
BUILDING ON TUNNELS

Suggestions to improve the decision making process



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PREFACE

With this thesis, I will finish my master of science Construction, Management & Engineering at the TU Delft. Moreover, it is the end of my period as a student. As a student, I've enjoyed being educated about innovations and the state of the art methods of solving problems in construction industry. But I think I've learned the most important lesson during this thesis: it's tempting to adopt ideas of experienced people but they are not necessarily right.

During my path towards becoming a Master of Science, I'm supported by a lot of people. Especially I would like to thank my parents, they gave me all the opportunities to do this study. My mother by welcoming me home every time I was totally exhausted after studying hard (or enjoying the other aspects of being a student), and my father by keep believing in my capabilities and supporting me to use them. I would like to thank my sister, for supporting me to walk my own path and for being a good friend. I also would like to thank my friends, for making my student time the best I could have imagined.

Writing this thesis would have been impossible without the help of some people. First of all, I would like to thank Professor Bosch for his valuable comments and his enthusiasm about the topic and my approach to tackle the problem. Secondly I would like to thank Martijn Leijten. His effort to keep me on the right track and guidance to stick to the content were very valuable in order to successfully finalizing a scientific research. Hendrik Ploeger, for his help in the legal part and giving comments on all my written documents. I also would like to thank all interviewees, for sharing their experiences and answering all my questions. But most of all I would like to thank Frans Taselaar and Cees Hompe, for investing so much time in the guidance of this research. I've had a great time during my months at the office of Hompe & Taselaar in Amsterdam. Although writing a thesis is a process of ups and downs, I've enjoyed every day of doing this research, thanks to the supportive working place that is created. So Cees, Frans, Nic, Richard and Joke, thank you!

I wish all readers of this thesis a lot of reading pleasure. I hope there is something useful in it for you.

Amsterdam, September 2011

ABSTRACT

BACKGROUND

Tunnels are increasingly built in urban area in order to minimize nuisance for the city while improving the capacity of infrastructure. Besides the desire to decrease nuisance, the vision to create a compact city is developed since a compact city has a smaller environmental footprint and there are economic advantages when a city increases without expanding the city boundaries. The underground can give a big contribution to achieving a compact city, but only if the land above the underground solutions is used efficiently as well. Decision making towards building on the tunnel can be a solution.

Therefore the following research objective is defined:

Give suggestions to improve the decision making process for building on tunnels by exploring opportunities and strategies in multi-actor decision making.

First the difficulties regarding building on tunnels are researched. Several conditions are defined. This is followed by researching decision making process strategies. Both aspects are validated for two real life projects: Spoorzone Delft and Zuidas. Results from these case studies are used to define general suggestions.

THEORY

Tunnel safety

Most conditions for building on tunnels are caused by the safety aspects for the infrastructure. Extra attention must be paid to external safety. External safety standards describe two kinds of risks: individual risk (IR) and group risk (GR).

The IR profile is the result of a quantitative risk analysis and determines the safety zone around the infrastructure. Within the safety zone, the development of vulnerable properties is not allowed. Other properties (also known as partly vulnerable properties) can be developed, if this can be well argued. The GR can be used as a guideline for development within the safety zone. The GR introduce possibilities for discussion about which properties are vulnerable and the accepted amount of people killed due to a single incident. Dealing with these possibilities for discussion requires paying attention to the perception of safety. This can be done by using ethical considerations.

Ownership of properties

Limited rights in rem describe the possibilities to arrange ownership of property in case of multiple use of land. Every owner has strict liability of damage from his property to others. Regarding building on a tunnel, there is an increased risk of damage caused by/ in one property to the other. In order to prevent the increased risk resulting in a deadlock for the process, attention must be paid to the perception of liability regarding risks. This can be done using ethical considerations as well.

CONDITIONS REGARDING BUILDING ON TUNNELS

There are no rules and regulations prohibiting building on tunnels. But there are several aspects that need to be covered:

- > Determine the safety zone in the surrounding of the tunnel. Within the safety zone only partly vulnerable properties can be developed.
- > Commission a limited right in rem for owning more than one property on one piece of land.

ACHIEVING QUALITY

With building on tunnels, the infrastructure project and the land development project are interdependent. There is not one actor who can make hierarchical decisions without influencing the interests and objectives of other actors. According to process management theories, quality within a project with high interdependencies can be achieved by meeting the interest of all involved actors as much as possible.

Process management

In order to achieve such quality, the process must be designed in which parties collaborate and aim for achieving their own objectives as well as achieving the overall project objectives. This can be done by using four general process management strategies.

The first main strategy is to **create an open process**. Inviting a variety of actors with different objectives for the project will enrich the outcome of the process. Furthermore by involving a variety of actors, a variety of interests will be served and therefore the support for the project increases.

The second main strategy is to **protect actors' core values**. The project organization must respect the core values and make actors aware that they will do as much as possible to find a solution in line with all core values. When an actor's core values are harmed, it is important to argue why the solution is chosen and to be open for complaints and suggestions.

The third strategy is to **guarantee the speed of the process**. Lacking progress gives actors the possibility to withdraw from the process. Regarding building on tunnels a financial benefit must be covered. With lacking progress, the profit from land development decreases due the time value of money.

The last main strategy is defined as **guaranteeing the substance of the process**. A decision without content allows actors to be uncommitted to the decision. The conditions from rules and regulations and rational analyses can give input in order to come to substance.

The perception of safety and the perception of liability

Not only rational analyses for safety and liability regarding building on tunnels are important input for decision making. The perception of these aspects plays a role as well, which can be considered by using ethical considerations.

Scenario analyses provide an insight in consequences of certain incidents. Instead of using the basis of safety standards (quantitative risk assessments); scenarios are often used for decision making. Furthermore, infrastructure owners are not interested in an increased risk on damage to the infrastructure, when the cause of the increased risk is not in their interest.

SUGGESTIONS TO IMPROVE THE DECISION MAKING PROCESS

The several main strategies have been divided into 25 indicators to test decision making processes upon these strategies. Two case projects, Zuidas and Spoorzone Delft have been tested, resulting in the following suggestions to improve decision making.

- > Focus on the prospects of gain with building on tunnels. Building on tunnels can be an incentive for collaboration among a variety of actors due to possible financial benefits, increase of urban quality and attractive locations for land development.
- > Realize one project organization with all critical actors represented. Then solutions are supported by a wide variety of actors. Moreover, for building

on tunnels decisions cannot be made by a single actor since this goes beyond his expertise and/ or authority.

- > Take care of a transparent overall risk profile, being the result of a QRA. Uncertainties can cause a substantial prospect of loss. When the process is lacking in one or more of the four overall process management aspects, it is suggested to compensate the lacking process with a collective risk mitigation plan.
- > Use the same approach for deciding upon building on tunnels for highway tunnels as for railway tunnels. Different data and safety measures can be the input for analyses that might result in a different outcome. Besides some details, both types of tunnels have to deal with similar difficulties therefore it is suggested to have the same approach.

These suggestions follow from the scope of this research. There were several limitations and further research might provide more prescriptive improvements:

- > Increase of data: perform more case studies to obtain more objective data in order to define prescriptive improvements.
- > Costs and benefits: make a financial and societal evaluation of two alternatives. One alternative holding expanding city boundaries, one alternative holding building on the tunnel.
- > Dealing with subjective information in an analysis: it is questioned if clear standards are a solution for the desire to minimize discussion regarding tunnel safety. It is recommended to do research on how to deal with subjective information within QRA's and be clear in the role of scenario analyses in decision making.

SAMENVATTING

ACHTERGROND

In toenemende mate worden er tunnels in stedelijk gebied gebouwd om de hinder voor de stad te minimaliseren. Daarbij wordt de capaciteit van de infrastructuur verhoogd. Daarnaast sluit ondergronds ruimtegebruik aan bij de visie van een compacte stad. Door het verstedelijken (en geen stadsuitbreiding) draagt een compacte stad bij aan een vermindering van de milieu/ omgevingsbeschadiging en zijn er economische voordelen. Ondergrondse oplossingen kunnen een grote bijdrage leveren binnen de doelstellingen van een compacte stad, maar alleen als de ruimte boven de ondergrondse oplossing ook efficiënt gebruikt wordt. Toch wordt er bijna nooit op een tunnel gebouwd.

Dit leidt tot de volgende onderzoeksdoelstelling:

Het vinden van suggesties om de besluitvorming voor bouwen op tunnels te verbeteren door kansen en strategieën te onderzoeken binnen multi-actor besluitvorming.

Allereerst worden de moeilijkheden bij bouwen op tunnels onderzocht, waaruit verschillende randvoorwaarden voor de besluitvorming worden gedefinieerd. Vervolgens is er meer onderzoek gedaan naar besluitvormingsstrategieën. Vanuit beide onderdelen zijn indicatoren voor goede besluitvorming gedefinieerd die getest zijn aan de hand van twee cases: Spoorzone Delft en Zuidas. De resultaten van deze twee cases zijn gebruikt om algemene verbeteringsuggesties te doen.

THEORIE

Tunnelveiligheid

De meeste randvoorwaarden bij bouwen op tunnels komen voort uit veiligheidsaspecten. Er moet aandacht besteed worden aan externe veiligheid. Binnen de externe veiligheid richtlijnen worden er twee risico's beschreven: plaatsgebonden risico (= individual risk, IR) en groepsrisico (GR).

Het IR wordt bepaald door een kwantitatieve risico analyse. Hiermee wordt de veiligheidszone rond de infrastructuur bepaald. Er is geen beperking op de ontwikkeling van functies buiten de veiligheidszone. Binnen de veiligheidszone mag alleen beperkt kwetsbare bebouwing gerealiseerd worden. Het groepsrisico wordt gebruikt als richtlijn voor de ontwikkeling binnen de

veiligheidszone. Met de groepsrisico richtlijn ontstaat de mogelijkheid voor discussie welke functies en bebouwing binnen de veiligheidszone ontwikkeld mogen worden. Besluitvorming zal dus niet alleen plaatsvinden op basis van objectieve analyses, maar er moet ook aandacht worden besteed aan de perceptie van veiligheid aan de hand van ethische afwegingen.

Eigendomsverhoudingen

Eigendomsverhoudingen worden geregeld binnen het zakelijk recht. Er zijn mogelijkheden voor meervoudig ruimtegebruik en gelaagd eigendom door het verstrekken van een recht van opstal of erfpacht. Elke eigenaar draagt risicoaansprakelijkheid. Dat betekent bij bouwen op tunnels dat het risico op schade waarvoor een eigenaar aansprakelijk gesteld kan worden is verhoogd. De (toekomstige) eigenaar kan dit ervaren als een impasse voor de besluitvorming. Om dit te voorkomen kunnen ook hier ethische afwegingen gemaakt worden.

RANDVOORWAARDEN BIJ BOUWEN OP TUNNELS

Er zijn geen regels of wetten gevonden waardoor bouwen op tunnels niet is toegestaan. De volgende randvoorwaarden moeten wel in beschouwing genomen worden:

- > Bepaal de veiligheidszone rond de infrastructuur. Binnen de veiligheidszone mag alleen beperkt kwetsbare bebouwing gerealiseerd worden.
- > Verstek een zakelijk recht om gelaagd eigendom mogelijk te maken.

HET BEHALEN VAN KWALITEIT

Het infrastructuurproject en de gebiedsontwikkeling zijn afhankelijk van elkaar bij bouwen op tunnels. Het is niet mogelijk één partij aan te wijzen die beslissingen kan nemen zonder dat dit een effect heeft op de belangen en doelen van andere partijen. Procesmanagement beschrijft dat kwaliteit voor een project met grote afhankelijkheden behaald kan worden door de belangen van de betrokken partijen zoveel mogelijk tegemoet te komen.

Procesmanagement

Dergelijke kwaliteit kan behaald worden door samenwerking tussen de partijen, met behulp van vier algemene procesmanagementstrategieën:

Als eerste moet men sturen op een **open proces**. Door verschillende partijen uit te nodigen in het proces zal het resultaat worden verrijkt en waarbij diverse belangen worden behartigd. Daarmee kan er een groter draagvlak voor het project ontstaan.

Ten tweede moeten de **kernwaarden** van de betrokken partijen beschermd worden. Er moet gezocht worden naar oplossingen waarin alle partijen zich kunnen vinden. Als dit niet mogelijk is, moet er tenminste goed beargumenteerd worden waarom er toch voor die oplossing is gekozen.

Als derde strategie moet de **voortgang van het proces** gewaarborgd zijn. Zonder voortgang zullen partijen geneigd zijn om zich terug te trekken. Bij bouwen op tunnels kan het financiële voordeel een extra motivatie zijn voor een snel proces omdat de winst uit gebiedsontwikkeling zal verminderen met de tijd.

Als laatste hoofdstrategie is het waarborgen van de **inhoud van het proces** genoemd. Zonder inhoudelijke beslissingen kunnen partijen zich terugtrekken omdat ze geen affiniteit met de beslissing hebben. Binnen deze strategie kunnen risicoanalyses ook haar aandeel leveren.

De beleving van veiligheid en aansprakelijkheid

Het resultaat van een scenario analyse kan partijen afschrikken, omdat er alleen naar de consequentie van een scenario wordt gekeken. Daarbij zijn infrastructuur beheerders er niet in geïnteresseerd om extra risico's te dragen met betrekking tot mogelijke schade aan de bebouwing op de infrastructuur.

Ethische afwegingen geven aandacht aan onder andere de transparantie van risico's en de vrijwillige instemming van risico's. Dit biedt mogelijk een oplossing voor de besluitvorming.

VERBETERSUGGESTIES VOOR DE BESLUITVORMING

De hoofd strategieën zijn te valideren aan de hand van 25 indicatoren. Twee projecten, Spoorzone Delft en Zuidas zijn nader bekeken om de verbeteringsuggesties te doen:

- > Concentreer op de winstmogelijkheden van het bouwen op tunnels. Gebiedsontwikkeling op de tunnel kan een motivatie zijn voor partijen om samen te werken. Er kan een financiële bijdrage geleverd worden aan de

tunnel uit de gebiedsontwikkeling, maar ook de kwaliteit van het gebied kan verbeterd worden en het dak van de tunnel is vaak een toplocatie voor een gebouw.

- > Zorg er voor dat alle beslissende partijen binnen de projectorganisatie vertegenwoordigd worden. Beslissingen omtrent bouwen op tunnels kunnen simpelweg niet door één partij genomen worden omdat dit buiten een eenzijdige expertise en autoriteit gaat.
- > Zorg voor een transparant risicoprofiel. Het risicoprofiel is het resultaat van een kwantitatieve risicoanalyse. De risico's kunnen een reden zijn voor onzekerheid in mogelijke kosten/ schade, maar ook voor angst op een verslechterde samenwerking. Een collectief risicomanagement plan kan ook een uitkomst bieden.
- > De benadering van het vaststellen of bouwen op tunnels mag, moet voor ieder type tunnel gelijk zijn. Alle typen infrastructuur dienen een vergelijkbaar belang en moeten binnen dezelfde randvoorwaarden opereren. Daarom is het gewenst om voor ieder type tunnel een kwantitatieve risico analyse uit te voeren, waarin uiteraard verschillende data als input geleverd kan worden en verschillende veiligheidsmaatregelen genomen kunnen worden.

De verbeteringsuggesties komen voort uit de aanpak die bij dit onderzoek is gebruikt. De beperkingen van het onderzoek, en de beperkingen van de cases resulteert in de volgende onderwerpen voor verder onderzoek:

- > Vergroot de objectiviteit van het onderzoek door meer cases te onderzoeken.
- > Doe een uitgebreide kosten- batenanalyse. Bouwen op tunnels levert niet alleen een financieel voordeel, maar ook een waarde voor de omgeving. Het zou waardevol zijn als er meer inzicht is in de kosten en baten van bouwen op de tunnel en bouwen naast de tunnel.
- > Bekijk de mogelijkheden om subjectieve informatie te gebruiken binnen analyses. Uit dit onderzoek is gebleken dat elke analyse beperkingen heeft met betrekking tot de objectiviteit van informatie. Ook wordt aanbevolen onderzoek te doen naar wat de rol zou moeten en kunnen zijn van scenarioanalyses binnen besluitvorming.

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LIST OF ABBREVIATIONS

I&M	Ministry of Infrastructure and the Environment (Ministerie van Infrastructuur en het Milieu)
OBS	Ontwikkelingsbedrijf Spoorzone
OCSD	Ontwikkelingscombinatie Spoorzone Delft
QRA	Quantitative Risk Assessment
RWS	Rijkswaterstaat
SceA	Scenario Analysis
VROM	Ministry of Housing, Spatial Planning and the Environment (Ministerie van Volkshuisvesting Ruimtelijke Ordening en het Milieu)
V&W	Ministry of Transport, Public Works and Watermanagement (Ministerie van Verkeer en Waterstaat)



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PART A: INTRODUCTION

This graduation research is a compulsory part of the M.Sc. program of Construction, Management & Engineering (CME), Delft University Technology. In order to have a connection with practice, the research is executed in collaboration with the engineering and advising company Hompe & Taselaar B.V.'. The company is specialized in preparing, planning and executing projects in urban areas with a focus on the use of the underground.

The reason to construct a tunnel for main infrastructure is either to cross a barrier (like a river) or to minimize nuisance for the environment. Keeping the last reason in mind, it is remarkable that the area on the tunnel is not often used for intensive land development.

1 PROBLEM

The first Dutch infrastructure tunnel (Maastunnel) was built from 1937 - 1942 to cross a river. From that moment tunnels were built to cross rivers but also to cross other infrastructure. From the nineties tunnels became a solution to achieve environmental and urban objectives as well. These objectives rise from the vision to create a compact city as stated in the note for the area (2006) and draft national policy strategy for infrastructure and spatial planning (2011).

Creating a compact city has two main advantages compared to expanding cities. The first advantage, as stressed in the Fourth Report on Spatial Planning is: by using land effectively, daily travel distances decrease and the city has a smaller environmental footprint. (van der Hoeven, 2010). The second argument reasons that layering functions has an economic advantage. Krugman states that concentrations of industry are self-sustaining. This is argued from the perspective to minimize transportation costs. (Krugman, 1991). The underground space can have a big contribution in achieving a compact city, but only if the area above the underground solution is also used efficiently.

Several urban (re)development projects introduce underground infrastructural alternatives. Projects as Leidsche Rijn, ZuidAs, Spoortunnel Delft and A2 Maastricht have plans to construct the infrastructure in a tunnel. The created land on the tunnel and in its surroundings is used for leisure, (local) infrastructure and sometimes to develop buildings. These projects are generally aiming at creating a high quality urban area. Urban development can be defined as the sum of infrastructure and land development. Infrastructure aims to contribute to a good traffic flow and good accessibility. Land development aims for improving liability and spatial quality. (Kenniscentrum PPS, 2004), (Hertogh, 1997) Infrastructure development and land development are interdependent: without land development, high quality infrastructure is not necessary and vice versa. At the same time the two are in conflict with each other.

The construction method of the tunnel is interdependent with the possibilities of the aboveground functions. The location of the tunnel below ground level causes interdependencies as well. Interdependencies between a variety of functions result in interdependency between actors. When actors are interdependent, they rely on each other. Decisions made by one actor have a direct effect on other actors. Therefore the decision making process of a project where a tunnel is constructed and the land will be developed, cannot

be seen as a hierarchical process in which one actor determines the outcome. Instead the actors find themselves in a network. A network of actors can be defined as a number of actors with different goals, interests and resources, who depend on each other for the realization of their goals. (de Bruijn & ten Heuvelhof, 2008, p. 1)

Infrastructural projects often cross a large area. Therefore these projects are often on the agenda of national government. When a decision is made to continue with the project, the project can count on support from national government. On the other hand, land development is concentrated on a certain location. A land development project can count on support from local actors since the quality of the area will be improved. An integral of main infrastructure with local land development serves a variety of interests and the support for the overall project can be increased.

While having the aspects explained of a complex city, interdependency of actors and increasing support by serving a variety of actors, it is remarkable that not often buildings are developed on a tunnel. As stressed before, the underground space can have a big contribution in achieving a compact city, but only if the land on the tunnel is also used efficiently. Decision making towards building on the tunnel can be a solution, but how should decision making look like and what can be the deadlocks in the process?

2 RESEARCH

The research objective is:

Find suggestions to improve the decision making process for building on tunnels by exploring opportunities and strategies in multi-actor decision making.

Or in Dutch:

Het vinden van suggesties om de besluitvorming voor bouwen op tunnels te verbeteren door kansen en strategieën te onderzoeken binnen multi-actor besluitvorming.

Improvements can be defined as progress towards what is better. Therefore one has to aspire high quality in the decision-making for building on tunnels.

2.1 RESEARCH APPROACH

In order to define improvements for the decision making process the general conditions under which building on tunnels is possible should be considered. Therefore the aspects that increase the complexity of the project should be researched. The multi-actor network should deal with the increasing complexity for which knowledge is desired.

When building on a tunnel is considered, it is assumed that the complexity is increased by aspects including:

- Legal aspects: ownership has to be divided since the tunnel property is not owned by the same party as the land property.
- Legal aspects: the risk profile changes since there is a possibility of damage from the tunnel to the buildings and vice versa. The actors have to deal with the increasing risks and a liability issue has to be cleared.
- Constructive: the tunnel and buildings will be constructively interdependent.
- Safety: the tunnel and the functions in the surrounding area must fit within the safety regulations.
- Financial aspects: the land development can contribute to the investment in the tunnel.

As a result of conversations with experts and a literature study, the constructive aspects are out of the scope of the research. It is assumed that from a constructive point of view, building on the tunnel is possible. The other aspects will be elaborated. Information from literature as well as experience from interviewees is used for the legal, safety and financial aspects.

After the conditions that increase complexity are researched, the decision making process is researched. In order to achieve quality in decision making, one must first define quality. Consequently, strategies and opportunities for decision making in a multi-actor network can be obtained from literature and practice.

Both parts of the literature research (increased complexity and decision making strategies) contribute to a roadmap for decision making for building on tunnels. Whether the roadmap actually contributes to decision making towards building on tunnels is tested within actual cases.

2.2 RESEARCH QUESTIONS AND METHODOLOGY

In order to achieve the research objective the following research question has to be answered:

WHAT ARE SUGGESTIONS CONTRIBUTING TO A SUPPORTIVE DECISION REGARDING BUILDING ON TUNNELS?

The main research question can be answered when the following sub-questions are answered:

Sub-question 1

What are the general conditions for building on tunnels?

Methods:

Do research on aspects that contribute to the complexity of the project:

- Explore tunnel safety standards and regulations
- Explore public law for conditions to generate income with land development
- Explore private law concerning shared/layered ownership

Result:

An elaboration on the general conditions for building on tunnels (part B).

Sub-question 2

Which strategies and opportunities can be used for high-quality decision-making in a multi-actor network?

Method:

Factors which contribute to high-quality decision making can be defined using literature. The following material will be used:

- Theories from de Bruijn and ten Heuvelhof
- Theories from Teisman on public management
- Theories from Kingdon on matrix organizations
- Theories from Koppenjan and Klijn
- Execute quick scans with interviews

Result:

Factors that contribute to high-quality decision making (part C)

Sub-question 3

In which way can the proposed roadmap (result from question 1 and 2) be used to improve decision-making in 'building on tunnels' projects?

Methods:

- Execute case studies with interviews
- Validate roadmap through a cross case analysis (compare results)

Result:

Suggested improvements for multi-actor decision making for building on tunnel (part D and E).

2.3 RESEARCH BOUNDARIES

In order to make the research feasible some aspects of the problem can be explored and other aspects will be out of the scope of the research. A list of the research boundaries with the argumentation is summarized below.

- Possible case projects are projects in which tunnels are a necessary and integral part of the urban (re)development. Projects in which building on the tunnel is not an integral part of the decision-making might be used for ideas by doing a quick-scan.
- There are obviously a lot of aspects that will determine conditions and requirements for building on tunnels. Only the aspects that are decisive and/ or a driving force for continuing with building on tunnels are explored. When aspects are assumed to be negotiable or can be avoided (e.g. by adapting the design) they will be out of the scope of the research.
- Exploring technical solutions to meet conditions and requirements are out of the scope of the research.
- The research is based on Dutch projects and the situation in the Netherlands. Still, the objective of the research isn't meant for the Netherlands solely. Therefore the report is written in English. Still, some suggestions might be possible solely within the Netherlands. Also the different legal system of all countries should be considered before adopting the conditions.

PART B: COMPLEXITY OF BUILDING ON TUNNELS

When building on the tunnel is considered, the project organization has to deal with extra difficulties. Since the functions of the land development and the infrastructure are interdependent, the overall project organization has to deal with interfaces.

This part of the research describes aspects that determine the complexity of building on tunnels. As resulted from the problem exploration, three aspects will be researched: safety, legal aspects, and financial and social advantages. The first two aspects cover additional difficulties rising from introducing building on the tunnel. The third aspect, financial and social advantages, is the driving force behind building on tunnels: financial and social advantages.

3 SAFETY

Underground structures are subject to discussion about safety issues. When an incident happens in a tunnel, there are limited routes to exit the tunnel. Furthermore, emergency services have difficulties to enter the tunnel and have limited view to provide the right services on the right locations. In case of land development on the tunnel, the consequence of an incident in the tunnel can be more substantial. Therefore safety will be discussed in this chapter.

3.1 PHYSICAL AND SOCIAL SAFETY

Safety can be defined in a psychological and mathematical way. Psychologists define safety as 'lack of perceived controllability' (Vlek, 1990, p. 236) and 'fear of loss' (Schaalsma, Vlek, & Lourens, 1990, p. 158). Suddle (2004) stresses in his Ph.D. thesis that these psychological definitions are informal. The formal safety can be defined as the combination of the probability that a hazard will occur and the consequence of that hazard. The psychological definitions of risk are related to both risk perception and subjective elements of safety. Hence these argumentations do not provide the answer to the question 'how safe or unsafe is an activity', or 'what is the effect of a safety measure in accordance with human risk and financial aspects'. (Suddle, 2004, p. 21) Psychological research shows that risk involves many more aspects than just the expected number of fatalities per unit of time. (Fischhoff, Watson, & Hope, 1990)

Since one has to deal with safety in objective and subjective terms, safety can be hardly assessed solely objective. Therefore a decision maker should be aware of a certain level of safety since making a decision involves accepting a certain level of physical safety. (Suddle, 2004) The following paragraphs will further explain objective and subjective safety.

3.2 TUNNEL SAFETY STANDARDS

Objective safety can be integrated in the overall weighted risk analysis. The result of the weighted risk analysis can be used as a support tool for decision making as well as to determine if the safety level is within the standards. Moreover, guaranteeing the physical safety is of importance for the continuation of a tunnel project.

In 'Besluit externe veiligheid inrichtingen' (Bevi) the standards for external safety are determined. This holds that a safety zone around the tunnel is used for the limitations of the land development. This safety zone is the zone in

which the individual risk (IR)¹ of death due to an accident is 10^{-6} per year. Within this zone the development of vulnerable properties² is prohibited. Partly vulnerable³ properties can be developed, but only when it can be well argued to take an extra risk. (Besluit externe veiligheid inrichtingen, 2004) This distinction of vulnerable and partly vulnerable properties is made because the group risk (GR)⁴ for vulnerable properties is higher.

When land development takes place within the safety zone, one has to argue the development with the acceptance of the group risk. The group risk guidelines are not strict: when the development plans can be well argued, the group risk can be accepted even when they are not in line with the guidelines. The GR level increases exponentially with the amount of people who are exposed to the risk. When the infrastructure is completed, municipality has to decide if the land development plan is acceptable argued from the GR levels.

In order to minimize the individual risk, safety measures can be taken. To determine which safety measure should be taken, a cost benefit analysis can be executed (see text box below).

¹ Individual risk (IR)= the probability that a person who is permanently present at a certain location in the vicinity of an activity will be killed as a consequence of an accident of that activity. (Suddle, 2004, pp. 26-29)

² Vulnerable properties = buildings with a permanent residential function, buildings in which people stay who are not self-reliant, and buildings where a lot of people stay during the day (such as large offices, shopping malls).

³ Partly vulnerable properties = small offices, hotels, leisure objects (as sports facilities) and shops.

⁴ Group risk (GR)= the probability per year that in an accident more than a certain number (e.g. 10, 100 or 1000) of people are killed. (Suddle, 2004, pp. 26-29)

Example: Taking safety measures

The explosion in a tunnel of a vehicle with hazardous materials resulted in a collision of the tunnel and the building on the tunnel. Minimizing the risk can be done by taking safety measures in three ways (Suddle, 2004, pp. 80-85):

1. *Changing the structure*
 - a. *Of the tunnel: stabilizing the structure of the tunnel walls and roof and pouring an extra layer of concrete.*
 - b. *Of the building: designing a column free building with an independent structure.*
2. *Changing human behavior: decrease the allowed speed in the tunnel.*
3. *Changing function: detouring hazardous materials.*

With the realization of a tunnel, the safety zone shifts from a parallel zone along the infrastructure to an increase of the safety zone around the tunnel entrances. The zone shifts towards the tunnel along the tunnel structure as can be seen in the two dimensional Figure 3-1 (Basisnet werkgroep weg, 2009, pp. 8, 63-64). This is comparable in the third dimension (height), since an explosion manifests itself equally from one point in all directions. Increasing the length of the tunnel results in a bigger risk at the entrances since the probability of a scenario increases with an increasing length. The realization of ventilation shafts and/or limiting the length of the tunnel contributes to the minimization of the probability of the risk. By realizing ventilation shafts, the consequence manifests itself there and the individual risk at that location increases as well.

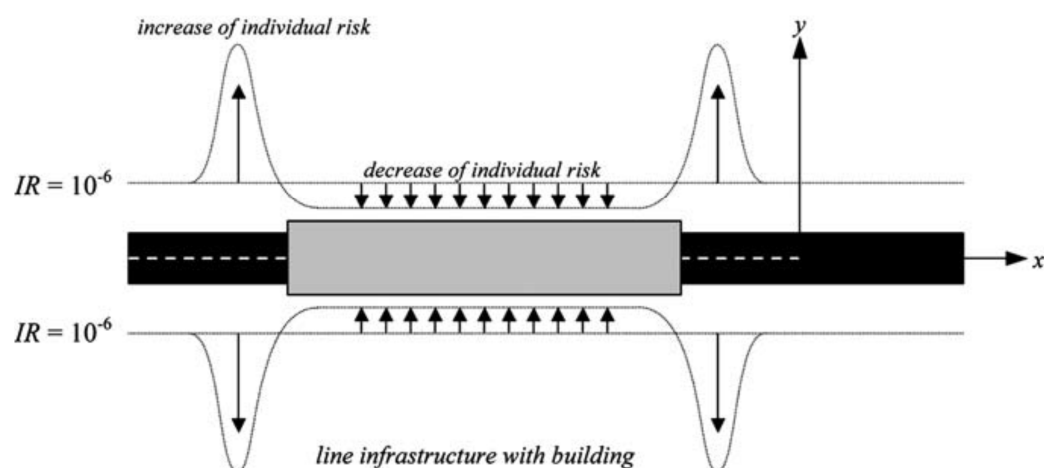


FIGURE 3-1: INDIVIDUAL RISK NEAR A TUNNEL (SUDDLE, 2004)

Although the standards for roadways and railways are the same, the safety zone for railways is often smaller. The probability for an accident is smaller and therefore the safety zone shifts towards the infrastructure or is absent since the IR is smaller than 10^{-6} .

Result quick scan: Overpassing Bos & Lommer A10 Amsterdam

In the nineties there were plans to overpass the A10 in Amsterdam in the district of Bos & Lommer with a building. The Quantitative Risk Assessment performed by Suddle shows an IR of 2×10^{-6} for the external safety. This means from the safety standards that only partly vulnerable properties are allowed to be realized and only if it can be well argued. When the A10 needed to close for maintenance, this was an opportunity to build the overpassing as well. Measures are taken to the façade and the structure of the building in order to decrease the risks during operations and only non-residential functions are located in the building (as sports facilities).

3.3 PERCEPTION OF SAFETY

Although most risk experts suggest the acceptability of risks should be directly proportional to the outcomes of risk assessments (Brumsem, van de Poel, Zandvoort, & Mulder, 2009), instead political- social- and psychological aspects prevail during decision making. (Suddle, 2004, p. 4) Optimizing physical safety and proving an acceptable level of physical safety is not always decisive in the decision making process. The standards create a grey area for decision making since Basisnet weg states that within a safety zone there are limited possibilities to build. However some find this grey area difficult to deal with and rather see the safety zone as a strict zone where realizing buildings isn't allowed, it also provides room for decision making.

Result quick scan: Overpassing Bos & Lommer A10 (Amsterdam)

The overpassing of the A10 West, Bos & Lommer shows that decision making is not solely determined from the standards. The desire to connect the two city parts was decisive and a building is realized within the safety zone. Decision makers perceived the risk as acceptable since value was created in the area.

Another aspect determining the acceptable level of safety is the mindset of the decision makers. Incidents in the (near) past can influence requirements and desires. Therefore the acceptance of risks can be derived from the aspects that are important for the perception of risks. Perception of risks is determined by ethical considerations and the time frame decision making takes place.

Result quick scan: Redevelopment Nieuwmarkt on metro tunnel (Amsterdam)

During the sixties and seventies Amsterdam planned to build a metro through the city center. Since houses needed to be demolished, a lot of residents demonstrated against the plans. In the end, the metro was build. The Second World War was in peoples memory, therefore the tunnels were designed with bomb shelters.

4 LEGAL ASPECTS

The second source of complexity rises from legal aspects. When buildings are realized on the tunnel, ownership of the properties must be arranged. The Dutch Civil Code describes that ownership of land is not limited by depth. Therefore owning land means that one owns the land until the center of the earth. (Art 5:20 BW) Article 5:21 BW explains the exclusive right of using the property is limited to the depth at which the owner has no interest in opposing the use by others. In order to deviate from the basic right that one owns land until the center of the earth, agreements must be made.

This research deals with the case that a tunnel is built and then land is developed on top of it. Therefore it is necessary for the tunnel owner to have all rights of the land during construction since it is useless for any other purposes. When the land is owned or leased by another party as the tunnel owner, expropriation might be necessary. After the tunnel is built, the ground level offers opportunities for land development. Then the ownership of properties must be (re)arranged. Corresponding liability must be taken into account as well.

4.1 OWNERSHIP OF PROPERTY

The limited rights in rem⁵ describe rights to arrange ownership of property between parties. These rights contribute to facilitating layered ownership. In the Netherlands there are two methods to facilitate this.

- Building right⁶: the right to own property in, on top of or above another's property. (Art 5:101 BW)
- Leasehold⁷: the right to own and use a property on another's property. (Art 5:85 BW)

After the establishment of a limited right in rem, the original owner is called the naked owner. There is a slight difference between the two types: with a leasehold the total property is commissioned and the rights of the naked owner for his property are significantly limited. With a building right the naked owner

⁵ In rem = zakelijk recht

⁶ Building right = recht van opstal

⁷ Leasehold = erfpacht

is allowed to keep using his property as long as he doesn't limit the lessee⁸ in his use and vice versa.

Conditions of these limitations can be discussed. A horizontal separation of the ground is achieved, with the corresponding liabilities. (Centrum Ondergronds Bouwen and Ravi, 2000, pp. 14-16), (Ploeger, 1997)

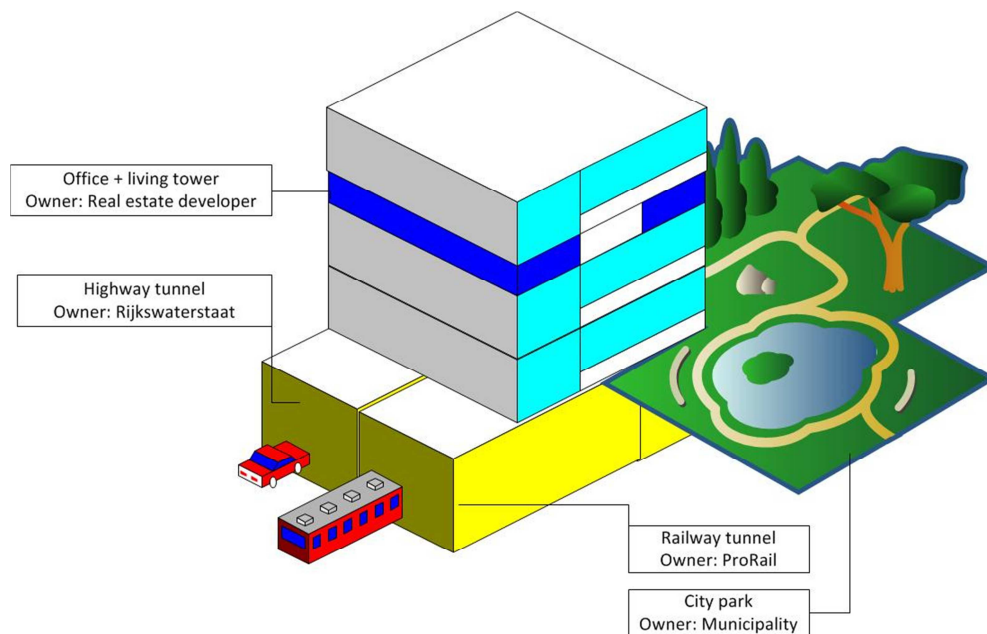


FIGURE 4-1: EXAMPLE OF SEVERAL PROPERTY OWNERS AT ONE LOCATION

⁸ Lessee = pachter

Example: Ownership

Figure 4-1 shows a simplified sketch of a building and public space on tunnels. The different properties are owned by different parties.

In this example the tunnel owners are the naked owners of the land. The city park is owned by the municipality, commissioned by a leasehold. The building is owned by a private land developer, commissioned by a leasehold as well.

The other possibility, the tunnels are commissioned by a limited right in rem, the building owner and municipality are the naked owners.

Obviously, there are interdependencies between the tunnel and the building and city park as:

- *Administrative interdependence: the original (or naked) owner must approve changes of the building and public space. Public space has unlimited elements. All elements of the public space must be approved by the naked owner.*
- *Constructive interdependence: the building is founded on the tunnel. It is possible to make use of the same foundation for the different properties. Another interdependence is that a tree won't be able to grow when there is no intermediate ground layer.*

The interdependencies are not limited as described in this example. Every interdependency contributes to the limitations of the plans or might contribute to changing the plans.

4.2 MEANING OF LAYERED PROPERTIES

Owning a property brings liabilities. Therefore it should be considered what it means to own a property on a tunnel and what it means for the tunnel owner when a property is built on the tunnel.

When a party is liable for certain damage, he is obliged to compensate for the damage. Someone can be held liable as stressed by the following sections of Dutch Civil Code:

- Tort⁹ (Art 6:162 BW). When a defect can be demonstrated and can be accounted to a party, one can speak of tort. Therefore a party must be in default and this must be proved.
- Strict liability¹⁰ (Art 6:174 BW). When a defect is demonstrated the owner of the property can be held liable according to strict liability. It's not necessary to prove that the owner was in default.

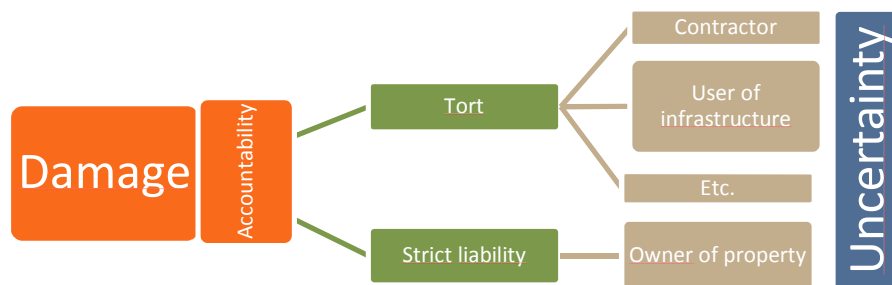


FIGURE 4-2: LIABILITY IN CASE OF DAMAGE

Private law states that the owner of the underground structure is liable for any damage to other properties caused by a defect of his property and vice versa. Since the structure of the tunnel and the buildings can be integrated in operational phase, allowing buildings on the tunnel introduce extra uncertainty about liability in case of damage. Discussion might rise about ownership of the substructure and who was responsible for preventing a defect to occur.

In order to make parties accept the increased uncertainty regarding the liability, parties must perceive their liability is acceptable. Mutual trust between tunnel owner and the land developer can be helpful in order to create a supportive climate. The land developer needs trust that decisions for the infrastructure development are not conflicting with the interests for land development.

In the Netherlands contracts between public and private parties have to be made according to the public procurement rules. There is a tension between these rules and the desire to work on long term, trustworthy relations between

⁹ Tort = onrechtmatige daad

¹⁰ Strict liability = risico aansprakelijkheid

parties. Integrity is at risk when partnerships are made in early phases of the process. When the land developer is a private party and the initial owner of the ground, the starting situation is such that a partnership can be achieved easily without conflicting the procurement rules. (Coops & Wolting, 2011)

4.3 DISCUSSION ABOUT LIABILITY AND RESPONSIBILITY

There is an interdependency between tunnel and buildings. Intensive collaboration and mutual trust will contribute to sharing and dividing liability in case of damage. But making a party liable for a type of damage, is not immediately inherent to his social responsibility. For example liability in case of an accident in a tunnel is usually carried by the tunnel owner. But in case of an accident, the local fire department has to deal with the consequence. Furthermore, the mayor will be in the news headlines since an accident happens in his municipality. The demand for a safe tunnel from the municipalities viewpoint is therefore justified. But allow municipalities to have the power to delay a tunnel opening might be undesired as well. Therefore consensus must be created between the critical actors.

With construction projects there is always a risk for discussion about liabilities in case of damage. When there will be damage on the aboveground properties due an explosion in the tunnel, the cause of the damage is clear to everybody. But who was responsible for preventing the damage is not always clear. When the design and construction is contracted to other parties, the question rises if the contractor fulfilled his tasks properly. It's can be more attractive to build on a location where there is no risk on damage due to a tunnel under the building. For that reason, it's conceivable that the tunnel owner and land owner prefer a location for land development where there is a clear distinction between their properties.

Don't allow buildings on the tunnel can be argued from liability, the difficulties from liability should be similar for every situation. Therefore the following hypothesis is formulated: 'whether parties allow building on tunnels is dependent on how the parties perceive liability'. Their perception can rise from several (not always rational) arguments as involvement in claims in past projects.

It can be concluded that every role brings both liabilities and responsibilities. Although legal liability might be considered as facts that are non-discussable, they can be perceived as big uncertainties. The project team can consider the

possible (legal and social) consequences of these uncertainties to be decisive to block buildings on the tunnels. Since it is not possible to negotiate on every uncertainty one should desire an intensive collaboration between the critical actors. Furthermore the decision makers should not only pay attention to the legal liability but consider social responsibility for damage to be important as well.

5 FINANCIAL AND SOCIAL ADVANTAGES

Building on the tunnel can be argued from financial advantages. If the decision making process results in constructing a tunnel in an urban area, this can be argued with advantages in a social context. A tunnel can be seen as a solution to achieve profitable growth without neglecting social and environmental challenges. Not only profit is decisive, but the contribution to society and environment creates value as well.

Multiple use of space has financial advantages. When the enormous part of a city that is in use by infrastructure can be used for other functions as well, a city can grow without expanding its city boundaries. The high pressure on the scarce area can be released. This chapter deals with the possibility to recover costs for site preparation and explains how financial advantages can be achieved by building on tunnels.

5.1 SPATIAL PLANNING ACT

In the Netherlands the public sector has a strong role in the land development compared to countries as the United Kingdom. According to Needham, Koenders and Kruijt (1993) this can be argued from two aspects. The first aspect is related to the high costs that are involved with the land preparation given the poor soil conditions and drainage problems. Secondly, government aims to secure low cost sites for housing and still maintain steady returns for builders and investors.

A section of the spatial planning act is land development act¹¹. The land development act arranges the financial- technical- and legal issues of land development. The spatial planning act was meant to enable a municipality to give direction in the content of property development plans. Furthermore, the costs and benefits of the development can be shared equally between the present and future property owners and therefore costs for the site preparation can be recovered. (van den Brand, van Gelder, & van Sandick, 2008)

During the nineties land purchase, preparing the site for development and selling the land was beneficial. Making profit by land development for commercial projects allows the municipality to recover costs for site

¹¹ Land development act = grondexploitatiewet, grex

preparation for projects with a negative budget as social housing projects. During these years also private investors were interested in the land market and site preparation. In these years Dutch government also developed the principle to give more freedom to the market. Therefore market competition in land development was born.

The validity of the content of the land development plan is assessed according to three criteria. (van den Brand, van Gelder, & van Sandick, 2008) The first criteria is *profitability*. The area must experience profit from the development. The profit can be direct – the profit is achieved in the direct physical area – or indirect. Indirect profit is achieved for example when the air quality is improved or when a green area is created in an area beyond in order to compensate the lack of nature in the developed area. Another criteria is *accountability*. This means that the costs must be related directly to the plan. For example costs (as for utility services and parking facilities) that can be financed by user rates are not accountable within the land development plan. The last criteria is *proportionality*. Costs must be divided according to benefit per location.

When these criteria are covered, costs for site preparation can be recovered through the spatial planning act. Therefore the costs of preparing the tunnel roof as a building site can be recovered through the spatial planning act. First, building on the tunnel is profitable for the (local) area since facilities can be developed, employment (in the yet to be realized offices) can be created etc. The second criteria, accountability, is also covered. Making the tunnel roof ready for the development of land (taking safety measures, establish local infrastructure and landscaping etc.) is directly accountable for the future property owners since they make use of it. Proportionality, the last criteria, can be discussed. The costs to take safety measures are not only beneficial for the property owners direct on the tunnel, but also the property owners next to the tunnel. Therefore the project boundaries should be chosen within a certain zone around the tunnel.

The tunnel itself has a wider scope than the local land development. When a tunnel is constructed, it can be assumed that the costs for the tunnel can't be recovered through the spatial planning act since the contribution to society is not only in terms of financial growth but also value is created in non-monetary terms. Dutch Ministries of Economic Affairs and of Infrastructure and the Environment defined a manual (OEI) to evaluate infrastructure projects. By using OEI, all effects are monetized in order to balance options. Then the

economic value¹² of a certain infrastructure project can be calculated with a Net Present Value calculation. (Onderzoeksprogramma Economische Effecten Infrastructuur, 2000) By assuming that the decision for building a tunnel is made through an economic evaluation, building on the tunnel can be argued with a financial evaluation¹³.

5.2 ECONOMIC ADVANTAGES ARGUED

Infrastructure is necessary for national purposes. Constructing infrastructure in a tunnel can be argued from a variety of interests and actors. Therefore value is created to a wide scope. It's hard to measure this value and the value will differ for every actor. When a tunnel is considered, the financial advantages of building on the tunnel can be used as an extra argument. The costs for making the tunnel prepared for land development depends on the necessity of safety measures that must be taken and the kind of buildings that are desired to be developed. But a foundation of the tunnel must be made anyway (the high groundwater level in the Netherlands results in tension piles in order to guarantee stability).

Result quick scan: Redevelopment Nieuwmarkt, Oostlijn (Amsterdam)

After the tunnel for the metro Oostline was built, the desire to develop the area similar as it was before forced municipality to be collaborative. Making the tunnel roof a stable property for land development was considered to be a marginal expense. How it was exactly arranged with costs is forgotten nowadays, therefore it's impossible that it was a matter of concern back then.

Building on the tunnel should be on the agenda for the decision making on the tunnel. When the bare soil is owned by a public party (as the municipality) the profit made by land development can make the tunnel economically more feasible. In case of private ownership of land, the tunnel owner can

¹² Economic evaluation = evaluation of a project from a governmental viewpoint. A balance is made of costs and benefits for the society as a whole by taking direct effects (effects that are notified by the users and/ or the operational party) and indirect effects (effects for parties outside the scope of the project) into account.

¹³ Financial evaluation = evaluation of a project on the result of the liquidity analysis and profitability analysis (sufficient return on investment) by using actual prices as paid on the market.

compensate the initial owner by allowing the development of land after completion. Instead of starting an authoritative expropriation process, collaboration can be achieved.

It can be concluded that every situation has different arguments for building on the tunnel or above main infrastructure. It can be to compromise the initial local residents as happened at the Nieuwmarkt, Oostlijn Amsterdam, but also to connect two parts of the city (Bos & Lommer).

PART C: ROADMAP FOR DECISION MAKING

Rational quantifications are often preferred as input for decision making in order to compare alternatives objectively. Others prefer to involve emotional aspects as well, since emotions show our preferences. Roeser (2006) states that 'emotions are an indispensable normative guide in judging the moral acceptability of technological risks'. A decision based on emotions can be considered to be irrational. But an irrational decision for the project can be a rational decision for the decision maker. Teisman (2005, p. 96) states that decision making can be defined as the sum of a decision and the decision maker. Since decision making is considered to be more than balancing rational information, engineers shouldn't ignore the emotional and ethical aspects either.

This part of the research discusses which critical factors should be considered during the decision making process. Methods for dealing with the critical factors are described that can be used as indicators during the case studies. In order to describe strategies for dealing with the critical factors, two management styles are discussed. Furthermore, the result of the complexity of building on tunnels is used as input for the roadmap complemented with results from interviews.

6 QUALITY IN DECISION MAKING

The construction of the Tramtunnel in The Hague was not considered to be easy. During construction major technical difficulties occurred which forced the employer and contractor into a change of the design. This resulted in a huge delay in construction and an enormous budget overrun. The city center was experiencing a lot of nuisance of the building pit for years. (van Tol, 2003) From a cost effectiveness point of view, low quality was achieved during decision making. Presently, the Tramtunnel is part of the track for four tram lines serving the city center with high accessibility. Entitle the decision making as low quality might be narrow minded. The question arises: when is quality achieved during decision making?

When quality in decision making is defined, the definition can be narrowed for building on tunnels. This chapter balances the quality definition of two management mainstreams and concludes with a definition for quality in decision making.

6.1 MANAGEMENT MAINSTREAMS

In general two mainstreams for management can be distinguished: project management and process management. These two mainstreams of management consider different methods to achieve quality.

Quality according to project management

In project management terms, quality is defined as meeting customer's requirements. Project Quality Management (PQM) is used to produce the correct result (product quality) in the correct way (process quality). This is addressed by both defining the objective of the project accurate, complete and clear, and defining a project quality plan that ensures that the process leads to the result that meets the requirements. Key in achieving quality is to use and define standards. (Verbraeck, 2009) Project Management quality is focusing on the quality of the content.

Quality according to process management

Enserink & Monnikhof (2001) define quality as the extent to which an existing or expected problem situation is improved and thereby meeting the interests of all involved parties as much as possible. Quality is perceived differently by actors since they have different interests. Furthermore problems and interests

change during the process and it is difficult to keep formulating and communicating them accordingly. In a multi-actor network all actors are interdependent to achieve their interests. Therefore, quality can be achieved through joint decision making. (de Bruijn & ten Heuvelhof, Management in Networks On multi-actor decision making, 2008, p. 23)

6.2 MEASURING QUALITY

Quality can be measured on different ways. Often quantifying factors and aspects is used in order to balance options. This can be done by using monetary and non-monetary methods. By monetary methods economic and financial evaluation can be distinguished. With a financial evaluation the liquidity and profitability of a project is assessed. A Net Present Value is used taking investments and expected financial returns into account. The financial evaluation is mostly used by private parties to assess a project. An economic evaluation takes social aspects into account as well. Not only actual cash flows are used but also un-priced effects as gain for environment and travel gain are part of the Net Present Value calculation. An economic evaluation is used to assess the costs and benefits for the government. (Verheaghe, 2009)

Non-monetary methods are methods as a Multi-Criteria Analysis. The value of every criterion is quantified and a weight is added to prioritize criteria. Non-monetary methods aim for a rational measurement of quality on certain criteria.

The result of a MCA depends on the actor that executes the analysis since every actor values the factors differently. An example: one actor might qualify increasing the amount of car lanes as positive (good accessibility), the other might qualify it as negative (increase of nuisance for the environment).

Teisman (2005, pp. 53-54) discussed that the preferences of consumers is not only dependent on inherent elements (contributing to physical quality) but also on external characteristics as the appearance (contributing to external quality). In urban development projects the physical quality can be determined by factors as developed surface for living and office, accessibility by car and public transport, and the level of carbon emissions. The external quality can be determined by imponderable factors as attractiveness, allure, emotions, appearance and convenience.

Both methods (monetary and non-monetary methods) measure quality on the content of the end-result. As for the result of an analysis, the end result of a project is perceived differently by the actors as well. Not only physical quality is of importance. Instead using the end-result it is also possible to measure quality on the satisfaction with the process of involved actors. (de Bruijn, ten Heuvelhof, & in 't Veld, 2002)

6.3 QUALITY DEFINED

In both project management as process management quality is described similar. The method to achieve and measure quality differs. In project management the objective of the project is determined and used to measure quality. There are several tools to deal with changing requirements from the customers but the principle of fixing the objective remains. Standards are used to structure the complex system. In process management the unstructured nature is seen as a consequence of decision making (de Bruijn & ten Heuvelhof, Management in Networks On multi-actor decision making, 2008, p. 23). Defining standards aiming for structure creates only more chaos for the overall system since every actor might define standards. (Teisman, Publiek management op de grens van chaos en orde, 2005, p. 7)

Since actors find themselves in a multi-actor network there is not one authoritative actor; the objective defined by the project team is not the only and static objective. Subsequently, rationalizing the criteria contributing to 'this' quality, is not automatically supported by other actors and quality still isn't achieved. For building on tunnels it's impossible to have an authoritative process. As resulted from the chapter on legal aspects, there are different property owners during the operational phase. Due the high (legal and physical) interdependency between the owners, an hierarchical decision making process is impossible.

Therefore quality is defined as:

"The extent to which an existing or expected problem situation is improved and thereby meeting the interests of all involved parties as much as possible."

The existing or expected problem situation when building on tunnels is considered is: limiting the urban development by not allowing building on tunnels.

7 ACHIEVING QUALITY

When area development is coupled to a tunnel project, building on the tunnel should be considered. When it is decided to build on the tunnel, the parties have to deal with increased complexity. Therefore one can desire some strategies in order to achieve quality.

To improve the problem situation (limiting urban development by not allowing building on the tunnel), the difficulties that are discussed in part B have to be conquered.

The second part of achieving quality is to meet the interests of the involved parties as much as possible. Therefore the actors who have an interest in the project should be involved. While initiators prefer to reduce complexity by defining system boundaries and ignore the environment where the system is situated they should pay attention to these parties as well. Therefore one must design an attractive process. How to create an attractive process is discussed in this chapter.

7.1 DESIGN AN ATTRACTIVE PROCESS

Create an open process

The first element is *openness*. This element rises from the assumption that the initiator is in a network of actors and is not capable of making unilateral decisions. Methods to achieve openness are:

The initiator should allow other parties to participate in decision making. Being aware of the power an actor has (blocking power, productive power), the resources an actor can use (in terms of legal resources or support in another (powerful) arena), the interests and perception of an actor and how the actor behaves in the multi-actor network is essential in order to deal with all actors. Involving actors results in reducing strategic uncertainty, increase the probability of effectiveness (the 'best' decision for society won't be executed if it's not supported by the other actors), increase of innovation and enrichment (by confronting interests opportunities rise to link solutions) and the absence of some actors might result in impossible or very costly solutions. (Klijn, van Bueren, & Koppenjan, 2000, p. 106)

At the start of the process where actors enter, minimal substantive choices must be made. Decision making in a network shouldn't come as a surprise for

the actors, instead a formal decision is the already fully negotiated result of the process. (de Bruijn & ten Heuvelhof, 2008, p. 75) Starting with substantive choices creates initial distrust and a lack of governance capacity. (Teisman, van Buuren, & Gerrits, 2009, p. 208) Besides, the position actors in the multi-actor network can be threatened by substantive choices at the start.

Furthermore the process and its management should be transparent. Transparency means that actors can check whether the process is sound and offers them sufficient opportunities to promote their interests. A process manager must have an independent position towards the actors. The process agreements (who is included in the process, how are his interests protected and when are decisions made) must be clear for all parties at all times.

Finally, the actors must be able to pursue their own interests. Problems or conflicts might be born from a specific actor that isn't notified by the other actors. Since the process should be open for any issues regarding the project, every actor must be able to bring aspects to the agenda.

Protecting actors' core values

The second element is *protecting core values* of the involved actors. The core values are the oxygen for the organization. Core values are stable principles, without these values the organization wouldn't exist. Making actors aware that their core values will be protected raises the willingness to participate in the process.

First, actors must explain their core values when entering the process. Often, the core activities of an organization are well known (for example for Rijkswaterstaat: 'preventing floods, providing fast and safe infrastructure etc.) but the core values are unknown. The core values are not related to single issues but are values that are vital to a party's existence (For example, the core values of Rijkswaterstaat are: 'result oriented, approachable, providing service, integrity and enterprising'). (Rijkswaterstaat, 2011) Organizations' core values can be protected, since they often formulated the core values and don't have to do with a single issue. On the other hand, platforms for residents not always have core values. Often the value 'Not In My BackYard' (NIMBY) is pursued and is conflicting with any process (there is always somebody's backyard affected in a process). Still this value should be respected. With respect for such values, commitment to the process can be achieved.

Furthermore, substantive choices must be transformed into process agreements. When actors don't feel committed to a decision, they are not immediately blocked in the process. By transforming the substance into process agreements the opponents can still participate.

Thirdly, actors should have the option to leave the process when they don't feel committed anymore. Entering a process is much more attractive when there is a possibility to leave the process. This element is also an incentive for the process manager to keep the actors committed since it's not desired for the process that actors leave.

When actors decide to leave the process, it's not always wise to ignore their existence and core values. They might enter the process again or can create support in other networks. By informing all actors and parties who's interest is at stake, they must be able to keep pursuing their core values. As a process manager, it's possible to create trust within the participating and non-participating actors that their core values will be kept in mind.

Guaranteeing the speed of the process

The *speed of the process* should be guaranteed as well. When no decisions are made for a longer period, the outcome might be a sluggish process without clear result and might cause that actors prefer to withdraw.

The first method to guarantee the speed of the process is to create prospects of gain as well as incentives for cooperative behavior. The financial advantage of building on the tunnel is a great opportunity for parties (especially with productive power) to participate in the process. The created value in the end situation is an incentive for the local residents to cooperate. Building on the tunnel must be used as an issue on the agenda to speed up the process.

Furthermore disasters create windows of opportunity for decision making. For example an explosion from hazardous materials can be an opportunity to prohibit hazardous materials in urban area (safety is increased, see chapter 33.2). Or the economic crisis resulted in a fast process for infrastructure decision making. Also political circumstances can create an opportunity to make a decision. In order to make use of windows of opportunity, actors should gather information and build on relations. Useless information and relations of today can be tomorrow's headline. Being alert on unpredictable issues can be

used for negotiation with actors that might be not committed or blocking the decision making process in the future. (de Bruijn & ten Heuvelhof, 2008, p. 72)

When the process is heading towards sluggishness, command and control (or an authoritative statement) can be used for the other involved actors to collaborate. 'Threatening' with a solution from a powerful actor, forces the other parties to negotiate in order to come with a better solution and reach consensus. Also as learned from redevelopment projects where local residents participated in the decision making process, as soon as the participation results in consensus, other authorities can't postpone the implementation of the decision anymore. Then the credibility of other public authorities would be at stake.

Guaranteeing the substance of the process

The last element is that the *substance of the process* should be guaranteed as well. When decisions are made, but they don't have any substance, actors can be uncommitted to the decision.

The first method to guarantee substance of the process is to invite experts without an interest in the outcome of the process. These experts are trusted by the other actors. For example the constructive safety of building on the tunnel roof can be explained by an independent engineering advisor.

Commonly, stakeholders who participate in the process are also expert on certain issues. However his expertise on an issue might be impressive, his role in the process subjective. Therefore other actors might distrust his expertise on the issue. His expertise should be acknowledged and can be used for proving the reliability of the outcome from the independent expert.

The third method is to create a multi-issue agenda. Having a wide agenda, serving the interests of the participating actors commits the actors to the process. As long as the actors stay interested in the result of the process they keep participating. A multiple issue agenda also creates the incentive to negotiate on different aspects: win some, lose some. Implementing different rounds in the decision making also gives room for negotiation. (de Bruijn & ten Heuvelhof, 2008, p. 49)

Finally, the information from rational analyses can be used. Since every actor brings in his information, discussion might rise about the reliability of the information. Having input from 'rational' analyses, brings the discussion back to

substance. How to deal with the information and what information is correct must be negotiated between actors. An expert can facilitate this negotiation and prevent to end in negotiated nonsense (the negotiation resulted knowledge which is in conflict with the state of existing knowledge). (de Bruijn & ten Heuvelhof, 2008, p. 71)

7.2 ATTENTION FOR THE PERCEPTION OF SAFETY

By optimizing the ethical acceptability of risks concerning safety, one could lead towards deciding for building on tunnels. Brumsem et al. (2009) defined four considerations for perception risks. These are applied on the case building on tunnels, in which the risk caused by a tunnel in operational phase for the buildings is considered. If buildings would be perceived as risks for the environment there wouldn't be so much freedom for private parties to develop buildings. Therefore the risk of damage to the tunnel as a consequence from an event in the building isn't considered. Also risks during the construction aren't considered since this all has to do with the building planning and is out of the scope of this research.

Informed consent

A certain risk is perceived as less harmful when all possible affected people are aware of a risk and consent voluntarily to the risks. Creating awareness of risks resulting from the location in this case can be done through visibility of the tunnel for users of the area on the tunnel. Furthermore the functions on the tunnel must be entered voluntarily.

Examples of achieving informed consent for building on tunnels is to have daylight in the tunnel via the entrance and see the tunnel entrance from the building on/ above the tunnel. Furthermore, functions as shopping, sport facilities and housing are considered to be entered (or purchased) voluntarily. Buildings where service is offered are most often not used voluntarily (hospitals, city hall etc.).

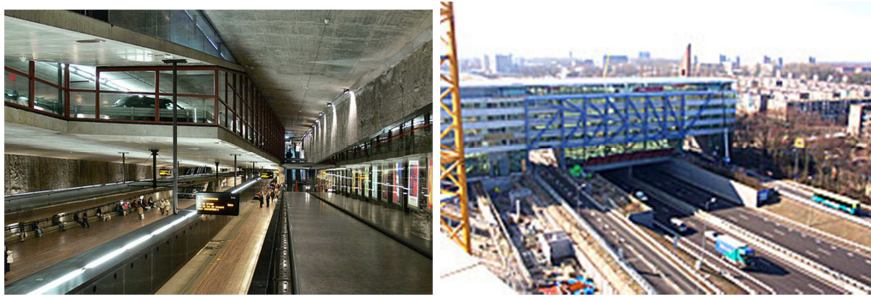


FIGURE 7-1: LEFT TRAMTUNNEL THE HAGUE, RIGHT OVERPASSING BOS EN LOMMER A10

Substitutability of created benefits

People are more willing to accept a risk when the created benefit can't be created somewhere else where the risk is smaller. The benefit must be place dependent. In case of building on tunnels, a dense area is equivalent to the problem. Connecting two parts of a city is often used as argument for the tunnel. Don't allow the realization of buildings on the tunnel can threaten this aim, however the physical barrier of the infrastructure is taken away.

For the area development of Nieuwmarkt building on the tunnel rised from this consideration. The construction of the Oostlijn through the Nieuwmarkt area was preceded by a lot of demonstrations from local residents. Houses needed to be demolished and there was minimal support from the local residents. After finishing the Oostlijn, people wanted to heal the scarfs the Oostlijn left. Therefore the initial street pattern is brought back and housing is realized on the tunnel.

Equal treatment

When people are treated equally in relation to certain this contributes to the perception of safety. An obvious ethical decision is valuing a human life. Some researchers value a human life upon their economic contribution to welfare. This assumes that the impact of people killed is dependent on for example the amount of taxes they pay. Morally this assumption is incorrect and won't be accepted by decision makers. One should use the principle of equality.

For building on tunnels this can be realized by creating a mix of functions on the tunnel: not only social renting but also office locations, other housing and sports facilities should be built. Then less powerful people don't feel as if they are hidden at an unsafe location. Another method is to realize housing for the

decision makers. When the decision maker wants to live at a certain location, the location is considered to be safe by others as well.

Fair distribution

The benefits that are achieved by taking a certain risk should be distributed fairly between the people that can be harmed by the risk.

For building on tunnels this can be achieved by compensating the possible affected persons. For example creating value in the area makes living in the area attractive. This can be done through the spatial planning act. Attention must be paid that people are not compensated by paying them directly because then more vulnerable groups are attracted to the area and the previous consideration is threatened. Moreover, when an accident happens and there are fatalities, government might be judged to bribe which is considered to be unethical as well.

7.3 IMPROVE THE PERCEPTION OF LIABILITY

Liability is defined as the legal accountability in case of damage. Who is liable for which risks can be agreed in contracts. However agreements might seem non-discussable, in practice they might turn out to be not as clear as considered initially. Often the cause of damage is not clear, so effectuate the agreements on liability isn't as easy as considered. As discussed in the safety paragraphs, the transport through the tunnel increases the risk on damage on the aboveground properties. In case of damage from an accident in the tunnel and corresponding risks for the aboveground properties, it might be unclear if the taken safety measures were effective. In order to achieve quality, actors must perceive their liability as acceptable. Therefore the four considerations of Brumsum et al. are used for the perception of liability as well.

Informed consent

A certain risk is perceived as less harmful when all possible affected parties are aware of a risk and consent voluntarily to the risks. Therefore the liabilities should be transparent. Since it's hardly impossible to discuss and have arrangements on all possible scenarios, general consensus is necessary within the liable parties. Moreover, not only liable parties are possible affected, but also residents and municipality can be affected. Therefore the transparency must go beyond the liable parties and the affected parties should be aware of the general agreements as well.

This can be reached by transparent communication about liabilities. One entity as a contact for collecting and handling claims and complaints can help with dealing with affected people. In order to have such a contact point, the employees should be aware of the substructure for general liabilities. Between the liable parties, informed consent can be reached by discussing the possibilities with experts. Not only law firms can help by arranging liabilities, but also experts from best practices of building on tunnels in other projects can strengthen informed consent. When liabilities are divided in reference projects, it might be applicable to the particular project as well.

Substitutability of created benefits

People are more willing to accept a risk when the created benefit can't be created somewhere else where the risk is smaller. Concerning liability this can be approached from the perspective that a party is less willing to accept a liability other parties are better able to manage and deal with the liability. Therefore it should be considered which party is most applicable to be the risk owner. One should consider that a risk owner needs an incentive to minimize the risk (for example since his interest is at stake, or get a financial compensation when the risk didn't occur). The risk owner must be compensated for taking a certain risk by the other parties in the network.

Equal treatment

When parties are treated equally in relation to certain risks and the advantages of risky activities, they are more likely to accept the risk. Concerning liability, there shouldn't be one authoritative actor in the position to transfer all liability to other parties. When parties each other treated equally, they will probably less focused on transferring risks to parties that are less capable of dealing with the risk. The organization must be a network of actors in which hierarchical decisions are prevented.

Fair distribution

The benefits that are achieved by taking a certain risk should be distributed fairly between the parties that can be harmed by the risk. Therefore a risk management plan must be considered within the network. A response must be planned so that parties know what their task is in case of the occurrence of a risk. There are four responses possible for dealing with a risk (Kortman, 2009):

- Accept: no proactive action, but reactive action. The risk owner should make a contingency plan to deal with the risk if it occurs.
- Avoid: eliminate the impact by changing the scope, the project plan or the cause of the risk (e.g. safety measures).
- Transfer: transfer the risk to a third party who is better able to handle the risk (and that can take the risk). Since the risk management plan is result of a partnership, transfer all risks to one of the partners isn't recommended (then the trust between parties can be harmed). But insuring a risk is possible.
- Reduce: reduce probability and/or impact of the risk event. Monitor the residual risk and have a contingency plan.

8 QUALITY INDICATORS

In order to know when the decision making process is heading towards quality, indicators are defined. These indicators emerged from the previous chapter on achieving quality. The enumeration in this chapter is not complete, there are more methods which can contribute to achieving quality. These methods are seen as possible implementations of the strategies. It are indicators that will help by the translation of quality in theory to quality in practice.

8.1 DESIGN AN ATTRACTIVE PROCESS

Create an open process

1. Involve all relevant parties in the decision making process:
 - > Parties that have blocking power (as municipality and infrastructure authority).
 - > Parties that have productive power (as experts, land developers and financiers).
 - > Parties that have an interest in the result (as local residents).
 - > Parties that are morally involved (as environmental groups).
2. No substantive choices at the start of the process
3. Ensure a transparent process and management
4. The process manager must ensure that every actor can bring aspects to the agenda.

Protect parties' core values

5. Every actor must explain their core values when entering the process.
6. Commitment to the process by respecting core values and transform substantive choices in process agreements.
7. Actors should have the option to exit the process.
8. Keep informing actors about the progress of the decision making also when they are not participating actively.

Guarantee the speed of the process

9. Create prospects of gain and incentives.
10. Use windows of opportunity.
11. Use command and control as an incentive to collaborate.

Guarantee the substance of the process

12. Invite substantive experts without an interest in the outcome of the process.
13. Distinguish experts from stakeholders.
14. Make a multi-issue agenda.
15. Use information from rational analyses.

8.2 PAY ATTENTION TO THE PERCEPTION OF SAFETY

16. Make the tunnel visible for the aboveground functions and vice versa.
17. Create functions on the tunnel which people voluntarily use.
18. A mix of people and functions must be exposed to the risk.
19. Benefit that is created must be invested in the area where people are exposed to the risk (also through land development act).

8.3 IMPROVE THE PERCEPTION OF LIABILITY

20. Make risks and organizational structure transparent.
21. Invest in a good collaboration instead of transfer all risks to other parties.
22. Make use of examples and divisions of liability from other projects.
23. Prevent unilateral decisions for the risk division.
24. Divide risks upon ability to manage and carry risks and their interest in increasing the risk.
25. Execute a risk analysis and consider responses (accept, transfer, avoid or treat).

PART D: CASE STUDIES

This part of the report discusses the case studies. The projects Spoorzone Delft and Zuidas Amsterdam are selected as case studies. Both projects include plans to build on the tunnels. In appendices 3 and 4 the timeline of the projects and an introduction to the projects is presented. Since the Zuidas is still in the decision making phase, the project decision in 2007 to stop that process is considered as well.

An insight is created in a variety of interests and views by interviewing a variety of representatives. The information from the interviews complemented with general information from project documents and websites give the overall results. The interview protocol can be found in appendix 2. The elaborations of the interviews are confidential and therefore not part of the report.

This part concludes with a cross case analysis in order to discuss the validity of the indicators described in the roadmap. The most important indicators for improving decision making for building on tunnels are discussed, the indicators that didn't affect the process concerning building on tunnels are neglected in the cross case analysis.

9 SPOORZONE DELFT

Last century the train traffic increased in the Randstad. The railway track in Delft consists of two tracks where the rest of the railways between Amsterdam and Rotterdam is served with four tracks. Presently the city center of Delft is crossed by 350 trains a day via a train viaduct. The trains cause nuisance for the local residents and the viaduct works as a barrier in the city center. Furthermore the capacity of the two track railway is reached on the present viaduct.

The project Spoorzone holds the construction of two railway tunnels through the city center of Delft, land development, a new station and a city hall. In the end situation a four track railway will be operational in a tunnel. The tunnel roof will be used for public space, a station with city hall and two buildings for housing and offices. Furthermore, the two monumental buildings will have its foundation on the tunnel as well. (Spoorzone Delft, 2009)

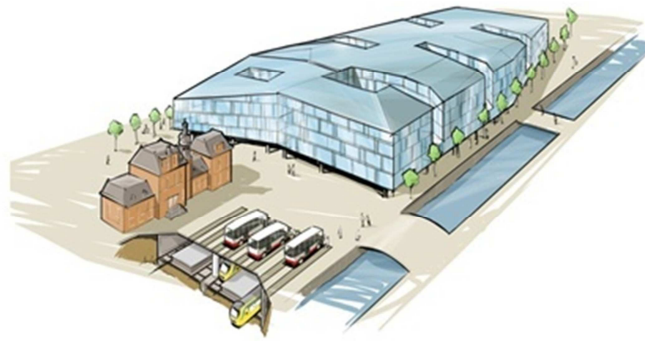


FIGURE 9-1: CITY HALL AND STATION ON THE TRAIN TUNNEL (SPOORZONE DELFT, 2011)

9.1 ATTRACTIVENESS OF THE PROCESS

The process of Spoorzone Delft is started with the research for a four track railway, while presently the city of Delft is crossed by a two track railway. A doubling of the railway would have consequences in terms of nuisance for the environment. Therefore the doubling of the track above ground level (on a viaduct) was not supported by the city and its residents. Since the city was already encountered with nuisance from the railway this was an opportunity for a wide variety of actors to be involved and improve the present situation.

9.1.1 INDICATORS FOR CREATING AN OPEN PROCESS

1. *Involve all relevant parties*

In order to create support with a variety of actors, the municipality involved as much parties as possible. Furthermore contests for urban plans are held in which the opinion of local residents resulted in decisions for the plans. The project organization is open for input from a variety of parties. (Spoorzone Delft)

2. *No substantive choices at the start of the process*

At the time the process started in 1993, there were no substantive choices. The preliminary studies resulted in a starting situation: the desire for two extra tracks and improving the urban area along the railway track. From the starting situation alternatives were developed.

Municipality desired to have land development on and in the surrounding of the tunnel. ProRail researched the options and conditions.

National government assigned ProRail and the municipality of Delft to jointly do project preparations. Several other parties are included from the start as area developers. With a wide variety of actors the project organization came to the content of the plans.

3. *Ensure a transparent process and management*

In 2007 the municipality established the Ontwikkelingsbedrijf Spoorzone Delft BV (OBS) in order to carry out the tasks agreed during the planning period. Municipality of Delft outsourced the task of OBS director to an experienced manager in the field of infrastructure and area development. Since all tasks of the overall project are managed by OBS, there is a transparent organization.

'The composition of the team and collaborative conditions have an important share in the outcome of the planning process'

During the planning process of Spoorzone Delft, there was no need for an external process manager. Both parties ProRail and the municipality of Delft collaborated and acted according to their interdependencies.

4. Allow actors to bring aspects to the agenda

During the planning process every actor was free to bring aspects to the agenda. Residential groups organized meetings to discuss the plans and ventilate opinions. The topics discussed during these meetings were an important input for the agenda of the project organization.

9.1.2 INDICATORS FOR PROTECTING PARTIES' CORE VALUES

'A complex project always raises discussion on issues. Parties have to keep pursuing their own interests while respecting the opinion of other parties.'

5. Actors explain their core values when entering the process

All parties communicated their main interest at the start of the process. There are a lot of conflicting interests which makes the collaboration hard. In the end, a plan is made in which the common interests and actor specific interests are served as much as possible. The core values motivated the actors for their collaboration.

6. Commitment to process

Some decisions conflict with the interests of other parties. An example is the consequences of phasing the infrastructure and land development. The tunnel is built presently, the land development takes place afterwards. The agreement is made that any extra costs for the area development due to changes to the tunnel will be paid by the municipality (converted in the land price). The potential disadvantage for the land development by project decisions for the tunnel is transformed into a process agreement to protect core values.

'The capacity problem of the railway wasn't seen as a problem all the time. Therefore the need for the project was not always evident.'

ProRail was not committed to the process all the time. After the track decision for the HSL, the two extra tracks through Delft weren't necessary anymore. Investing in a tunnel from national resources to solve a local problem was not in the interest of ProRail. The initial project decision to construct a two track tunnel resulted in a lacking commitment of ProRail which is exposed in the present risk division (see indicator 21). In order to keep ProRail committed, the project scope is changed to construct a four track tunnel.

7. Actors should have the option to leave the process

Although the decision making process can be divided in four parts (appendix 3), options to leave the process were minimal. Municipality of Delft and local residents executed such an intensive lobby that it was hardly impossible for others to leave the process. For example, even when the process was heading towards a two track alternative resulting in minimal value for national government, there were no exits to leave the process. Instead the project was changed into a four track alternative in order to create value for a long term.

The construction combination of the tunnel Combinatie Cromme Lijn (CCL) is asked to participate in the tender for the construction of the city hall. This participation isn't obligatory. Options to leave the process are restricted within certain boundaries: when an agreement is made, actors have to act within this (tender) agreement.

8. Inform all actors about decision making process

Besides the involvement of the critical actors, the progress of the decision making can be followed through the official participation rounds. The outcome is communicated on the project website. (Sporzone Delft, p. Inspraak historie)

9.1.3 INDICATORS FOR GUARANTEEING THE SPEED OF THE PROCESS

The process is slowed down during the tender phase. A two railway track tunnel was tendered initially, the procedure is repeated for a four railway track tunnel.

9. Create prospects of gain and incentives

The decision was made to construct the railway in a tunnel based upon the prospects of gain for all actors. The nuisance for the environment would decrease and the project can be financially more attractive due the area

development plans. Moreover the station area becomes a better welcome to the city.

'In the first urban plans, an intensive land development program was projected on the tunnel. After the tunnel decision, most buildings are planned to be realized alongside the tunnel.'

In the beginning of the process a lot of potential prospects of gain were created for land development. The intensive land development program promised a significant financial contribution from the municipality out of the land development for the project. With this contribution a project decision could be made. After the project decision the land development program changed and the financial gain became less, while the gain in quality of the area increased. Probably, municipality used other resources for the investment.

10. Use windows of opportunity

The municipality of Delft used the opportunity to decrease nuisance from the railway viaduct when ProRail started with planning a four track railway. Also area developers NS Poort and Ballast Nedam Ontwikkelingsmaatschappij used this opportunity to be committed to the process since they foresaw the possibility to develop a huge area in the city center. Therefore the opportunity for a tunnel project with area development is used by a variety of actors. The ministries of Housing, Spatial Planning and the Environment (VROM) and Transport, Public works and Watermanagement (V&W) facilitated the use of this window of opportunity (indicator 11).

11. Use command and control as incentive to collaborate

From the start of the project preparations in 1993, ProRail and the municipality of Delft were enforced to collaborate by the ministries of Housing, Spatial Planning and the Environment (VROM) and Transport, Public works and Watermanagement (V&W). Since the project is financed from both actors, national government used command and control for collaboration.

9.1.4 INDICATORS FOR GUARANTEEING THE SUBSTANCE OF THE PROCESS

12. Invite substantive experts

The area development has invited experts (Q-team) for their vision on the plans. These experts are appointed by OBS. The Q-team is used to assess the plans. (Sporzone Delft, 2009)

The interest group of the local residents organized several meetings as well. Experts were invited to explain the plans for Delft. Also experts from other (reference) projects were invited to share their experience. Furthermore, OCDS has an advisers role as well.

13. Distinguish experts from stakeholders

While ProRail is an expert on the infrastructure part, the land development is not within their field of expertise. OBS relies on the expertise of ProRail while ProRail gives priority to completing the construction of infrastructure as soon as possible. This also has its effects for building on the tunnel. ProRail doesn't desire to allow building on the tunnels. Still ProRail was requested to perform the risk analysis and come up with conditions.

14. Make a multi-issue agenda

By coupling infrastructure development with the quality of the area a multi-issue agenda was born. The multi-issue agenda contributed to the complexity of the project. This is experienced differently by the actors, some find it an advantage, some a disadvantage. Preferably the multi-issue agenda must be similar for the construction of the project (an integral contract for tunnel and land development), then optimization can go further.

'A variety of interests makes collaboration hard and an integral approach almost impossible.'

15. Use information from rational analyses

Rational analyses are performed by ProRail in order to determine the risk profile and the conditions for building on tunnels (paragraph 9.2.1).

9.2 SAFETY

This paragraph assesses the physical safety in the project first. Then the indicators for the perception of safety are used in order to validate the roadmap.

9.2.1 PHYSICAL SAFETY

ProRail performed an integral risk analysis in order to assess the level of safety. This analysis resulted in some safety measures. The safety measures for building on the tunnel include limitations of transport of hazardous materials through the tunnel and a fire resistant walls of two hours.

'Having a maximum on transport of hazardous materials through the tunnel results in taking internal safety into account solely.'

The residual risk for external safety is within the standards and is accepted by municipality.

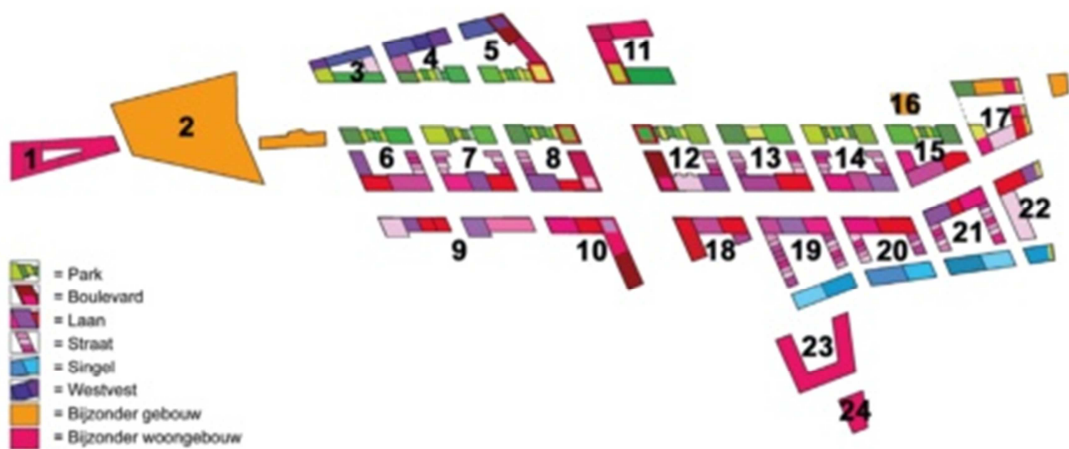


FIGURE 9-2: LAND DEVELOPMENT PROGRAM FROM STATION AND CITY HALL (PLOT 2) TO THE SOUTH (PLOT 17) (SPOORZONE DELFT, 2009)

9.2.2 INDICATORS FOR PAYING ATTENTION TO THE PERCEPTION OF SAFETY

The changed plans to realize buildings only on plot 2, 16 and 17 might be the result of the perception of safety aspects. The indicators are validated below.

16. Make tunnel visible for aboveground functions and vice versa

Buildings on the tunnel are planned to be built on plot 2, 16 and 17. Plot 17 is considered to be a very attractive plot due the good location and open view towards both the south via the railway and to the city hall via the park. Therefore the architecture will be probably more outstanding than for the other plots.

The view is very good towards the tunnel entrance over the railway track and there is a great visibility of the tunnel and building. The city hall is integrated with the station and therefore the visibility of the tunnel and city hall is adequate as well. However the plans are in line with the indicator, these decisions are made from an urban planning point of view, not from a perception of safety point of view.

17. Create functions on the tunnel which people voluntarily use

The city hall has functions that residents use involuntary. The city hall is integrated with the station since services can be shared. Furthermore the present city hall is outdated and the majority of the land will be owned by the municipality anyway. The last argument for locating the city hall on the tunnel is the good accessibility. There are valid arguments for having the city hall integrated with the station but it is conflicting with the perception of safety indicator of voluntary use of functions. The buildings on plot 16 and 17 will be used voluntarily since the plots are assigned to function as residential, office and leisure and services. (Sporzone Delft, 2009)

18. A mix of people must be exposed to the risk

Plot 16 is used for tunnel installations and for public functions during the day and night. The first two floors of plot 17 will be used as a transparent location for offices/ retail. The higher floors will be used for (upper-class) housing. With these plans a mix of functions will be created and therefore a mix of people will be exposed to the risk. (Sporzone Delft, 2009)

19. Invest benefit in area

It's likely that there will be minimal profit from building on the tunnel in financial terms. But building on the tunnel on these specific locations is planned in order to create a more attractive urban area. Therefore the social benefit is invested in the area.

'Building on the tunnel isn't profitable.'

With the formation of OBS, the costs and revenues for the area development are planned to be in balance. The OBS corporation has the possibilities to equalize the costs and the revenues for the whole area.

9.3 LEGAL ASPECTS

First it will be explained how the actors deal with the aspects ownership and liability. Then the indicators for improving the perception of liability will be used in order to validate the framework with the outcome of the process.

9.3.1 OWNERSHIP

When the project decision was made to continue with the project in 2005, ownership of land was rearranged. Initially, ProRail owned the land where the viaduct was situated. The streets besides the viaduct were owned by the municipality. ProRail and the municipality agreed to exchange ownership. Presently, the plans for the tunnel roof are subject to changes and ProRail has to consent for every new plan. Since the tunnel is built for a long term and won't change a lot over time, municipality prefers to own the land where the tunnel is located as well. Then the surface can be designed and changed without a lot of procedural difficulties. The tunnel will be commissioned by a building right in that situation. However ProRail is open towards negotiation, there is a preference to own the land itself. The railway crosses a lot of municipalities and having all land in ownership makes administration for ProRail easier.

9.3.2 LIABILITY

The tunnel owner is only liable for damage within the tunnel caused by activities in the tunnel. The scenario of damage to the buildings in the surroundings of the tunnel caused by activities in the tunnel (e.g. BLEVE) isn't used as a decisive scenario. The probability of occurrence of that scenario is negligible and the municipality agreed to carry this risk.

'ProRail shifted the risk on damage to the tunnel due accidents in the buildings to the municipality.'

The other way around, the land owner carries strict liability for damage to the tunnel caused by activities in the buildings.

9.3.3 INDICATORS FOR IMPROVING THE PERCEPTION OF LIABILITY

Usually, public parties deal differently with risks. Private parties tend to have a large insurance package while public parties are able to accept a risk and carry liability.

20. Risks and organization must be transparent

OBS is responsible for most communication. For all parties it's clear where to go to with complaints. BOS/D insisted on a central desk to declare any damage. Now, reporting the damage is very clear. Handling the damage isn't done correctly yet. It's not clear what happens behind the central desk and feedback on reported damage isn't always given.

When a defect is found in the tunnel structure that caused damage to the building, ProRail is liable according to strict liability. ProRail stressed that they don't want to carry any liability for the external risks. Furthermore, the future real estate owner carries liability when a defect of his property causes damage to the tunnel. The land developer didn't come up with these liabilities and considered this as a role for the municipality. It seems that parties are not sure how liability is arranged within the organization. Moreover, the interfaces are hard to manage and might be not transparent either.

21. Good collaboration instead of transferring all risks

ProRail's interest concerns the tunnel, so there will be a risk that less income can be generated from area development than initially assumed. These risks are transferred to the municipality. When an integral contract for tunnel and area development would be tendered, the possibilities to optimize the tunnel and area development would be increased. Then the risk on less income from land development can be caused by decreasing land prices, which can't be controlled.

'In practice ProRail prevails in the collaboration due to their expertise in large projects.'

The risks for buildings on the tunnels during operations are carried by the municipality, since the municipality has an interest in the land development.

22. Make use of examples of liability from other projects

ProRail has experience in large project as Spoorzone Delft. Their experience is widely used in the project. CCL also employed experienced staff in tunnel projects. Municipality started the OBS and employed some external experienced staff in order to serve the overall interests of the project. It is assumed that experienced staff makes use of best practices from their previous projects. The land developer is not yet busy with their liabilities.

23. Prevent unilateral decisions for the risk division

Initially, all risks were shifted to the municipality when the project decision was made. After some reconsiderations and negotiation the risks are divided differently. Still ProRail doesn't want to be liable for damage from the buildings to the tunnel. Municipality is planning to transfer the operational risk of the building for damage to the tunnel to the future owner of the building.

'Discussions on the scope of the project resulted in the present risk division.'

For construction risks there will be a construction all risk insurance. The premium for this insurance might be a bit higher than in regular area development projects and will be paid by the area developer.

24. Execute risk analyses and consider responses

The risks on damage to the buildings from an accident in the tunnel are carried by the municipality as well. This is the result from risk analyses: the transport of hazardous materials is minimized and the construction of the tunnel is adapted as such that there is no safety zone. Therefore external safety can be disregarded. Near the ventilation shafts and evacuation shafts there are no limitations from an external safety point of view either. Municipality finds the probability on the risks on a lot of fatalities that minimal that insuring isn't necessary and municipality takes the risk.

10 ZUIDAS

Amsterdam has been known for being a major international hub. Amsterdam would like to maintain this image to increase the impact of the Netherlands as a country in the world economy. Due to the good accessibility, high quality area and a wide variety of functions in the area the location of Zuidas is chosen as the best location for creating an international city center in the Netherlands.

The Zuidas area consists of 270 hectares and is crossed by the highway A10 and several public transport tracks. At the moment there are three alternatives for the infrastructure. In all three alternatives the A10 will be located below ground level. On this tunnel the local infrastructure is planned. The alternatives differ for the train and metro: With the first alternative, the train and metro will be located in a tunnel as well. Land will be developed on these tunnels. With the second alternative the train and metro are built on top of each other. Land will be developed next to the infrastructure. The third alternative consists of a viaduct for train and metro. No buildings can be developed in the infrastructure zone (also called the Zuidasdok).

Anno 2011, the three alternatives are too expensive. The project organization is heading towards a decision for the coming years. After constructing the A10 in a tunnel, it can be decided to continue with one of the alternatives in order to reach the goals and ambitions as defined in the vision for the Zuidas.



FIGURE 10-1: ALTERNATIVE ZUIDASDOK BELOW GROUND LEVEL

10.1 ATTRACTIVENESS OF THE PROCESS

The process of Zuidas Dok didn't result in a project decision yet. In this chapter a distinction is made between the process until 2007 and the process after 2008.

In 2007 a prospectus was developed for executing the project as a public private partnership. Lacking support from private parties resulted in a time-out of the process. (Zuidas, pp. website - nieuws) In 2008 van den Berg was asked by national government to research the viability of Zuidasdok. With the results from the van den Berg committee, the process continued.

Presently, the project organization is constituted as follows:

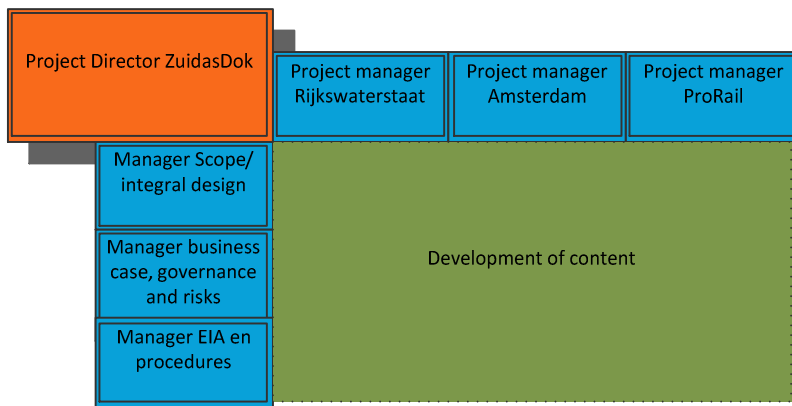


FIGURE 10-2: PROJECT ORGANIZATION ZUIDASDOK

10.1.1 INDICATORS FOR CREATING AN OPEN PROCESS

1. Involve all relevant parties

The process is initiated by municipality of Amsterdam to develop a general vision for the area. National government became involved since national infrastructure crossed the area and municipality suggested to construct the main infrastructure in a tunnel. National government was interested to increase the capacity of the highway and the railway. The involvement of actors in achieving the interest of another party was minimal. In 2006 a governance agreement was made between the most critical actors.

Presently, one project organization is working towards a solution in which all interests evolve. Therefore the project organization is constituted with the most critical actors. Other parties are only involved in the official public

participation rounds. Local residents experience it as difficult to influence the preliminary decisions of the project organization. Therefore not all relevant parties with corresponding interests are taken into account accurately although the project organization states something different.

2. No substantive choices at the start of the process

The process started without substantive choices in 1993. Municipality developed a vision for the overall area and thought of solutions for the (national) infrastructure. National government thought of solutions for their capacity problem as well. Both processes were ongoing parallel, but tuning between the two processes was lacking.

Rijkswaterstaat limits the land development on the tunnel roof. Other parties only question this choice when the possibilities within the solution space aren't sufficient.

3. Ensure a transparent process and management

During the start of the process, it's hard to speak of one process and a transparent management. National government wasn't supportive towards a solution to bring national infrastructure underground and collaboration was difficult.

'The collaboration between national government and Amsterdam didn't go very smoothly in the early phases of the project.'

Presently the process management is constituted as a transparent organization. Still the management team constitution isn't clear for the public. Local residents experience changing roles and persons in the project organization. With these changes some previous decisions aren't supported anymore. This results in an indistinct process and process management. Furthermore, the present project director of Zuidas Dok is officially employed by Rijkswaterstaat. Although his role is to serve the overall interests of the project it is hardly impossible to understand the interests of other parties as good as the interests of his own employer.

4. Allow actors to bring aspects to the agenda

The management team is established as a matrix organization see **Fout! Verwijzingsbron niet gevonden..** From three parties (Rijkswaterstaat, ProRail, City of Amsterdam) and from three disciplines (integral design, EIA (or MER in Dutch) and governance) a member of the management team serves the interests of the actor or deals with the discipline. From these six viewpoints aspects can be brought to the agenda within the project management team.

'Aspects are brought to the agenda from three roles and from three aspects'

10.1.2 INDICATORS FOR PROTECTING PARTIES' CORE VALUES

5. Actors explain their core values when entering the process

In the early phases of the process, it's hard to speak of collaboration and therefore it is assumed that the actors didn't explain their core values.

Presently, assessment criteria are determined in order to balance alternatives. These criteria are determined by giving the critical actors the possibility to show their core values in the project. These assessment criteria are presented to the public during participation rounds. Parties could express their view on these assessment criteria. With this process all actors were able to explain their core values.

6. Commitment to process

With the failing auction to sell shares in Zuidas project company to private parties, it is shown that the private parties weren't committed to the process sufficiently. After the failed auction, public parties have used this result to become committed to the process since they wanted the process to continue.

7. Actors should have the option to leave the process

History of the Zuidas process shows that there are options to leave the process. In the beginning, national government wasn't involved closely. The disappointment of Amsterdam after the failing auction made them less committed to the process. The private parties left the process at that time. After the joint preference decision of the commissioning parties in 2010, Rijkswaterstaat, ProRail and Amsterdam continued with the process together.

Presently a negotiation of the substance and financial contribution to the project is ongoing. All project organization members admit their interdependency: no one can achieve his goals alone. Therefore the actors intend to give each other possibilities during the negotiation process but the assumption that parties don't have to pay for realizing another actors' goal is also seen.

8. Inform all actors about decision making process

Before 2007, the actors were busy with the process independently. Furthermore, Amsterdam found the Zuidas a project for the region/ city. It was assumed that close involvement of other authorities wasn't necessary. The official documents (as the masterplan) are published for the public.

Presently, all actors are informed about the decision making process by the official participation rounds. The website communicates the participation rounds clearly and is accessible for every interested party. (website) Besides the official participation rounds, there are some extra public meetings where every interested party will be informed about the status of the project. They can reflect on the plans as well.

Although the official procedures are followed, the recent developments aren't communicated towards all actors yet. The plans are changing quickly, it is already difficult for the project members to stay informed. Working at one location helps with sharing information, still some actors fear that a decision comes as a surprise.

10.1.3 INDICATORS FOR GUARANTEEING THE SPEED OF THE PROCESS

9. Create prospects of gain and incentives

The different authorities had their own reasons for being involved in the Zuidas project. Before 2007, they didn't create prospects of gain for other actors. For example, Amsterdam needed a financial contribution for the tunnel. National government didn't see the prospect of gain by collaborating with a tunnel project.

Nowadays, all parties recognize their (actor specific and overall) problems and the interdependency to realize their aims. Prospects of gain and incentives are born by bringing the A10 underground. However these prospects of gain and incentives are created, actors are not able to utilize them since a decision for

the alternative has to be made first. Presently these prospects of gain are very uncertain and parties are hesitating to use them.

'Building on the tunnel is an opportunity since expanding the city at the expense of nature can be minimized.'

For the local residents building on the tunnel is seen as an opportunity as well. Not only the financial value that can be created by building on the tunnel counts, also protecting area with another function presently (as nature) can be seen as created value.

10. Use windows of opportunity

Although national government appointed the station Amsterdam Zuid as a national station project, municipality didn't use this opportunity to join forces in the process in the beginning of the process. The parties worked independently. Another window of opportunity was borne by a possible PPP. The ministry of Finance was interested in further developing a PPP and ABN and ING showed their interest around 2002. This opportunity is used, but didn't result in a viable prospectus. (Poelgeest, 2008), (Zuidas)

Presently, governmental parties cut in their expenses. Although windows of opportunity rise for building on tunnels, most actors want to keep the project simple and building on the tunnel is seen as a unnecessary complexity. Instead, the project organization is focusing on creating windows of opportunity in the future. By phasing the project and first bringing the A10 underground, opportunities rise for the development of the area since realizing housing is presently limited due nuisance from the A10. Also space is created for ProRail to increase the railway capacity (on the dike and underground). A public private partnership for a next phase might rise in the future by a midterm decision. On the longer term costs for expanding the railway can be done at the same time with generating revenues from area development (possibly on the tunnel) in the area. This creates possibilities for a sound business case.

'There are a lot of empty offices in the area. Developing offices on the tunnel is a risk since it requires investments without certainty about the revenues.'

11. Use command and control as incentive to collaborate

The ministry of Finance used its authority for the investigation of the viability for a PPP. The formation of a PPP failed in the end, but command and control is used.

Presently, when the collaboration between ProRail, RWS and municipality doesn't end in a satisfying decision, national government has to make a decision for the infrastructure independently. But RWS, ProRail and municipality experience present collaboration as equal.

10.1.4 INDICATORS FOR GUARANTEEING THE SUBSTANCE OF THE PROCESS

12. Invite substantive experts

After private banks have shown interest in being involved in the process, advisor Brinkman is invited to guide the process towards a PPP. A prospectus was developed in order to have an auction for the shares in the project company. Furthermore Credit Suisse was invited to give an external view on the prospectus since parties showed their doubts on the uncertainties. (Poelgeest, 2008)

Presently, expert judgments are held in order to have feedback on the plans for the alternatives. These experts don't have a role in the project and contribute to the quality of the plans. Also committee EIA has substantive experts who give feedback on the plans. The project organization has to act according to the advice of the committee EIA.

'A project organization focuses on the project solely. External experts can give a view on issues what the project organization missed.'

13. Distinguish experts from stakeholders

The role of Brinkman is questioned several times since he might have a stake in the outcome of the process. His interdependency was doubted since he has roles with the involved private parties as well. (Olij, 2008) Credit Suisse was not involved in any way, and can therefore be seen as an external expert. (Poelgeest, 2008)

Presently, the expert judgments are done by a committee with experts who don't have an interest in the outcome of the process. The advice for building on

tunnels is given by Rijkswaterstaat, who obviously does have an interest in the outcome.

14. Make a multi-issue agenda

In the early phases of the process, the parties were not collaborating and didn't make a multi-issue agenda. There was a priority list for infrastructural projects in Amsterdam. If the issues of these projects are discussed on a multi-issue agenda is unclear.

Presently the matrix organization of the management team results in a multi-issue agenda. A variety of issues and interests will be discussed during the management team meetings. One of the strategies to come to a sound business case is to introduce a multi-issue agenda as well. The following issues are being discussed:

- Higher financial contribution from the commissioning parties
- Economize the tunnel (for example by shortening the tunnel)
- Leave out some functions (for example by saving on the public transport terminal)
- Negotiate on a wider agenda by involving other projects as well (as Amstelveen line, Schiphol-Amsterdam-Almere highway track, North/South line)
- Looking for co-financers
- Further phasing in time and investments

Generating revenues from land development on the tunnel isn't one of the issues. Two of these possibilities, economize the tunnel and leave out some functions can threaten the values of parties. Future will tell how the project organization protects the values of parties.

15. Use information from rational analyses

Although the information from risk analyses is important for decision makers, it is not considered to be decisive. The project organization must advise decision makers on the basis of facts in order to enable wise decision making. Still scenario analyses should be done in order to understand decision making. For decision makers often the risk (probability x consequence) isn't decisive but solely the consequence. Attention is paid to both analyses (risk and scenario analysis).

'It's useless to have discussion about safety issues when the project decision isn't made yet.'

An exploration of Rijkswaterstaat concerning building on highway tunnels (Appendix 4.3) states that the BLEVE scenario is decisive. No matter what safety measures are taken, there is always a residual risk. Arguing from this scenario would lead towards minimal solution space for the integral project.

10.2 SAFETY

This paragraph assesses the physical safety in the project first. Then the indicators for the perception of safety are used in order to validate the roadmap.

The alternatives for the location of the infrastructure has priority now. For all alternatives there are preliminary sketches for the area development. Still, the role of safety in the process can only be assessed, not the actual outcome.

10.2.1 PHYSICAL SAFETY

Early in the process the requirement is stated that buildings cannot be realized on the A10 highway tunnels. A quantitative risk assessment isn't executed. Instead the BLEVE scenario is determined to be decisive and safety measures should be taken with respect to the possibility for a BLEVE. The involved costs for such safety measures are assumed to lead to excessive costs. Properties without a residential function (as parking garages and station buildings) can possibly be built on the tunnel. Still, the property must have an independent foundation, in order to ensure stability in case of a BLEVE. It's uncertain if the consequences and costs for safety measures regarding the consequences are argued from decent analyses.

However the scenario of a BLEVE is used for the requirement, interviewees rise questions upon the validity of the argumentation.

'Essentially, there is no difference from a safety point of view between building on the tunnel and building alongside the tunnel.'

10.2.2 INDICATORS FOR PAYING ATTENTION TO THE PERCEPTION OF SAFETY

16. Make tunnel visible for aboveground functions and vice versa

The land development plan consists of an intensive land development program on the train and metro tunnels. Therefore it's hardly impossible to have a view on the tunnel entrance from all buildings. (Zuidas, 2011)

17. Create functions on the tunnel which people voluntarily use

Since there is an intensive land development program projected on the tunnels, it is assumed that there will be functions that are also used involuntarily. (Zuidas, 2011)

18. A mix of people must be exposed to the risk

Present plans show that the Zuidas Dok area will be used by a mix of people. Public services, offices and housing will be realized.

19. Invest benefit in area

When buildings will be realized on the tunnel the national employers expect the municipality to contribute in the investments. Therefore it is expected that the benefit will be invested in the area through the land development act.

'Building on tunnels has the certainty of the costs and the uncertainty of the revenues.'

Furthermore by building on the tunnels, expanding the development in the areas around the infrastructure can be minimized. Therefore locations that have another function presently (as nature) can be spared.

10.3 LEGAL ASPECTS

10.3.1 OWNERSHIP

The project decision isn't made yet, therefore there is no detailed information yet on how the ownership after construction will be arranged.

It is stressed that Dutch legislation has the right on accession to ownership¹⁴. Therefore by building on tunnels, an in rem right must be commissioned to one of the properties. Without an in rem right, building and tunnel can't be

¹⁴ Accession to ownership = natrekking

separated in ownership. Since commissioning an in rem right requires to follow some procedures, Zuidas organization is not stimulating building on tunnels. But when buildings will be realized on the tunnel, it is desired that the tunnel is commissioned with an in rem right and the land development can take place without a lot of procedures to discuss the conditions of the in rem right.

10.3.2 LIABILITY

For ZuidasDok an external company (Aon) is requested to research the possibilities to finance the risks and do recommendations concerning the insurance possibilities for the overall project. How the project risks will be insured in practice isn't decided yet. Starting point is the interdependency between different parties since land development will take place on and in the surroundings of the main infrastructure. As a result parties will cause nuisance and cause damage to others. The Aon research pays attention to the (kind of) risks and the insurability of these risks. The most efficient insurance possibilities are elaborated.

For building on tunnels the risks during operations are important. Material damage infrastructure, material damage to buildings, material damage to others and injuries due risks in exploitation phase of the infrastructure (as explosions, fire etc.) can be insured by construction all risk insurance and business liability insurance. The risk on damage to the infrastructure/ tunnel caused by its surroundings is minimal in all project phases.

It is advised to have an integral insurance for the overall project. Involved parties pay a part of the premium depending on their role. The total premium paid will be less than with all separate insurances. Furthermore it is assumed that it's more transparent what is insured and which quality in insurances is achieved. (Aon, 2011)

10.3.3 INDICATORS FOR IMPROVING THE PERCEPTION OF LIABILITY

To test the indicators of the perception of liability, the findings of Aon are used as if the insurances are arranged according to their advice. Obviously, information from the interviews is used as well.

20. Risks and organization must be transparent

The organization structure is not clear to all involved actors. The project website doesn't give a clear overview of the organization either.

With the overall insurance, a lot of ambiguity is taken away. There is one insurance company with one insurance policy. The premium every party pays is dependent on the risk allocation and the role of a party in minimizing the risk. Therefore the risk profile must be known resulting in an improvement of transparency. The risks regarding building on tunnels are considered to be unclear to RWS. Therefore building on the tunnel is prohibited.

21. Good collaboration instead of transferring all risks

Rijkswaterstaat and ProRail both try to shift most risks for building on tunnels towards the party who is interested in building on tunnels: Amsterdam.

'When the area developer together with Rijkswaterstaat would be capable of giving content to building on tunnels, Rijkswaterstaat has to be more flexible in this matter as well.'

Presently, the risks on damage from the surroundings to the tunnel is used as an argument for prohibiting building on tunnels. ProRail shifts the possible risks on unavailability of the infrastructure caused by an incident in the buildings towards the municipality/ land owner. Rijkswaterstaat pursues the same transfer. Others stress that the risks on damage from buildings on the tunnel is negligible. (Aon, 2011) Parties don't collaborate in this matter, but keep the collective risk of infrastructure in the urban area Zuidas out of their scope.

The project organization is working at one office in order to keep communicating between the actors in the project organization. This helps with the collaboration. Future will tell if it actually turns out that the risks are also equally shared.

22. Make use of examples of liability from other projects

The project organization has very experienced employees in order to decide not only on project analyses but on experience from other projects as well. One interviewee compares Zuidas with other projects where infrastructure and land development interfere.

Furthermore, the involvement of an independent advisor for the insurances proves the desired use of best practices elsewhere.

23. Prevent unilateral decisions for the risk division

With the collective insurance for the overall project, the risks are shared within the parties. Therefore the risk division is heading towards a division in which parties carry risks that are actually in their capacity to manage. The premium that is paid by the parties follows from the risk allocation. The contribution can be changed on the basis of calculation after incidents. (Aon, 2011)

24. Divide risks upon ability to manage and interest

Initially, all risks are insured in one package. Therefore the incentive to manage risks and prevent risks from occurring might be gone. It is considered that when a risk occurs, the premium for parties who were able to prevent the risk should increase. (Aon) With such a system, the initial aim of preventing parties to discuss ages on liability for incidents might disappear.

25. Execute risk analyses and consider responses

For building on the A10 tunnel a risk analysis isn't done. Rijkswaterstaat has the policy that building on the tunnel isn't allowed. For other project risks, an extensive risk analyses is executed. (Aon, 2011)

11 CROSS CASE ANALYSIS

This chapter will compare the results of the two case projects. The previous chapters describe the processes of Spoorzone Delft and Zuidas generally. In this chapter the analysis will focus on building on tunnels; the results are confronted with each other and an explanation for the differences is researched.

The indicators that didn't affect the outcome of the decision building on tunnels are neglected in this chapter. Furthermore, Spoorzone Delft and Zuidas are projects with some similarities and some differences. The differences make it hard to compare the cases resulting in prescriptive improvements. Therefore the result of this chapter won't give an improved roadmap for decision making, instead it leads to suggestions for improving the decision making regarding building on tunnels.

11.1 COMPARING THE TWO CASES

Two main differences between the cases are important to point out. The first difference concerns the scope of the projects. Zuidas has a wider scope (highway, railway and local transport complemented with an extensive land development program) than Delft (railway and land development). The second main difference can be found in the present phase of the projects. Delft is already under construction, for Zuidas the project decision has to be made for the infrastructure part.

In order to compare two project decisions with each other, the failure of the Zuidas auction of the prospectus in 2007 is used. Since there were important arguments for restarting the process, and the empirical data is mainly focused on the process that is going on presently, results are used of Zuidas 2011 as well. Therefore the indicators are qualified for three 'cases': Spoorzone Delft, Zuidas 2007 and Zuidas 2011.

The following outcomes are used:

- > Spoorzone Delft: some residential functions and services will be developed on the railway tunnel.
- > Zuidas 2007: failure of PPP auction regarding the plans to have an intensive land development program on the railway tunnel.
- > Zuidas 2011: decision making process heading towards a highway tunnel without buildings on the tunnel.

For Zuidas 2007, limited data is found and the process stopped before the plans were very detailed, therefore some indicators couldn't be qualified, especially regarding safety and liability.

11.2 RESULTS CASE ANALYSES

The general decision making roadmap that was made for this research consists of 25 indicators. The results of the analyses are presented in table . During the two case analyses, some of them didn't particularly contribute to a decision regarding building on tunnels. These indicators will be neglected for the further cross case analysis. Also some indicators have shown some overlap with other indicators. During the interviews no other element appeared as being decisive. Therefore the indicators defined for this research can be qualified as being complete for these cases.

Indicator 21 has some overlap with number 23 (prevent unilateral decisions for the risk division); indicator 25 has some overlap with indicator 15 (use information from rational analyses); and indicator 19 has some overlap with number 16. Although these six indicators are important for decision making, they are integrated and only indicators 19, 21 and 25 are considered in further analysis.

	Indicator	Delft	Zuidas 2007	Zuidas 2011	Effect on decision	Overlap with?
1	Involve all relevant parties	YES	NO	+/-	-	-
2	No substantive choices at the start of the process	YES	?/NO	NO	YES	-
3	Ensure a transparent process	YES	NO	NO	-	-
4	Allow actors to bring aspects to the agenda	YES	NO	YES	YES	-
5	Every actor must explain their core values	YES	NO	YES	-	-
6	Commitment to process	YES	NO	NO	YES	-
7	Actors should have the option to exit the process	?/NO	YES	+/-	-	-
8	Keep informing actors about the progress of the decision making	YES	NO	+/-	-	-
9	Create prospects of gain and incentives	YES	YES	NO	YES	-
10	Use windows of opportunity	YES	NO	YES	YES	-
11	Use command and control as an incentive to collaborate	YES	YES	YES	-	-
12	Invite substantive experts without an interest in the outcome of the process	YES	YES	YES	-	-
13	Distinguish experts from stakeholders	NO	?/NO	NO	YES	-
14	Make a multi-issue agenda	+/-	+/-	YES	-	-
15	Use information from rational analyses	YES	?/NO	NO	YES	25
16	Make the tunnel visible for the aboveground functions and vice versa	YES	?/NO	NO	YES	19
17	Create functions on the tunnel which people voluntarily use	NO	NO	NO	-	-
18	A mix of people and functions must be exposed to the risk	YES	YES	YES	-	-
19	Invest benefit in area	YES	YES	YES	YES	16
20	Risks and organization transparent	NO	?/NO	YES	YES	-
21	Collaboration instead of transferring risks	NO	?/NO	YES	YES	23
22	Make use of examples and divisions of liability from other projects	YES	?	YES	-	-
23	Prevent unilateral decisions for the risk division	NO	?/NO	YES	YES	21
24	Divide risks upon ability to manage and carry risks and their interest in increasing the risk	YES	?	YES	-	-
25	Execute risk analyses and consider responses	YES	?/NO	NO	YES	15

TABLE 11-1: RESULTS CASE STUDIES

11.3 ATTRACTIVENESS OF PROCESS REGARDING BUILDING ON TUNNELS

In this paragraph the differences of the results of the cases are considered and an explanation is researched for differences.

NO SUBSTANTIVE CHOICES AT THE START OF THE PROCESS

Rijkswaterstaat has the initial requirement that building on the highway tunnel is not allowed (Zuidas 2011). ProRail is more open and doesn't have an initial requirement regarding building on tunnels (Delft). It's uncertain what the requirements were for Zuidas before 2007, but no images are found on which buildings would have been developed on the highway tunnel.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
2 No substantive choices at the start of the process <i>Was the initial client requirement specification free of requirements regarding building on tunnels?</i>	YES	?/ NO	NO	Different clients for the tunnel - Probability accident - Maintaining prohibition - Experience in city - Availability agreements

TABLE 11-2: RESULT INDICATOR 2

Possible explanation

Although RWS and ProRail are responsible for different kinds of infrastructure, their objectives are similar. The different attitude of the two organizations can be explained by four aspects. Still every organization has its own particular culture and approach of dealing with aspects which might be inexplicable. Therefore in this elaboration there is a focus on the difference of infrastructure (rail and highway) and the corresponding aspects.

The first aspect is the difference in maintaining a prohibition. For highways, even when hazardous materials are prohibited at a certain route, a driver can make his own choice to ignore it. For both infrastructure types, some hazardous material routes are appointed. Since every user of the railway has to be reported, and ProRail has to give permission to the transporting companies,

the control of ProRail to deal with hazardous materials is more substantial than for Rijkswaterstaat.

Secondly, the probability of an accident in a highway tunnel is considered to be more substantial than for a railway tunnel. This is the result of applying safety systems as signaling, that can be installed for a railway track.

Thirdly, the Dutch railway tracks connect city centers, where national highways connect city boundaries. Therefore ProRail has built more experience in urban area and the pressure from land development in scarce area can be better understood by ProRail.

The last aspect has to do with the availability of the infrastructure. ProRail has availability agreements with his main users. When the railway isn't available a fine has to be paid to these main users. Whether this fine covers all (financial, economic and social) losses due to the unavailability is beyond the interest of ProRail. For ProRail it is sufficient to transfer the risk upon fines due to unavailability caused by accidents in the building. For RWS this is more difficult, since the availability of a highway isn't directly proportional to the tax people have to pay for using a certain (part of the) highway.

ALLOW ACTORS TO BRING ASPECTS TO THE AGENDA

In Delft, the land developers are able to discuss their concerns about building on the tunnel with OBS. The early Zuidas process showed minimal collaboration (and therefore discussing issues and desires was difficult). The present Zuidas organization allows it to discuss the land development on the tunnel from three roles and from three aspects.

	Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
4	Allow actors to bring aspects to the agenda <i>Are actors able to discuss issues and desires regarding the land development on the tunnel?</i>	YES	NO	YES	- Different initiator - Interdependency actors

TABLE 11-3: RESULT INDICATOR 4

Possible explanation

During the early Zuidas process, the infrastructure project and the land development project were separated. When two projects are interdependent, it can be attractive to minimize the interfaces between the projects. Then the actors can be tempted to focus on their own objectives instead of focusing on the overall project objectives.

The Spoorzone Delft was initiated by the infrastructure capacity problem. Although in Delft the minimal capacity of the railway wasn't seen as a problem all the time, the actors were committed to the process (due to their interest in the outcome or due to command and control). They were collaborative in creating solutions that were supported by the others. With this attitude, actors are able to discuss their issues and desires easily. A similar attitude is recognized for Zuidas 2011. The lacking capacity of the infrastructure can't be neglected and actors acknowledge the interdependencies of achieving each other's objectives.

By understanding the interdependency of achieving project objectives and actor specific objectives, a climate is created where actors are able to discuss their worries, issues and desires concerning building on tunnels more accurately.

COMMITMENT TO THE PROCESS

This indicator is recognized in the Delft process by the potential extra costs for land development on the tunnel are paid by the municipality. For Zuidas 2007 the possibility for a PPP was an opportunity to neglect the interests of other actors. Although Zuidas 2011 has an overall ambition and objective, all actors must contribute (by investing in the project) when they want their interest to be met.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
6 Commitment to process <i>Is the project organization transforming potential disadvantages for an actor into a process agreement?</i>	YES	NO	NO	- Political climate - Project phase - Connection of objectives

TABLE 11-4: RESULT INDICATOR 6

Possible explanation

Presently, the Dutch public authorities are cutting in their expenses. In the present Zuidas process, actors are balancing which party has to pay for which parts of the project. Public parties are forced to look stricter to what their interest is exactly and only pay for those aspects that directly contribute to achieving their individual interest. There was less political pressure on the budget during the process of Delft.

Interviewees from Delft stressed that the optimization of value could have been better by having an integral approach for the execution of the project. Most potential disadvantages regarding profit from land development and extra expenses to the tunnel to make land development possible might occur during execution. It's possible that the necessity of this indicator is seen at the execution phase of the project.

The Zuidas 2007 process didn't connect the several objectives to each other. Therefore the project organization might have been unaware of the potential advantage of using this strategy.

CREATE PROSPECTS OF GAIN AND INCENTIVES

For Delft this indicator scores positive due to the decision that was made to have an intensive land development program projected on the tunnel roof. This changed after the decision into a few buildings on the tunnel. In the prospectus of Zuidas 2007, the land development on the train tunnel was used as a prospect of gain by land/ building sale as well. The present Zuidas doesn't have buildings on the tunnel no actor is using this option as a prospect of gain yet.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
9 Create prospects of gain and incentives <i>Is the project organization using building on the tunnel in order to create prospects of gain?</i>	YES	YES	NO	Different perceptions of costs, benefits and value

TABLE 11-5: RESULT INDICATOR 9

Possible explanation

As stressed previously, the revenues from land development in Delft contributed to a large investment of Delft for the tunnel project. As follows

from Spoorzone Delft, using this strategy seems very effective. Presently, the contribution of Delft is paid from other resources. This decision leads to the assumption that the value of the urban quality exceeds the costs that are paid from other resources presently.

For Zuidas 2007, the risks were substantial due to lacking involvement of the infrastructural parties. Therefore, the prospects of loss were notified as well and can be seen as an important factor for the negative outcome of the process.

In Zuidas 2011, this strategy isn't used. Some find the return on investment not sufficient for the limited area on the highway tunnel and argue that land can be developed elsewhere.

USE WINDOWS OF OPPORTUNITY

Only for Zuidas 2007 the infrastructure problem wasn't used for questioning the lacking urban quality. Instead, the lacking urban quality raised questions for the capacity of the problem, but it isn't used for connecting the two problems.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
10 Use windows of opportunity <i>Is the infrastructure problem used in order to create awareness of the lacking urban quality?</i>	YES	NO	YES	- Different initiator - Support local residents

TABLE 11-6: RESULT INDICATOR 10

Possible explanation

The interviewees acknowledged that most actors are organized from one sector only. Therefore their expertise is mainly in one field. In the early Zuidas process, the lacking expertise of other fields could have been contributing to the negative outcome. The process after 2007 didn't start all over, there are lessons learned in the past and are used here. Moreover, the infrastructure problem was increased so the window of opportunity increased as well.

Another difference can be found that for Zuidas 2011 and Delft the infrastructure problem is used for the urban quality problem. In Zuidas 2007 it was attempted to make use of the lacking urban quality to solve a potential infrastructure problem. It is possible that less powerful actors (as local residents) make better use of the initiation of a powerful actor (national

government, represented by RWS and/ or ProRail) than vice versa. This makes sense since powerful actors have authority within their field. For local residents, in this topic seen as less powerful actors, it can be impossible to require improvements. As soon as another problem arises, they can make use of that problem for creating support for their problem as well. Therefore, the successful use of this indicator can be dependent on the support from a variety of actors (indicator 1).

DISTINGUISH EXPERTS FROM STAKEHOLDERS

For the Delft case, ProRail performed the risk analysis. Their interest (they rather don't have buildings on the tunnel) was contradictory with the outcome of the analysis. For Zuidas there was no data regarding this indicator. For Zuidas 2011, there is no quantitative risk assessment for building on the tunnels performed.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
13 Distinguish experts from stakeholders <i>Are risk analyses regarding external safety on the tunnel roof performed by experts who don't have an interest in the outcome?</i>	NO	?	NO	<ul style="list-style-type: none"> - All experts have an interest - Experts are perceived as reliable

TABLE 11-7: RESULT INDICATOR 13

Possible explanation

It might be impossible to find experts on external safety that don't have an interest in the outcome. Even when an independent expert is employed for such an analysis he might be influenced by the interests and information of others. It can be possible to transform the outcome of such an analysis into a process agreement: whatever the result might be, the actors accept the result.

For Delft the outcome of the analysis (performed by ProRail) was that building on the tunnel was allowed. This suggests that ProRail was supportive for building on the tunnel. The interest of ProRail might have been to allow land development on the tunnel in order to receive a higher contribution for the tunnel project. It's also possible that ProRail had an interest in meeting the interests of other actors since they understood the 'protection of core values' strategies very well.

11.4 PERCEPTION OF SAFETY AND LIABILITY

In this paragraph the indicators of the perception of safety and the perception of liability are qualified and discussed.

INVEST BENEFIT IN AREA

This indicator is very obvious. When the infrastructure is built in a tunnel, this immediately brings value to the area since the nuisance decreases on the long term. For Delft and Zuidas 2011, the benefit is invested in the area by using the revenues from land development (partly) to contribute to the construction of the tunnel. For Zuidas 2007 the profit made by land development was attempted to use for the construction of a tunnel by using a PPP.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
19 Invest benefit in area <i>Is the value of building on the tunnel (by profit or by urban quality) used within the area?</i>	YES	YES	YES	<ul style="list-style-type: none"> - Profit alone is not enough for a supportive decision. - Supporting urban quality requires local involvement.

TABLE 11-8: RESULT INDICATOR 19

Possible explanation

Zuidas 2007 was financially driven. The prospectus and the involvement of large financial institutions suggested that the investments can be earned back by the land development. Moreover, the two initiating banks were located in the area, so the value for the area could have been a reason for them to be involved as well. For profit driven actors, the project wasn't attractive enough, since none of the actors did a bid for the shares in the project company during the auction.

The value driven actors (public parties) were still interested in bringing the infrastructure underground, therefore the process continued. For Delft, the value is mainly created by decreasing the nuisance for the present residents and the land development in the surrounding of the tunnel. This value was acceptable due to the commitment of others and their successful lobby. It is assumed that societal value is accepted only when society comes up for this value by a lobby.

RISKS AND ORGANIZATION TRANSPARENT

Interviewees of Delft have given contradictory answers concerning their liability. The municipality and ProRail initially carry liability. Municipality perceives that some risks are carried by the land developer in the future, while the land developer doesn't acknowledge this. Although the Zuidas 2007 was trying to shift all risks toward private parties, in practice there is always a residual liability for public parties since it concerns public functions. For Zuidas 2011, there will be a collective project insurance which makes the overall risk profile more transparent. In the advice of a collective insurance, the option for building on tunnels is still included.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
20 Risks and risk allocation is transparent <i>Is it clear to parties who carry liability what their liability regarding buildings on the tunnel is?</i>	NO	?/NO	YES	<ul style="list-style-type: none"> - Phase of the project - Collective insurance as compensation for lacking process - Different complexity of projects

TABLE 11-9: RESULT INDICATOR 20

Possible explanation

For Zuidas 2011, it was desired to have an insight in the risks and the possibility to deal with the risks within the organization. This can be argued since the project consists of so many aspects and actors. Moreover, the process management strategies don't score very positive; it is possible that there is lacking trust between actors. A collective insurance can be used as compensation.

The desire to have an overall insurance isn't found in Delft. This can be the result of the open process and the protection of core values. It is also possible that a collective insurance or other way of transparent allocation of risks is performed in the past, but in the present phase of the project it might be impossible to have a transparent risk allocation.

For Zuidas 2007 it is possible that the auction failed due to lacking transparency, but not enough data is found to elaborate more in this matter.

GOOD COLLABORATION INSTEAD OF TRANSFERRING ALL RISKS

In the Delft process, it is stressed that some of the risks are carried by the municipality due to the prevailing role ProRail has in the process. In Zuidas 2007, the collaboration between risk carrying parties was minimal. The advice for Zuidas 2011 shows that an integral insurance should be desired. This advice is welcomed by the project organization.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
21 Good collaboration instead of transferring all risks <i>Are the project organizations preventing unilateral decisions regarding liability?</i>	NO	?/NO	YES	- Good process makes prevailing role acceptable.

TABLE 11-10: RESULT INDICATOR 21

Possible explanation

For Spoorzone Delft, it seems as if the prevailing role of ProRail during the process is accepted. This can be explained from their openness and protection of core values within the process. In the present Zuidas process, an integral risk management and insurance analysis is done which can be the result of less openness and the lacking protection of core values in the past.

EXECUTE RISK ANALYSES AND CONSIDER RESPONSES

For Spoorzone Delft, a risk analysis resulted in some safety measures in order to allow building on tunnels. For Zuidas 2011, the requirement is defined first whereafter an explanation for the requirement is given in the field of scenario analyses. There is no data found for Zuidas 2007.

Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011	Possible explanation
25 Execute risk analyses and consider responses <i>Is a risk analysis performed and are safety measures considered in order to allow building on tunnels?</i>	YES	?	NO	

TABLE 11-11: RESULT INDICATOR 25

Possible explanation

A declaration of RWS is given which explains the validity of the requirement to prohibit buildings on the tunnel. As discussed with indicator 2, there are several explanations for the differences. The reason why some actors prefer the use of quantitative risk assessments and some prefer the use of a scenario analysis is discussed in chapter 11.6.

11.5 RELATIONS BETWEEN INDICATORS

The explanation for different results, suggested some relations between indicators. In this chapter these relations are discussed. Therefore the overall table with all results is presented first:

	Indicator	Spoorzone Delft	Zuidas 2007	Zuidas 2011
2	No substantive choices at the start of the process <i>Was the initial client requirement specification free of requirements regarding building on tunnels?</i>	YES	?/ NO	NO
4	Allow actors to bring aspects to the agenda <i>Are actors able to discuss issues and desires regarding the land development on the tunnel?</i>	YES	NO	YES
6	Commitment to process <i>Is the project organization transforming potential disadvantages for an actor into a process agreement?</i>	YES	NO	NO
9	Create prospects of gain and incentives <i>Is the project organization using building on the tunnel in order to create prospects of gain?</i>	YES	YES	NO
10	Use windows of opportunity <i>Is the infrastructure problem used in order to create awareness of the lacking urban quality or vice versa?</i>	YES	NO	YES
13	Distinguish experts from stakeholders <i>Are risk analyses regarding external safety on the tunnel roof performed by experts who don't have an interest in the outcome?</i>	NO	?	NO
19	Invest benefit in area <i>Is the value of building on the tunnel (by profit or by urban quality) used within the area?</i>	YES	YES	YES
20	Risks and organization transparent <i>Is it clear to parties who carry liability what their liability regarding buildings on the tunnel is?</i>	NO	?/NO	YES
21	Good collaboration instead of transferring all risks <i>Are the project organizations preventing unilateral decisions regarding liability?</i>	NO	?/NO	YES
25	Execute risk analyses and consider responses <i>Is a risk analysis performed and are safety measures considered in order to allow building on tunnels?</i>	YES	?	NO

TABLE 11-12: RESULT CROSS CASE ANALYSIS

With indicator 4, the differences between the cases about 'if' and 'how' actors are able to bring their issues and desires to the agenda, is explained by the commitment of the actors. Indicator 6, commitment to the process by

transforming potential disadvantages into process agreements, is narrowing the possibilities on the way actors can be committed. Commitment can also be the result when actors have an interest in the outcome of the process (indicator 9) or when they are enforced to collaborate due to pressure from other authorities (indicator 11, neglected here due to the minimal relevance for building on tunnels specifically).

From these cases it can be seen that when the commitment to the process in a narrow sense isn't met, the potential disadvantages must be minimized by using another strategy. For Zuidas 2011 this is done by making the overall risks and the organization transparent within a collective insurance. It might be possible that when indicator 6 (commitment in a narrow sense) is lacking it can be compensated by a transparent risk profile.

It sounds logical that when parties find it difficult to enter a process, or when they feel as if their interests won't be met sufficiently, transparency in the risk profile can compensate the possible lack of trust in the organization. For Delft, this wasn't necessary due to the more positive result on openness and protection of core values.

From these cases it can be seen that a transparent risk profile can compensate lacking openness and protection of core values in the past. Still, a substantive choice at the start of the process isn't changed.

11.6 QUANTITATIVE RISK ASSESSMENT VS SCENARIO ANALYSIS

The results of the cross case analysis have shown that actors deal differently with safety. Some perform a quantitative risk assessment (QRA), while others involve a scenario analysis (SceA) as well. This raises questions about the applicability of these analyses for building on tunnels.

For discussing the reliability of QRA's, a conclusion of a scientific paper upon forecasting is cited (Makridakisa & Taleb, 2009):

'The forecasts of statistical models are "mechanical", unable to predict changes and turning points, and unable to make predictions for brand new situations, or when there are limited amounts of data. These tasks require intelligence, knowledge and an ability to learn which are possessed only by humans. Yet, as we saw, judgmental forecasts are less accurate than the brainless, mechanistic ones provided by statistical models. Forecasters find themselves between Carybdis and Scylla. On the one hand, they understand the limitations of the statistical models. On the other hand, their own judgment cannot be trusted. The biggest advantage of statistical predictions is their objectivity, which seems to be more important than the intelligence, knowledge and ability of humans to learn. The problem with humans is that they suffer from inconsistency, wishful thinking and all sorts of biases that diminish the accuracy of their predictions. The biggest challenge and only solution to the problem is for humans to find ways to exploit their intelligence, knowledge and ability to learn while avoiding their inconsistencies, wishful thinking and biases. We believe that much work can be done in this direction.'

Regarding building on tunnels, it can be questioned if the amounts of data are sufficient for reliable outcomes within a QRA. It's hard to have reliable information upon probabilities for the 'low probability, large consequence' scenarios. Furthermore, there are so many measures for minimizing the consequence that quantifying the possible consequence is hard as well. Moreover, possessing the outcomes is done by humans and therefore the accuracy of predictions can be diminished. So, according to Makridakisa & Taleb, the reliability of a QRA can be questioned.

Unlike this statement, present discussion regarding tunnel safety in the Netherlands focuses on the lack of clear regulations. The EU regulations differ from Dutch regulations and differ with the requirements from the fire department. Furthermore, the aim of the scenario analysis is unclear. Some use SceA as a tool for preparing upon disasters (as happens with Spoorzone Delft) while others use it as a tool for changing designs (as happens with Zuidas). The last subject within the tunnel safety discussion is that regulations do not prescribe safety measures that can be used in order to reach an acceptable safety level. (Andersson Elffers Felix, Grontmij, 2011)

Still, there has to be agreement upon how to balance the acceptable safety level. Without any regulation for safety levels and guideline how to come to the quantification for safety levels, decision making is completely dependent on the whims of individual decision makers. The result of a scenario analysis (how many people might die as a result of a certain accident) enables decision

makers even more to steer towards their interest by picking a scenario as being decisive that gives results that are in line with their interest. From the two cases Zuidas and Spoorzone Delft it has appeared that a QRA enables a decision allowing building on a tunnel. Scenario analyses create a deadlock for the decision making.

PART E: CONCLUSIONS AND RECOMMENDATIONS

In this part the conclusions and recommendations of the research are drawn. Before the research was executed, research questions were defined. The main research question will be answered in the conclusion chapter. Also remarkable findings are discussed.

The conclusions can be seen as recommendations for practice. However, several limitations of the research are recognized as well. These limitations introduce recommendations for further research which are described in the recommendations chapter.

12 CONCLUSIONS

Building on tunnels is possible. There are no rules and regulations that prescribe interdictions regarding land development on a tunnel. Having said that building on tunnels is possible, other conclusions can be drawn from the theory and case studies as well. In order to prevent the conclusion being a repetition of the overall report, this chapter will focus on the overall (redefined) objective of the research:

WHAT ARE SUGGESTIONS CONTRIBUTING TO A SUPPORTIVE DECISION REGARDING BUILDING ON TUNNELS?

MAKE SURE THAT THE GENERAL CONDITIONS ARE MET

Building on a tunnel introduces several difficulties. Some conditions have to be covered since they are determined by law or since they are the driving force to desire buildings on the tunnel:

> **Determine the safety zone in the surrounding of the tunnel.**

Within a boundary of the individual risk of 10^{-6} , only partly vulnerable properties can be developed. Outside the safety zone all properties can be developed. The safety zone can shift towards the tunnel by taking safety measures. The safety regulations are similar for train and highway tunnels.

> **Commission a limited right in rem for owning more than one property on one piece of land.**

Every property owner carries strict liability upon damage to others caused by defects of his property.

> **Focus on a transparent but viable business case.**

The financial and societal values that come along with the land development on the tunnel should exceed the costs for preparing the tunnel roof as a site for land development. In order to enable parties to make a decision, they must be aware of the costs and benefits of the alternatives. It can be attractive to use a large area for land development as a contribution for the tunnel. Using a large area will go at the expense of the original functions of that area. The societal value of the original and possible functions must be considered as well.

SUGGESTED STRATEGIES FOR THE DECISION MAKING PROCESS

Not all actors desire to have buildings on the tunnel. The complexity of the project is increased, while a tunnel project in urban area is already very complex. Resulting from the two case analyses and the cross case analysis, process suggestions are done for building on tunnels specifically. One thing can be concluded up front: When process management is used from the start of the project it seems to be able to develop buildings on the tunnel. The arguments for prohibiting building on tunnels are borne from tunnel safety contents. Several suggestions are done regarding safety issues as well.

> Focus on the prospects of gain with building on tunnels.

The prospects of gain by building on tunnels are substantial. The financial contribution to the project from land development can increase. Moreover, the urban quality can be improved, both by developing desired functions and by minimizing land development outside the urban area (and therefore at the expense of other functions). Finally, the locations on the tunnel are in some situations popular: it mostly concerns locations with good accessibility and the view over the infrastructure can be phenomenal (consider the Nemo museum on the IJtunnel).

> Use windows of opportunity

Using windows of opportunity is only possible when there is support for solving a problem. It is possible to couple the lacking urban quality to an infrastructure problem only when both problems are supported. Solving a problem for society (lacking urban quality) requires support of the local actors. When the local actors don't experience the situation as being a problem, other actors won't be helpful in collaborating for a solution improving urban quality and look for a less expensive solution. Then the decision to construct a tunnel might be questioned and building on the tunnel isn't possible either.

> Realize one project organization with representation of the critical actors concerning land development and the tunnel.

Although process management stresses that decision making in a multi-actor network makes hierarchical decisions impossible, having all critical actors represented in one organization can be helpful during the process. One project organization without all critical actors truly represented can create uncertainties (as follows from Zuidas 2007).

Having all critical actors represented in the project organization prevents substantial decisions from one actor. Related to building on tunnels, the infrastructure owner knows the risks caused by the infrastructure best. Municipality and/ or land developer has expertise concerning land development. Therefore the requirements regarding land development must be the result of the information provided by all of these parties. A single authority deciding on this matter goes beyond his authority and/ or expertise.

> **Take care of a transparent overall risk profile**

While focusing on the prospects of gain, also take care of a transparent risk profile. Be aware that the prospects of loss don't exceed the prospects of gain. When actors fear pointing fingers in case of an incident, this might be caused by a lacking process and can be compensated by a collective insurance.

A Quantitative Risk Assessment (QRA) seems to be best suitable for decision making. A QRA is the basis for legislation and all scenarios are part of such analysis. When the QRA is performed with the involvement of most critical actors it is a fairly objective tool. Still, discussion might rise upon the validity of data and the interpretation of the result.

With a scenario analysis, objectivity might be questioned even more. There are no guidelines found regarding which scenarios should be considered and which scenarios can be neglected. By allowing scenarios as decisive, deadlocks are created. Moreover, all scenarios are part of the QRA. Still, scenarios with low probability and enormous consequence should be considered carefully in order to have a plan to minimize the catastrophe when it occurs.

> ***Use the same approach for highway tunnels as for railway tunnels***

For highway and railway tunnels, a different approach is used to consider building on tunnels. Since every risk mitigation strategy leaves a residual risk, the catastrophic scenarios are still possible although with a lower probability or consequence.

In general, there is no difference in highway tunnels and railway tunnels regarding the issues of building on tunnels. Both types of infrastructures deal with the same conditions. The result of a similar analysis for highway and railway tunnels can still be different. In order to come to a decision where building on tunnels can take place, the approach for railway tunnels should be adopted.

13 RECOMMENDATIONS

For current practice it is recommended to use the suggestions as described in the previous chapter. The recommendations as described in this chapter should be considered when using the suggestions, since the research has its limitations as well.

Increase of data

The present suggestions for decision making follow from two cases and a limited number of interviews. Most of the interviewees are still working on the project and for one of the two projects the decision isn't even made yet. It is possible that answers have a strategic background and the objectiveness can be questioned. Therefore the suggestions done in the conclusions should be validated in more projects. Also lessons of the decision making of projects that are operational can be useful in order to turn the suggestions into prescriptive improvements for the decision making regarding building on tunnels.

Costs and benefits

It is recommended to create an insight in the costs for site preparation elsewhere and the costs for site preparation on a tunnel roof. Then the actual benefit of building on tunnels is more sharp.

Also the assumption that building on the tunnel doesn't require high investments should be validated. Some interviewees stressed that building on the tunnel requires substantial investments since the tunnel needs expensive constructive adaptations. Others have found these investments minimal with respect to the overall costs.

A topic for further research could be: 'the financial and societal comparison of two alternatives, one including expanding city boundaries, one building on the tunnel'.

Dealing with subjective information in an analysis

The research has introduced questions upon the objectiveness of a risk analysis. It has been recognized that the outcome of the analysis is determined by the actor who is performing the analysis (and information might be used strategically in order to come to the decision that is desired). But on the other hand, it is stressed that having more clearness in the standards is desired as

well. Therefore the process management strategy to develop requirements with the critical actors and create 'negotiated knowledge' might have its limitations in practice.

Therefore it is advised to do more research upon how to deal with the subjective information within QRA's and give a more clear guideline on the use (e.g. which scenarios can be used, what kind of decisions can be made upon the results etc.) of scenario analyses.

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PART F: APPENDICES

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1 INTERVIEWEES

Quick scan interviews and expert meetings for problem exploration and generating ideas.

Name	Date interview/ conversation	Company/ Project
Nic Frederiks	18-04-2011	Municipality Amsterdam – Overpassing A10 Bos & Lommer
Taco van der Sar	13-05-2011	Dura Vermeer – A1 het Gooi
Auke Bijlsma	18-05-2011	Actiegroep Nieuwmarkt – Oostlijn & Nieuwmarkt Amsterdam
Arthur Verdellen	18-05-2011	Municipality Amsterdam – Oostlijn & Nieuwmarkt Amsterdam
Fred Verhaaren	06-06-2011	ProRail – Railway tunnel Best
Frank van der Hoeven	07-06-2011	TU Delft – Urban planning

Zuidas interviews

Name	Date interview	Company – role
Bert van Eekelen	10-06-2011	PRC – manager scope
Richard Jorissen	16-06-2011	Rijkswaterstaat – Project director ZuidasDok
Ron Snijders	05-07-2011	ProRail - Representing ProRail
Cees Geldof	06-07-2011	Municipality – area development
Bart van Bussel	07-07-2011	Infram – manager governance
Marleen Munnikma	08-06-2011	Vereniging Vrienden van het Beatrixpark – representing local residents
Diana Hubbeling	07-07-2011	ZuidasDok - laywer

Spoorzone Delft interviews

Name	Date interview	Company and role
Peter Gossink	10-06-2011	Dura Vermeer – project director CCL
Els van der Riet	09-06-2011	Municipality – lawyer OBS
JanGeert van der Post	09-06-2011	Municipality – manager conditionering
Rene Buvelot	24-06-2011	Quooste – Project manager planning ProRail
Willem de Wijs	15-06-2011	Ballast Nedam Ontwikkelingsmaatschappij – area developer for OCSD
Henk Rieff	28-06-2011	BOS/D – representing local residents

2 INTERVIEW PROTOCOL

The interview protocol is written in Dutch, since the interviews are held in Dutch. The minutes from all interviews are also written in Dutch and are confidential and therefore not included in this report.

De personen die geïnterviewd worden krijgen geen vragenlijst voorafgaand aan het interview toegestuurd. Er wordt vanuit gegaan dat de personen zonder voorbereiding antwoord kunnen geven op de vragen. Bovendien zal zonder voorbereiding een oprechter antwoord gegeven worden.

Het doel van elk interview is om te verifiëren of (en hoe) de gedefinieerde kwaliteit in beschouwing wordt genomen gedurende het proces van de twee cases. Kwaliteit was gedefinieerd als het bijdragen aan een huidig of toekomstig probleem waarbij de belangen van de betrokken partijen zoveel mogelijk tegemoet worden gekomen.

Het huidig of toekomstig probleem bij bouwen op tunnels is veiligheid. Het bijdragen aan een oplossing kan door: 1. Gebruik van procesmanagement; 2. Aandacht geven aan de perceptie van veiligheid; 3. Aandacht geven aan aansprakelijkheid en verantwoordelijkheid. Daarbij moeten de betrokken partijen tevreden zijn over het proces. De drie methodes kan door iedere partij verschillend worden ervaren, daarom is een diversiteit van partijen die geïnterviewd worden van belang. Er is op sommige onderdelen onderscheid gemaakt tussen de projectorganisatie en de andere betrokken partijen.

Introductie

De interviewer zal eerst een korte introductie van haar afstudeeronderzoek geven. Het belang en gebruik van interviews wordt toegelicht. Bovendien wordt de privacy van de geïnterviewde besproken (er worden geen citaten/verwijzingen in het rapport opgenomen maar wel een lijst met mensen die geïnterviewd worden), tenzij hier bezwaar tegen gemaakt wordt.

A: Algemeen

1. Wat is uw rol in het project?
2. Wat vindt u essentiële elementen (fysieke onderdelen) in het project?
3. Bent u op de hoogte van de plannen om op de tunnel te bouwen?
4. Welke extra maatregelen vond u dat er genomen moesten worden toen bouwen op de tunnel geïntroduceerd werd in het plan?

5. Wat vindt u belangrijke waarden die gedurende het proces afgewogen worden (zoals tijd, geld, ruimtelijke kwaliteit, veiligheid, hinder etc.)?

B: Rol van Procesmanagement (projectorganisatie)

1. Op welk moment bent u betrokken geraakt bij het project?
2. Hoe is het besluitvormingsproces ingericht?
3. Wie zijn er betrokken bij de besluiten over bouwen op tunnels?
4. Wie heeft het besluit genomen om op de tunnel te bouwen?
5. Welke afwegingen zijn gemaakt over het besluit?
6. Wat was de bijdrage van de andere betrokken partijen in dit besluit?
7. Zou er iets aan het planvormingsproces verbeterd kunnen worden?
Zoals?

B: Rol van Procesmanagement (bewoners-, bedrijvenplatforms)

1. Op welk moment bent u betrokken geraakt bij het project?
2. Was dit op eigen initiatief of op uitnodiging van de projectorganisatie?
3. Op welke manier probeert de projectorganisatie uw wensen en eisen in te vullen?
4. Was u betrokken bij het besluit om op de tunnel te bouwen?
5. Wat was uw inbreng en is uw inbreng meegenomen in de afweging?
6. Zou er iets aan het planvormingsproces veranderd kunnen worden?
Zoals?

C: Veiligheid bij bouwen op tunnels

Wanneer er op een tunnel wordt gebouwd zullen gebouwen blootgesteld kunnen worden de consequentie van ongelukken in de tunnel. Dit kan resulteren in veel schade aan de gevel/ het gebouw maar ook in doden en gewonden. Ongelukken in de tunnel zijn nooit helemaal te voorkomen, er blijft altijd een (rest) risico op een ongeluk met bijbehorende consequenties.

1. Wanneer vindt u het veilig om gebouwen te realiseren op de tunnel?
2. Hoe heeft u zich hierover laten informeren?
3. Welke rol speelt de informatie vanuit veiligheidsanalyses voor uw veiligheidsbesef?
4. Waar wordt uw veiligheidsbesef verder door bepaald?

D: Aansprakelijkheid en verantwoordelijkheid bij bouwen op tunnels

1. Wat weet u over de verdeling van aansprakelijkheden tussen de partijen?
2. Hoe en door wie zijn risico's verzekerd?
3. Hoe spelen de eigendomsverhoudingen hierbij een rol?
4. Op welke manier komen risico's op schade aan de gebouwen door de tunnel (tijdens exploitatie) aan bod gedurende het planvormingsproces? Hoe wordt getracht de schade te voorkomen en wie is daarvoor verantwoordelijk?
5. Komt schade aan de tunnel veroorzaakt door het gebouw aan bod? Hoe wordt getracht deze schade te voorkomen?

Alleen bij projectorganisatieleden:

6. Zou u uw eigen bedrijf/ organisatie aansprakelijk of verantwoordelijk beschouwen in geval van schade aan het gebouw door een incident in de tunnel?

Afsluiting

De verder gang van zaken wordt toegelicht: De interviewer werkt het interview uit en stuurt de uitwerking aan de geïnterviewde. De geïnterviewde wordt verzocht de uitwerking te controleren op onjuistheden. De geïnterviewde ontvangt na afronding van het afstuderen een samenvatting van het rapport.

Bedanken.

3 PROJECT ANALYSIS SPOORZONE DELFT

Generally the project history of Spoorzone Delft can be summarized in four parts:

- 1988 – 1992: exploratory research for four railway track
- 1992 – 1999: lobby for a railway tunnel
- 1999 – 2005: project decision preparations
- 2005 – present: project execution

In 1992 a research started with exploring the alternatives for a four-track railway between Dordrecht and Den Haag. This research was born from multiple perspectives, one of them was the option to construct the HSL-zuid through the city-center of Delft. Then a tunnel would be an option for the HSL tunnel and possibly for the present railway as well.

After the general research for a four-track railway, a lobby started to create support from a variety of actors. In the meantime the plans for HSL became more detailed and the decision was made for an alternative track without crossing the city center of Delft. Discussion arose if the tunnel was still necessary from national perspectives.

In 1999, as a result of the lobby, the municipality got a subsidiary to develop an urban plan for the area in case of the construction of a tunnel. The process for creating support from a variety of actors done by municipality and local residents was strategically changed into three main interests instead of focusing on the nuisance on local level solely:

- Serving national interest: ensuring capacity of the railway on the total track of Dordrecht – Amsterdam;
- Serving regional interest: improving the welcome of the city of Delft by having a more attractive station area;
- Serving local interest: reducing nuisance for the residents near the train viaduct.

With continuing to gather support, the plans for the overall station project were prepared.

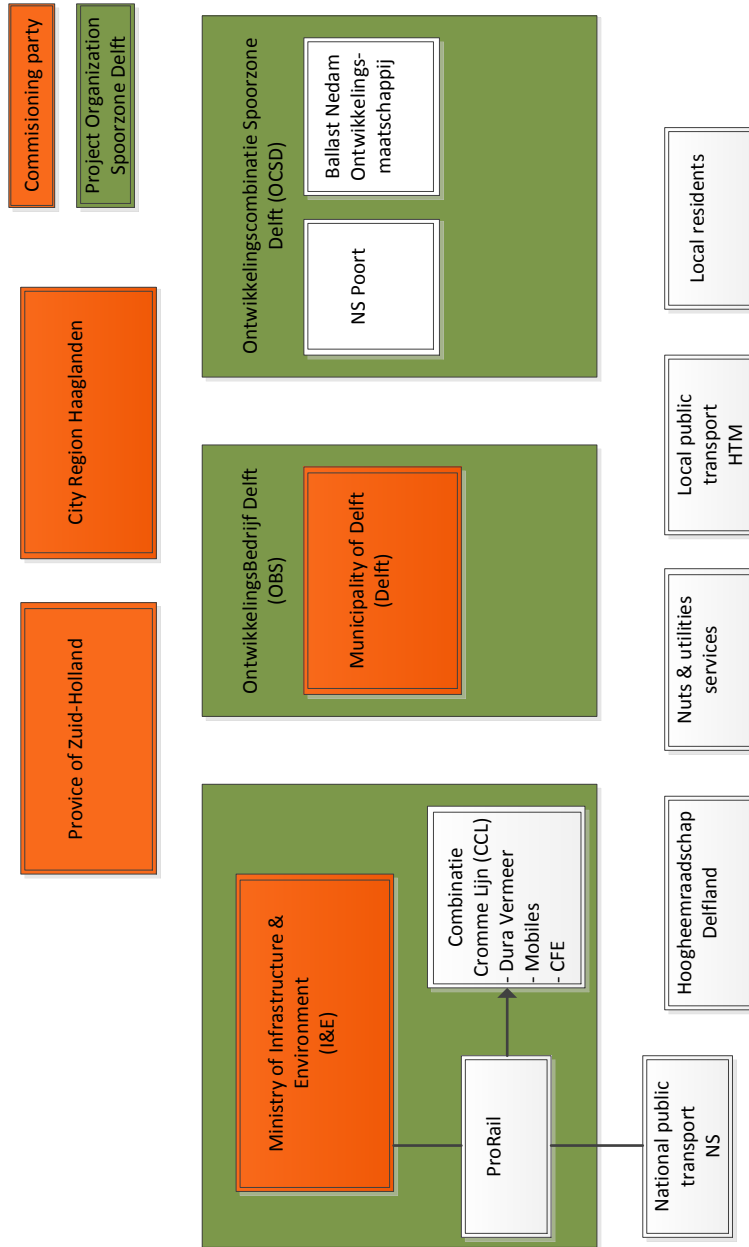
In 2005 the project is officially started. The designs for the tunnel became increasingly detailed and the tender was prepared. The designs for the city hall and station become more detailed as well.

3.1 TIMELINE

The timeline of decisions is given below.

Year	What	Critical actors
2009	Start construction tunnel	CCL, ProRail
2008	Tender for tunnel to Combinatie Cromme Lijn (CCL)	ProRail, CCL
2007	Mecanoo Architecten is selected to design the station and city hall	Mecanoo, municipality, local residents
2006	Finalization zoning plan	Municipality
2005	Agreement with area developers: Ontwikkelingscombinatie Spoorzone Delft (OCSD) is born	Municipality, Ballast Nedam Ontwikkelingsmaatschappij, NS Poort
2005	Public participation rounds for preliminary zoning plan	All actors
2003	Finalization Masterplan	ProRail, municipality
2003	Environmental impact assessment (in Dutch: MER)	Ministries of V&W and VROM
2002	Process agreement: ProRail and Delft are assigned to continue with the concept tunnel plans	Ministries of V&W and VROM, Province Zuid-Holland, Haaglanden and municipality Delft
2001	Safety analysis	Team integral safety
1999	Urban development vision: contest of urban planners, local residents vote for best urban plan	Joan Busquets, local residents, municipality
1997	Track decision HSL-zuid → Delft wasn't on the track so a tunnel for the HSL through Delft wasn't necessary	National government
1992	SWOT of four tracks with as a result the desire for a tunnel	Frits Palmboom, municipality
1988	Exploring four track railway Dordrecht – Amsterdam for the HSL-Zuid	National government, NS, ProRail

3.2 ACTORS



4 PROJECT ANALYSIS ZUIDAS

Generally the project history of Zuidas can be summarized in four parts:

- 1994 – 1998: initiative to develop Zuidas from municipality
- 1998 – 2008: exploration study of Zuidasdok
- 2008 – 2009: feasibility study van den Berg ZuidasDok
- Presently: project decision preparation ZuidasDok

In 1985 the Amsterdam World Trade Center was located in the Zuidas area. An increasing amount of companies was interested in having an office in Zuidas area. Therefore from 1994 the municipality started with working on an integral plan for Zuidas. With the support of national government to appoint Zuidas as a national 'sleutelproject' in 1997, the Zuidas project was actually born.

From 1998 the first alternatives for the infrastructure were presented by municipality. With the increasing involvement of national government new alternatives were introduced and old alternatives changed. In the meantime the Zuidas area became the location of some international companies. Some companies were interested in investing the development of Zuidas area. A prospectus for a public private partnership was developed. Private involvement appeared to be too minimal.

After the failure to create a sound business case for a public private partnership in 2008, national government researched what options might be viable for ZuidasDok. This resulted in the preference for underground infrastructure since this alternative creates the best options for the future. Risks, governance and a business case had to be researched further.

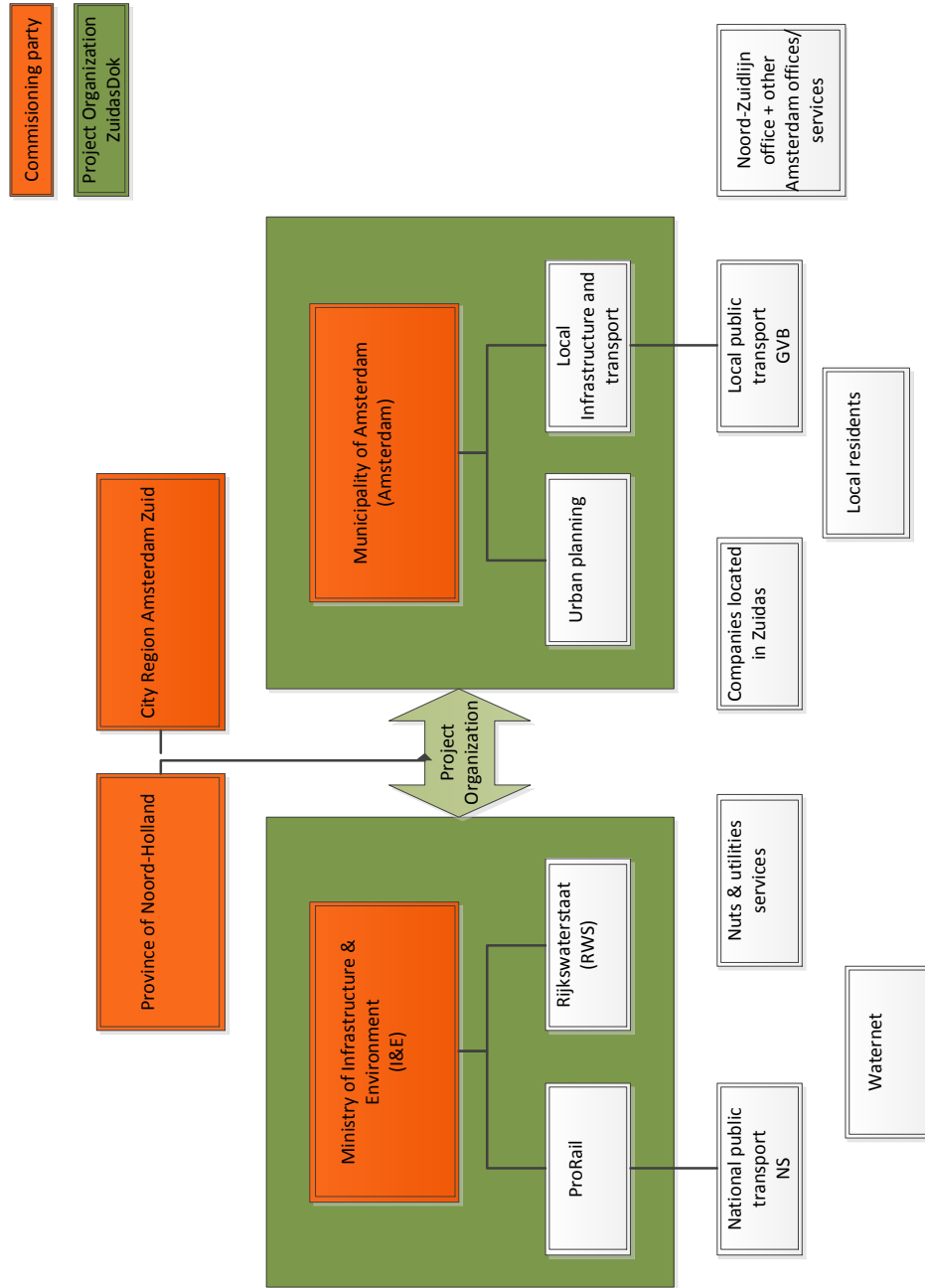
Presently, the project decision is prepared. Since the three alternatives proved to be too expensive, the project company is heading towards a project decision for a midterm period instead of heading towards a final situation. The midterm period decision contains the decision for constructing the A10 in a tunnel in order to make further development possible. How this further development looks like, will turn out in the future.

4.1 TIMELINE

The overall general timeline is presented in the table below.

Year	What	Critical actors
2010 - 2011	Preparation project decision for ZuidasDok under ground level	Project office ZuidasDok
2010	Presentation results national committee: → preference for all infrastructure in tunnel	National government, province of Noord-Holland, municipality of Amsterdam, city region.
2009	New mission and vision Zuidas	Project office Zuidas
2009	National committee 'Van den Berg' to research feasibility of 3 alternatives	National government
2007	Pre selection private parties → no sound business case Continue without private area developers	Project office Zuidas, private parties
2007	Formation of project office ZuidasDok	Municipality, RWS, ProRail
2006	Governance agreement	Municipality, National government, city region
2001	Starting note integral track: further optimization of 3 alternatives	Municipality, Ministries of VROM and V&W
1998	Masterplan Zuidas → Preference for 'Dok' or 'Dijk' (tunnel or dike), ground level is less preferred alternative	Municipality
1997	Zuidas appointed as 'Nieuw Sleutel Project'	National government
1994	Start integral planning	Municipality

4.2 ACTORS



4.3 BUILDING ON HIGHWAY TUNNELS (ISN'T POSSIBLE IN PRACTICE)

The text quoted below is a document written by Rijkswaterstaat and is send by project members of Zuidas, to the author of this research. The content is about prohibiting buildings on the highway tunnels.

“Bouwen op autotunnels (... kan in de praktijk niet)

Het bouwen van verblijfsruimtes op autotunnels is niet per sé verboden bij wet of beleidsregel van RWS. Uit toepassing van de tunnelwet volgt echter, dat bouwen van verblijfsruimten op autotunnels leidt tot excessief kostenverhogende maatregelen.

Toelichting:

De tunnelwet bepaalt het maximale risico dat gelopen mag worden in geval van een calamiteit. Het risico wordt vastgesteld door middel van een scenario-analyse voor de maatgevende gebeurtenis (in dit geval een zgn. 'bleve' (boiling liquid expanding vapour explosion: kokende vloeistof-gasexpansie-explosie, waarbij de tunnel uitbrandt en instort. Dit kan voorkomen indien bijvoorbeeld een LPG-tank ontbrandt). Indien verblijfsruimtes (kantoren, woningen, concertzalen etc.) op de tunnel worden geplaatst, is er sprake van een groepsrisico waaraan hele hoge eisen gesteld worden. In het geval van autotunnels is er ook sprake van ongecontroleerd gebruik (je kunt weggebruikers moeilijk sturen en een verbod op bv vervoer van gevaarlijke stoffen is niet te handhaven). De combinatie leidt tot dermate excessieve eisen aan de veiligheidsvoorzieningen, dat dit nooit binnen het beschikbare budget te realiseren is. Bij Rijkswaterstaat wordt dit daarom standaard niet gedaan.

Er zijn wel mogelijkheden om niet-verblijfsruimtes (zoals parkeergarages en stationshallen) op de autotunnel te plaatsen. Dit is per geval te beoordelen door veiligheidsdeskundigen. Als daarboven weer verblijfsruimtes komen (meer dan 15m boven het tunneldak kan dat in principe), dan mag dat alleen indien deze niet ook instorten bij de maatgevende gebeurtenis. In de praktijk betekent dat, dat ze onafhankelijk van de tunnel gefundeerd zijn. Dat werkt weer fors kostenverhogend.”