction that is not explicitly mentioned in the framework, but actually is a kind of overarching theme in the framework, is the timing of infrastructure projects. The New MetroRail project had a large impact on a lot of other infrastructure around it, a lot of which had to be relocated. However, some of this infrastructure was old and needed replacement in a few years. "When they first started the idea was that anything that they replaced, they would replace at current standard. My argument was that the standard it was in, because it was constructed twenty years ago, isn't the standard of the day, so the argument was: you can’t put it back that standard, you’ve got to put it back the new standard". First, the project was planning to put roads back in without grade separating, which would not pass safety requirements, then the problem became that the grade separation would include only one span of road, while the demand for that road would necessitate two spans. In this way, a lot of additional work was added to the project, as road upgrades were not part of the project budget: "we had to find additional funds for that, it either came from Main Roads, or from local government".

The main argument in this discussion was that it would be very expensive to make these changes in the future (especially, because at that time there would be an operating railway there). Additionally, the added community disruption when a piece of infrastructure would have to be upgraded again after five years was seen as a problem. It came down to making good choices in what would be hard or more expensive to build later and doing those works, while accommodating works that could easily be done at a later date. "We came to a solution that basically made allowances for things that were going to be very difficult to do at a later date, but allowed things that could be done simply at a later date".

In the end a lot of roads and intersections were upgraded to a current standard of service. "The classic example is building the second span of the bridges over roads [...], I think that might have cost an extra, in the order of half a million dollars and yet some simple analysis showed that to try and put those spans in a at a later stage
would cost in the order of $5 million". Another very good example, that also shows the commitment of various stakeholders in the process was the Roe Highway. Main Roads was upgrading this highway even before the NMR project was funded, yet Main Roads built a part of the two tunnels that would be needed for the NMR project, the full story is recounted in Box 6.5 below.

Box 6.5 Upgrading the Roe Highway

"Main Roads were going out to build the highway, it is the Roe Highway, and we got in on that project early, and we knew we needed it because we had the master plan, and they built half the tunnel for us under the highway there and that was effective. It would have been more effective if they had built the whole tunnel but it was so early, we didn't have authority for the project. [...] The planning was quite advanced for the railway then, so the Main Roads in their contract built a tunnel for us and a number of overpasses and they allowed in their design, the fact that there would be a freeway in the middle, so that the railway tracks could go either side of piers and they built their piers to withstand train impact or take into account train impact in the design of their piers. [...] That has been really helpful for us. They could only do that because the planning was in place, the route was in place. [...] It was very cost effective. [...] They put all their drainage into the median of the freeway, we had to then work out a drainage system, but nevertheless the amount of money that we saved on them building those tunnels while they had opened up the area, we could never have built them for the price they did, so that advantage outweighed any minor changes we had to do when we got there" (italics added).

There are several barriers and limitations to this approach. The main barriers are the constraints of time and cost set by the available budget and the commitment of people to these kind of extra works: "once you get into a project phase everyone is thinking of that project and focusing on that project, and it is hard to get them focusing on something that might happen in ten year's time". The main limitation is the uncertainty that the future brings. "There is going to be something that jumps up, and we are going to go 'oh, we should have allowed for that'; no one has got a perfect crystal ball".

One solution to some of these problems was used in this project: "there were seven or eight things that I wanted changed, what they agreed to do was that as it was put in a tender, as an option, so that we'd get a price on them, and so they became priced options in the tender. [...] Unless you have got a real cost on some of this stuff, you can't really make a decision whether you should include it in the project or not. [...] In the end we could then argue about real costs, real issues, and they also had to know what impact it had on their project".

Total resource use in a region

In Perth, the growth is also leading to a resource shortage. Here the amount of projects is pressing agencies to meet adequate deadlines, which is causing problems in the delivery of other projects. "One of our issues at the moment is that we are dealing with the resources boom in WA and the lack of ability for some agencies to respond to the amount of work that is on and the electricity authority is one of those. So if you need to shift services for example, they talk six to twelve months to shift a service and even if you go in and identify where the services are, they are not necessarily there when you dig them up, so all of a sudden what wasn't a problem, becomes a problem, and then they start talking about six months, nine months, [...] so a lot of that is where it has cost us time and money".

6.7 Improving planning for interaction in Perth

The planning process in Perth seems to be geared towards taking into account interactions between infrastructures in the master planning process. On the other
hand, a clear program of projects for the future is missing. The Metropolitan Development Program only provides a five year program, which does not give a very clear overview of future development. The Network City plan might change this in the future, as it has identified several ways to improve the MDP. Another issue that seems to curb the planning for interaction is the amount of different documents and plans that are used in planning the region. Other than in Queensland it is very hard to find out what the current planning practices are and most of the time the strategy in Perth is not clear from one document, but several documents need to be combined to gain an overview of the overall strategy. The recommendations for the Perth Region are therefore twofold. First, a program for infrastructure for the long term is needed in order to be able to take the interactions between infrastructures into account sufficiently. Second, the planning process in Perth needs to be “de-bureaucratized”. This might involve a restructuring of the Western Australian Planning Commission (as one of the interviewees suggested), but the end goal should be to make sure that the planning process is streamlined in such a way that it can be understood easily by outsiders and insiders alike.

6.8 Conclusion

The planning process in Perth is more technocratic than the planning process than that of South East Queensland, but seems to be better suited to take into account interactions. A large part of this can be attributed to institutions like the WAPC. It will be interesting to see how the Network City planning strategy will in the future achieve integrated infrastructure planning. The New MetroRail project turns out to be a great example of a project where the political process changed the regional planning at the last moment. On the other hand, most interviewees were still happy with the way the NMR project team tried to make sure that all interactions were taken into account sufficiently. The political commitment to the project, the project director’s focus on interaction and maybe most importantly the steering committee have had an important role in that.
7 Conclusions and Recommendations

"Failing to plan is planning to fail" – Alan Lakein

"A plan is useless, planning is essential" – Dwight Eisenhower

7.1 Introduction

In the previous 2 chapters the analytical framework developed in Chapter 3 has been tested according to the regional planning efforts in South East Queensland and Perth. In this chapter we come back to draw conclusions on the main question posed at the beginning of this thesis: how can the Office of Urban Management improve the infrastructure master planning process in South East Queensland to better take into account the interactions between infrastructures?

First, the main conclusions from each section in this chapter are summarized in Section 7.2. Readers are advised to start here before delving into the rest of the chapter. In Section 7.3 the main lessons from these case studies are summarized. Following that the framework is assessed for its viability and necessary changes are addressed. In Section 7.5 the planning effort in South East Queensland is evaluated and possible improvements are addressed. It is important to note that the measures for SEQ in this section should be verified by additional research before they can be applied. Then, a critical reflection on the research itself is presented and the limitations are addressed. Finally, recommendations for future research are presented.

7.2 Main Conclusions

In this Section the main conclusions from all following Sections will be summarized. The main lesson from our case studies is that an integrated plan does not mean that infrastructure interaction is sufficiently accounted for in the regional master planning of a region. Barriers that prevent this from happening are the complexity and uncertainty related to planning for interaction. Additionally, there are normative issues at play that prevent all stakeholders from being sufficiently involved in the planning process. A final problem is the institutional barriers to interaction. We have also concluded that our framework produces meaningful results for the improvement of infrastructure interaction in the regional master planning of infrastructure.

For our framework we further conclude that it is adequate for the analysis of infrastructure interaction in the regional master planning of infrastructure. Several additions were necessary to make it even more useful.

To improve master planning for infrastructure interaction in South East Queensland we conclude that the main problem is that there is no coordinating body for infrastructure interaction. We see the Office of Urban Management as the organization that should take this role by actively engaging stakeholders and their planning to come to a planning process more suited for infrastructure interaction. We have also found that the biggest discrepancy regarding the interactions between infrastructures is the difference between the way planning is done above and below ground. Including the utilities in a meaningful way in the planning process is one of the biggest challenges for the OUM.

When reflecting upon the research itself we conclude that the broad scope of the research has caused the risk of saying nothing substantial about a wide topic. We conclude however that our research does add useful knowledge, both to the research field on infrastructure interaction and to the planning process in South East Queensland. Our main conclusion here is that our research should be seen as the beginning of the research on infrastructure interaction in the regional master planning of infrastructure; not the end!

Several important topics for future research have been identified. The main one that we mention here is the need to expand the framework for a more fine grained understanding of each of the building blocks of the framework and with different infrastructure types.
In the remaining chapters each of these conclusions will be further expanded upon, other less important conclusions will be addressed as well.

7.3 Main Lessons from the case studies

The main lesson to draw from the case studies is that having an integrated plan does not mean that the regional planning is taking into account infrastructure interaction. This became especially clear in South East Queensland, where there have been only some instances where interactions have been consciously taken into consideration in the master planning and programming phases of planning. Two notable examples are the Darra to Springfield Transport Corridor and the Gold Coast hospital. On the other hand, the integrated planning does help to take into account interactions. The main advantage is the better visibility of what other stakeholders are planning. Therefore, other stakeholders are better equipped to see possible interactions. Hopefully this also leads to more communication between stakeholders to take these interactions into account.

From the case studies we can also identify several main barriers to planning for interaction. First of all, when taking into account interactions the complexity of planning goes up: more stakeholders, more physical infrastructure, more institutional constraints. The added complexity means that it becomes harder to analyze a problem and thus find fitting solutions. We have also seen that the devil is in the detail. The complexity of a project will go up in each stage of the planning process as the level of aggregation changes. When the project reaches the design stage of planning there will be a lot more interactions to take into account. Some of these can be foreseen, but others will emerge in this stage. This means that the chosen solutions for interaction must maintain a degree of flexibility in order to be able to respond to different situations.

A second, related and perhaps more important, barrier to planning for interaction is that master planning and programming is characterized by a high degree of uncertainty. The uncertainty starts at the level that the infrastructure project might be cancelled or a political decision may change the project, but can range down to a new development in the region after the project has been initiated or a change in the economy that renders the assumptions of the project incorrect. The New MetroRail project is of course an excellent example where the project was completely changed very late in the planning process. The complexity of a problem also has the tendency to increase the uncertainty related to that problem. The uncertainty in planning for interaction means that even when taken into account, when it comes down to it, the interaction might not be feasible.

As a third reason, there are normative issues at play. First and foremost, the political process drives out interaction, because often interaction costs money now and saves money later, while in order to get a project funded it needs to cost as little as possible. This is part of the strategic behavior that is often seen in planning processes like these. Similarly, if interaction actually saves money it might not save money for everyone: one stakeholder's gain could be the other one's loss. This is obvious in the utility sector, where interaction is not to the benefit of the utility organizations. Even between different government organizations the focus lies mostly on the own projects, not the whole of government outcome. This phenomenon can be described by what Mintzberg (1983) has called 'balkanization' (Mintzberg, 1983). This is where several parts of the same organization compete over scarce budget, time and resource allocations. In general, and especially in the case of infrastructure, government shows a high degree of balkanization.

Finally, there are institutional problems that pose a barrier to taking into account the interactions between infrastructures. In the case studies we have seen many forms of institutional problems. These range from the political process to specific laws or company structures. Some of them are very hard to treat. For example, we have seen the difference in strength of the Main Roads and Telecommunications Act. Where the Main Roads Act is a State Act, the Telecommunications Act is a Federal Act and by that much stronger. From a regional level this is a reality that is better accepted. Also, there are differing standards between roads and railways on earthworks etcetera. For
the co-location of infrastructure it would be a good idea to establish a combined standard for these items. A final institutional problem is the different legal status of different corridor reserves.

As a final conclusion we have found that the application of our framework produces meaningful results for the improvement of infrastructure interaction in the regional master planning of infrastructure.

In Figure 7.1 below a causal model of the main effects described above is presented. This is an attempt to show some of the effects that the described factors have on each other. As we can see the uncertainty and complexity of planning cause a decrease in the future applicability of planning and the applicability of planning at all respectively. The number of stakeholders increases complexity and the potential for interaction, which is also increased with an increase in complexity. Institutional effects can have a positive or negative effect depending on the particular effect (this is an area that needs more research). The potential for interaction will lead to more strategic behavior, which has a negative influence on future applicability. The flexibility of solutions can increase the future applicability and the applicability of planning.

![Causal model of the major problems for planning for interaction and their effects](image)

**Figure 7.1 Causal model of the major problems for planning for interaction and their effects**

### 7.4 Lessons for the Framework

One of the main rationales for the case studies was to assess the analytical framework as presented in Chapter 3 and to improve it if necessary. In this Section the main lessons from the case studies for the analytical framework are presented, which results in an updated framework for master planning and programming for interaction.

First of all we must state that fundamentally our framework has proven to be adequate for the analysis of infrastructure interaction in the regional master planning of infrastructure. What follows are several additions that add to the usefulness of the framework.

One of the main lessons from the SEQ case is that a focus on the region should not exclude the local level. This is not a direct criticism of the framework, but it needs to be mentioned that a regional focus is not only regional, but also includes the local level.

As we have seen in both case studies the notion of what infrastructure constitutes is different in different stages of planning and construction. In master planning a road is
a road, but once that road comes into detailed design it is suddenly a road, with bridges, overpasses, a shared access path and many other related structures. In other words the level of aggregation changes over the different stages of the project. Again, this is not a direct criticism of the framework, but it needs to be taken into account when planning for interaction.

Table 7.1 Improved analytical framework for the analysis of interactions between infrastructures in the regional master planning process (additions in bold)

<table>
<thead>
<tr>
<th>Process Requirements</th>
<th>Content Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Involves the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water</td>
<td>Resource Effects of Interaction</td>
</tr>
<tr>
<td>• A focus on planning of a region with the region as a holistic entity and taking into account both public and private planning, while taking into account the local and national context</td>
<td>• Save or cost space</td>
</tr>
<tr>
<td>• Sets the development objectives of a region and defines the long term program of projects to reach these goals</td>
<td>• Save or cost money</td>
</tr>
<tr>
<td>• Planning is used as strategic programming</td>
<td>• Save or cost materials</td>
</tr>
<tr>
<td>• Plans are used as a communication method and as a way to control internal and external stakeholders</td>
<td>• Save or cost time</td>
</tr>
<tr>
<td>• Planners work to find strategy, analyze strategy and are catalysts for future thinking</td>
<td>• Positive or negative social impact</td>
</tr>
<tr>
<td>• The planning process takes a network approach to decision making</td>
<td>Functionality Effects of Interaction</td>
</tr>
<tr>
<td>• There is a focus on interaction in the planning process.</td>
<td>• Increase or decrease safety</td>
</tr>
<tr>
<td></td>
<td>• Increase or decrease throughput</td>
</tr>
<tr>
<td></td>
<td>• Increase or decrease quality</td>
</tr>
<tr>
<td></td>
<td>• Increase or decrease waste</td>
</tr>
</tbody>
</table>

Types of Interactions to take into account:

- Dependence interaction
- Environmental interaction
- Institutional interaction
- Multi-actor interaction
- Spatial interaction
- Technological interaction

**Timing Interaction**

**Total Resource use in a Region**

On the content side of the framework there are additions necessary. First of all, the social cost and benefits of interaction have not been included explicitly in the framework. This needs to be addressed as in both case studies significant social gains and costs were found. Additionally, there are several other categories of interactions that need to be added to make the framework more complete. These are the timing interaction and the total resource use in a region.

Through the case studies a list has been found of interactions between infrastructures that can be used in master planning to gain a better understanding of the effects that new infrastructure has on other infrastructure. This list can be found in Appendix B. An important question for future research question is which of these interactions can be taken into account in the master planning and programming phases of planning to improve the planning outcome. The three interactions that can only be taken into account in the master planning and programming phases are multi-actor interaction, timing interaction and the total resource use in a region. For the other types of
interactions it needs to be decided on a case to case basis whether to take into account these interactions in the master planning and programming phases of infrastructure planning. This is dependent on the complexity and uncertainty of the problem at hand.

In Table 7.1 above the framework from chapter 3 is updated with the lessons learned from the case studies. These changes have been marked in bold.

### 7.5 Improving planning for interaction in SEQ

The final question to answer is how planning for interaction in South East Queensland can be improved. First of all, the specific problems in SEQ are analyzed that are barriers to taking into account interactions in the planning process. Secondly, some opportunities for improvements are made. Finally, several policy measures will be presented that can help in taking into account interactions.

#### 7.5.1 Problems in South East Queensland

From the case study in SEQ we conclude that the specific problems in South East Queensland are not related to the lack of a master planned program of projects. Rather it is the lack of a coordinating body that takes responsibility for infrastructure interaction in this programming. The program as it is now is the result of individual agencies doing their planning, while the Office of Urban Management only takes a minimal role in optimizing the planning for interaction.

The biggest discrepancy is between what is above and what is below ground. Transport infrastructure (the infrastructure above ground) leads development and is planned using corridors. The utilities like electricity and water (the infrastructure below ground) is not planned in such controlled way. Basically, the transport infrastructure projects are forced to pay for relocation whenever it goes over any utilities. Together with an institutionally enforced limited planning horizon for electricity and a semi-privatized utility sector causes a breeding ground for opportunistic behavior. In this case negative interaction is positive for stakeholders in the utility sectors: they get free new assets whenever there is new transport infrastructure in the area.

Another problem is the minimal involvement of the local governments in the decision making process. It is problematic at least to keep an important group of decision makers away from the regional planning process in such a way. This situation also has the potential for strategic behavior, where local government seemingly comply with the directions set out in the SEQIPP, but in the mean time ignore it for as long as possible. The Local Growth Management Strategies that are being used as input for future versions of the SEQIPP are hopefully a step in the right direction to solve this problem.

As we have already mentioned above there are some institutional problems in SEQ as well. The differing strengths of the Telecommunications Act and other infrastructure Acts are an important example. Another institutional problem is the limited room for planning and innovative investments in electricity because of anti-monopoly laws. Additionally, an institutional problem is the differences in organizational culture and structure between many of the different agencies and other stakeholders. Finally, there are some regulatory interactions between road and railway reserves and the question what kind of corridor a combined rail and road corridor is.

#### 7.5.2 Opportunities in South East Queensland

There are some major problems in South East Queensland as described above. However, in the case study we have also found some promising opportunities for South East Queensland that can allow the regional planning effort to focus more on interaction.

First of all, there is the Office of Urban Management, which seems perfectly poised to take a bigger role in planning for interaction. At this moment its role in influencing the planning done by individual agencies is minimal, but there are some good examples where the OUM has leveraged on good interactions.
Secondly, the SEQIPP is a good starting point for taking into account interactions between infrastructures more. More focus on utility infrastructure and local infrastructure is needed, but with that the SEQIPP could be a basis for stakeholders to work on interaction. Two related developments are also seen as an opportunity by many stakeholders. These are the joint project offices that have been started between many of the agencies, which are working together to develop and deliver infrastructure together. The other development that is a promising opportunity is the alliance style contracting that is emerging in SEQ.

7.5.3 Lessons from Perth
From the case study in Perth we can draw three important lessons for the regional planning in South East Queensland. First of all, we have seen that the planning process in Perth is managed by a strong coordination body: the Western Australian Planning Commission (WAPC). In this respect the Perth case study backs up our conclusion above that the Office of Urban Management needs a stronger role in coordinating the infrastructure planning process in order to better take into account the interactions between infrastructures.

A second conclusion is that South East Queensland should watch out to not fall into the bureaucracy trap. At this moment the planning process in South East Queensland is quite lean compared to the Perth planning process. This is an advantage that SEQ should try not to lose.

The final important lesson is that a strong project champion can have a very positive effect on taking into account the interactions between infrastructures.

7.5.4 Solutions for South East Queensland
Considering the above there are several solutions that we would like to present as possibilities for the Office of Urban Management to improve the regional master planning of infrastructure for infrastructure interaction in South East Queensland. Our first solution is that the Office of Urban Management should take a leading role in taking into account the interactions between infrastructures in the regional master planning process. It should actively engage stakeholders in finding ways to improve the way infrastructures interact with each other and have a bigger role in the final planning of the different agencies. A good way to do this might be the way that the WAPC in Perth has several committees, comprised of representatives from important stakeholders, which decide on various aspects of the planning field. There is a risk that this new drive to take into account more interactions by including more stakeholders and more factors and spending more time and resources on coordination leads to a paradox where this also leads to more bureaucracy. A balance needs to be found here between involvement and control, and allowing things to go their way.

The Office of Urban Management furthermore needs to include more stakeholders in the planning process. Local governments should be actively involved in the planning process and have their say. The Local Growth Management Strategies that are being used as input for future versions of the SEQIPP look like a good step in the direction of allowing local government to have their input. On the other hand, a more direct involvement of local government in the planning process would most likely be better. Not only local government is insufficiently involved in decision making. The utility infrastructures should not be allowed to stay outside of the planning process. Since planning for interaction is not directly in the interest of these stakeholders just offering more involvement is not sufficient. In this case we recommend creating win-win coalitions with the utility providers as well (De Bruijn and Ten Heuvelhof, 2000). This means that both parties should gain from working together. Here we will present some ways to achieve this, but more research on this topic is required. A first option could be to tender for utility corridors. Utility providers can bid for delivering their infrastructure in utility corridors (as described by Franken (2006)). This is not much more expensive, but leads to major benefits in the alignment of underground infrastructure with the infrastructure above ground. Another solution that can also be
used is Real Options. This basically means that the government takes a budget option in a tender on integrated planning (for example a utility corridor as discussed above). If needed this option can then be used, otherwise the reserved money flows back into the state fund. This option has been used successfully in Rockingham in the Perth Case Study. However, a requirement for these solutions is that there is competition in these private infrastructure markets.

Another recommendation is to continue to gain experience with alliance style contracting. Not only does it allow the planning of integrated infrastructure solutions, but it also brings the different agencies together. Something that in the long term might have a good impact on the way these agencies interact culturally. The OUM and government should be willing to lift institutional barriers that may arise because of this new approach. Starting alliances early also seems a good idea. This way projects can be combined and sent through the Environmental Impact Assessment and business case together.

As we have seen a lot of institutional problems have no direct solutions. On the other hand, there are institutional problems that can be treated easily. The OUM could start a standardization effort to find standards for combined corridors and start to find a new legal status for combined corridors. An internal committee that gets the mission to find further institutional problems and recommend resolutions seems like a good way to slowly work towards an institutional environment that is open to infrastructure interaction.

Another conclusion from Perth was that a project champion can have a positive effect on taking into account the interactions between infrastructures. At the moment the minister for infrastructure is also deputy premier and in this respect a strong person within the government. The OUM, while having little influence on this, should strive to keep this strong project champion.

Finally, since the field of infrastructure interaction is not very mature yet it is hard to know what interactions to take into account in regional master planning and what to leave for later phases. By monitoring projects and learning from the interactions that are found there, the whole planning process over time can be made better suited to take into account specific interactions at the right times. GIS systems (Lemer, 1998) and tools like Dial Before You Dig can help in learning and planning.

In conclusion, with the updated framework and the suggested solutions we hope that South East Queensland will succeed in taking into account the interactions between infrastructures in the regional master planning of infrastructure.

### 7.6 Reflection on the Research

In this section we will reflect upon the research and address some of the weak spots that one might find in this research.

A first point that needs to be addressed is the scope of the research. A comment on the research could be that the scope of the research has been posed to broadly. Is it really possible to draw conclusions on infrastructure interaction between all different infrastructures that were part of this research? This is a valid comment. In any research it is important to have a proper balance between depth and breadth. If a topic is too deep one risks saying a lot about nothing, while if one deals with a very broad topic the risk is saying nothing about a lot. First, we wish to assert here that we believe our framework to be a good start for the analysis of interactions between infrastructures in the regional master planning of infrastructure. Of course with more research the framework can be further refined and this is definitely recommended.

Secondly, our use of the framework in the case studies has allowed us to make some concrete recommendations for South East Queensland and to a limited extend for Perth. These recommendations are also subject to more research to assess their worth, but again they serve as a good basis for further analysis. It took a while, but finally we have been able to say something meaningful about the subject we were studying. Our conclusion is that this research should not be seen as the final word on infrastructure interaction in regional master planning; rather it should be seen as the beginning!
Another possible weakness in the research is the selection of interviewees. The snowballing strategy used for this selection is a good method to find new people to interview, but there needs to be a focus from the researcher on whether the entire research area gets a voice. Snowballing has the tendency to get people who were involved in the decision making, but not get the people that were not involved. In hindsight this focus might not have been present enough in this research. A group of interviewees that might not have had enough voice in the research is the utility infrastructure providers, although this is also caused by the fact that many of them did not want to be interviewed. This means that the research might be slightly biased towards the favor of infrastructure agencies.

Additionally, during the interviews, often interviewees would hold on to their own, implicit definitions of infrastructure, master planning and infrastructure interaction. Even when the definitions used in this research were clearly provided in writing by the researcher. Not only did this make the interviews themselves and the interpretation of these interviews harder, it also shows the subjective nature of the concepts used in this research.

### 7.7 Recommendations for Future Research

An important topic for future research is the analytical framework itself. The framework can be refined to gain a more fine grained understanding of how each building block of the framework influences the planning for interaction. The framework can also be tested on additional cases, possibly testing it on infrastructure types that were only minimally involved in the present research.

Related to this is something that was already mentioned before in this chapter: institutional factors comprise a big part of infrastructure interaction. More research on this, in itself broad, topic can be rewarding to understand the different sorts of institutional problems and opportunities there are.

Another question that needs to be answered in future research is what interactions can be fruitfully taken into account in the infrastructure master planning of a region. As we have seen the level of aggregation determines what interactions are visible at a particular time in the planning process; this implies that some interactions might not be appropriate to take into account this early in the planning process. The framework and the list of interactions that can be found in Appendix B can be used as a good starting point for future research on this topic.

A more or less implicit assumption in this research is that the relocation costs of utility infrastructure in a region is high. But how much does it actually cost? Is it worth it to spend a lot of effort on including utilities in an integrated planning process? In this research we have found some evidence that it is, but it is highly recommended to verify this in future research.

Another area of future research is how to include private infrastructure (i.e. utilities) in a planning process that takes into account interactions between infrastructures. The planning horizon of private infrastructure providers is often a lot shorter than that of public infrastructure providers. In addition private infrastructure is market based, and thus competitive, this might in some cases make long term planning competitively infeasible or unwanted. Finally, many of the private infrastructure providers are former state companies under monopoly legislation; this provides an institutional boundary to planning for interaction. Some possible solutions to these problems have been provided above, but these need to be verified by additional research.
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Policy.

Appendix A List of Interviews

Interviewees have been chosen using a technique called snowballing. Snowballing means that every interviewee is asked to present some additional people that they consider key informants in the research. In this way one quickly learns what the most important people or organizations are to talk to, because their name will come up often. In this way interviewees were selected. All key stakeholders were approached for an interview, but some declined or were not available. This means that in some cases important stakeholders have not been talked to. In other cases the interview with the key stakeholder was the longest interview. A weakness of the applied method is that stakeholders that are left outside of the field of stakeholders can fall by the wayside, while they may have very interesting insights to share. This weakness is further addressed in Section 7.6.

Table A.1 presents the data on the interviewees that can be shared without breaking the privacy contract that has been presented to each interviewee.

Table A.1 Interviewee data

<table>
<thead>
<tr>
<th>Interview Date</th>
<th>Interview Time</th>
<th>Interview Location</th>
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<td>10:00 – 11:30 AM</td>
<td>Rockingham</td>
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<td>Perth</td>
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## Appendix B List of Interactions

In Table 1 below a list of interactions with their possible effects is presented from the case studies. This list should be seen as indicative of the total plethora of interactions and their effects. It should be seen as the basis for research targeted at creating metrics for specific forms of interaction.

Table 1 List of interactions from the case studies and their possible effects

<table>
<thead>
<tr>
<th>Interactions</th>
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<tbody>
<tr>
<td><strong>Dependence Interaction</strong></td>
<td>Possible Effects</td>
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<td>Dependence on utility infrastructure</td>
<td>Depends.</td>
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<tr>
<td>Dependence on scarce utilities</td>
<td>Cost money.</td>
</tr>
<tr>
<td><strong>Environmental Interaction</strong></td>
<td>Possible Effects</td>
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<tr>
<td>Containment of noise in one corridor</td>
<td>Reduce waste.</td>
</tr>
<tr>
<td>Reduce output of environmental waste in urban environment</td>
<td>Reduce community impact.</td>
</tr>
<tr>
<td><strong>Institutional Interaction</strong></td>
<td>Possible Effects</td>
</tr>
<tr>
<td>Alliance style contracting</td>
<td>Save money, save materials. Might save or cost time.</td>
</tr>
<tr>
<td>Doing pre-work for a project that comes next</td>
<td>Save money, save resources, save materials, reduce community impact.</td>
</tr>
<tr>
<td>Different legal status of reserves and corridors</td>
<td>Cost money.</td>
</tr>
<tr>
<td>Differing infrastructure standards</td>
<td>Cost money, increase waste.</td>
</tr>
<tr>
<td>Having work done in the same area by the same contractor</td>
<td>Save money, save time, possibly save materials.</td>
</tr>
<tr>
<td>Changing standards</td>
<td>Depends.</td>
</tr>
<tr>
<td>Different amounts of power between stakeholders</td>
<td>Depends.</td>
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<tr>
<td><strong>Spatial Interaction</strong></td>
<td>Possible Effects</td>
</tr>
<tr>
<td>Build in the same corridor (green fields)</td>
<td>Save space, save money, save resources. Possible (negative) safety effect, possible (positive or negative) throughput effect. (Also depends on timing). Reduce community impact.</td>
</tr>
<tr>
<td>Build in the same corridor (brown fields)</td>
<td>Trade off between saving space and costing money. Trade off between costing money and increasing safety. Increase community impact.</td>
</tr>
<tr>
<td>Joint drainage or telecommunication trenches.</td>
<td>Save space, save money.</td>
</tr>
<tr>
<td>Shared site access</td>
<td>Save space, save money.</td>
</tr>
<tr>
<td>Reduction in catchment area</td>
<td>Reduce throughput.</td>
</tr>
<tr>
<td>Relocation of services</td>
<td>Cost money, cost time.</td>
</tr>
<tr>
<td>Effect on other roads</td>
<td>Increase total throughput, increase level of (service) quality. During construction: increase community impact</td>
</tr>
<tr>
<td><strong>Technological Interaction</strong></td>
<td><strong>Possible Effects</strong></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>----------------------------------------------</td>
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<tr>
<td>Differing technology standards</td>
<td>Trade off.</td>
</tr>
<tr>
<td><strong>Timing Interaction</strong></td>
<td><strong>Possible Effects</strong></td>
</tr>
<tr>
<td>Build next to an operating other</td>
<td>Cost money, cost time, decreased safety</td>
</tr>
<tr>
<td>infrastructure (bad timing)</td>
<td>(one off).</td>
</tr>
<tr>
<td>Timing two or more infrastructure</td>
<td>Save time, save costs, save materials.</td>
</tr>
<tr>
<td>projects together</td>
<td></td>
</tr>
<tr>
<td><strong>Total Resource Use in a Region</strong></td>
<td><strong>Possible Effects</strong></td>
</tr>
<tr>
<td>Having more projects in a region than</td>
<td>Cost money, possibly cost time</td>
</tr>
<tr>
<td>the region can handle</td>
<td></td>
</tr>
</tbody>
</table>
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auslink</td>
<td>Auslink is a Federal Australian fund for the creation of Federal infrastructure connecting regions and states.</td>
</tr>
<tr>
<td>Brisbane City Council (BCC)</td>
<td>The municipal administration of Brisbane, Queensland.</td>
</tr>
<tr>
<td>Design &amp; Construct (D &amp; C)</td>
<td>A form of contracting in which the contractor is responsible for designing and constructing the work under contract.</td>
</tr>
<tr>
<td>Department of Planning and Infrastructure (DPI)</td>
<td>The department in Western Australia responsible for planning of infrastructure.</td>
</tr>
<tr>
<td>Department of Main Roads (DMR)</td>
<td>The department in Queensland and Western Australia responsible for planning, building and maintaining the major road system. (note: these are two separate departments with the same name)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Defined in this research as <em>the institutional, multi-actor and physical dimensions of the gas, electricity, drinking water, sanitation, physical telecom and transport infrastructure for people and freight over road, rail and water.</em></td>
</tr>
<tr>
<td>Interaction</td>
<td>“the differing effect of one independent variable on the dependent variable, depending on the particular level of another independent variable” (Cozby, 2003)</td>
</tr>
<tr>
<td>Metropolitan Region Scheme (MRS)</td>
<td>The Metropolitan Region Scheme is the statutory planning scheme in Perth that shows land zoning and reservations.</td>
</tr>
<tr>
<td>Next Generation Infrastructures (NGI) Foundation</td>
<td>“The Next Generation Infrastructures Foundation represents a large international consortium of knowledge institutions, market players and governmental bodies, joining forces to solve the huge problems in today's infrastructure sectors” (Stichting Next Generation Infrastructures, 2004).</td>
</tr>
<tr>
<td>Office of Urban Management (OUM)</td>
<td>The Office of Urban Management is a part of the Department of Infrastructure in Queensland that is charged with the creation of the South East Queensland Infrastructure Plan and Program and the South East Queensland Regional Plan.</td>
</tr>
<tr>
<td>Program Management Office (PMO)</td>
<td>The Program Management Office is a part of the Department of Infrastructure in Queensland charged with the management of the implementation of infrastructure projects in SEQ.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>Public Private Partnership (PPP)</td>
<td>The building or operation of a service in the partnership of government and the private sector.</td>
</tr>
<tr>
<td>Public Utility Plant (PUP)</td>
<td>See: utility</td>
</tr>
<tr>
<td>Queensland Rail (QR)</td>
<td>A government owned company in Queensland responsible for the operation and maintenance of railways.</td>
</tr>
<tr>
<td>Queensland Transport (QT)</td>
<td>Queensland Transport is a department in the Queensland government that is responsible for the planning of transport infrastructure and public transport in Queensland.</td>
</tr>
<tr>
<td>Regional Master Planning</td>
<td>Defined in this research as 1) master planning setting the development objectives of a region and defining the long term program of projects to reach these goals and 2) regional planning planning of a region with the region as a holistic entity and taking into account both public and private planning</td>
</tr>
<tr>
<td>South East Queensland (SEQ)</td>
<td>South East Queensland (SEQ) is a region in Queensland that. The SEQ region covers 22,420 square kilometers (SEQ Council of Mayors, 2008), extending 240 km from Noosa in the north to the Gold Coast and New South Wales border in the south, and 140 km west to Toowoomba.</td>
</tr>
<tr>
<td>South East Queensland Infrastructure Plan and Program (SEQIPP)</td>
<td>The South East Queensland Infrastructure Plan and Program is an infrastructure planning document presenting an infrastructure program of AUS$80 billion for the coming 20 years to meet growth in South East Queensland.</td>
</tr>
<tr>
<td>South East Queensland Regional Plan</td>
<td>The SEQ Regional plan is the plan that sets targets for land use and development in the South East Queensland region for the coming 20 years.</td>
</tr>
<tr>
<td>Utility</td>
<td>Utilities are the primary infrastructures. This includes electricity, water, sewerage and telecommunication infrastructure. It is usually located underground.</td>
</tr>
<tr>
<td>Western Australian Planning Commission</td>
<td>The Western Australian Planning Commission is the government body charged with the coordination of regional infrastructure planning in Perth.</td>
</tr>
</tbody>
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