

# **Selection of project contract for rail infrastructure projects**

**Identification of the deciding factors for the selection of contract**

*Master of Science Thesis in the Master Degree Program Supply Chain Management*

**RICKARD HOLMBERG  
ERIK ROOS**

Department of Technology Management and Economics  
*Division of Industrial Marketing*  
CHALMERS UNIVERSITY OF TECHNOLOGY  
Gothenburg, Sweden, 2013  
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Department of Technology Management and Economics  
*Division of Industrial Marketing*

CHALMERS UNIVERSITY OF TECHNOLOGY  
SE-412 96 Göteborg  
Sweden  
Telephone +46(0)31-772 1000

Chalmers Reproservice  
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## **Abstract**

The Swedish construction industry struggles with low productivity compared to other industries. In order to increase the productivity the Swedish Transport Administration wants to transfer from the more regularly used Design Bid Build (DBB) project delivery method to the Design build (DB) project delivery method. The project delivery method is one of the parts of a project contract. The other parts are payment principle, procurement procedure and level of cooperation. The purpose of this thesis was to investigate how the STA should combine the procurement procedure, the project delivery method, the payment principle and the level of cooperation in different environments with different prerequisites. However, for STA, the combination of the DB project delivery method and different payment principles was of greatest interest. Especially the combination of DB project delivery method and the target cost payment principle.

In order to achieve the purpose of the thesis an investigation of existing theories about project contracts was reviewed. Further, interviews with relevant people have been conducted to understand the actors' opinions and attitudes regarding the selection of project contract. Findings showed that the contractors welcomed the increased use of the DB project delivery method. Moreover, it became obvious that there is not one project contract that suit all situations.

The research resulted in findings about several different decision factors for the selection of project contract. This ended up in a 2 by 2 matrix which categorized the projects and the selection of project contract depending on the decision factors. The results showed that the more uncertainties there are in the project the more important the level of cooperation is. It is also important to have a payment principle that facilitates cooperation. The recommendations to STA are to look further into cooperation and investigate if the implementation of DB project delivery method worked as intended.

**Key words:** Project contract, Project delivery method, Payment principle, cooperation level, Design Build project delivery method, Design Bid Build project delivery method, fixed price payment principle, variable payment principle, target cost payment principle, partnering



## Sammanfattning

Den svenska byggindustrin har problem med låg produktivitet jämför med andra industrier. För att öka produktiviteten har Trafikverket beslutat sig för ett skifte i entreprenadformer. Från historiskt välanvänt utförandeentreprenad till totalentreprenad. Entreprenadform är en av de innehållande delarna i ett kontrakt. De övriga är upphandlingsförfarandet, ersättningsformen och nivån på samarbetet. Syftet med examensarbetet var att ta reda på hur Trafikverket borde kombinera upphandlingsförfarande, entreprenadform, ersättningsform och samarbetsnivå i olika miljöer med olika förutsättningar. Från Trafikverkets sida var kombinationen av totalentreprenad och olika ersättningsformer av störst intresse. Framförallt totalentreprenad tillsammans med riktkostnad.

För att uppnå syftet med examensarbetet så gjordes en djupgående genomgång av befintliga akademiska rapporter om kontrakt inom infrastruktur. Vidare genomfördes intervjuer med relevanta personer för att få en förståelse för aktörernas åsikter och inställningar angående val av kontraktsform. Det blev uppenbart att entreprenörerna uppskattade Trafikverkets beslut om ett ökat användande av totalentreprenad. Vidare så blev det uppenbart att det inte finns en kontraktstyp som passar i alla situationer.

Undersökningarna resulterade i upptäckten av flera olika beslutsfaktorer som avgör valet av kontraktstyp. Detta resulterade, i sin tur, i en 2\*2-matris som kategorisade projekten och valet av kontraktstyp beroende på beslutsfaktorerna. Resultaten visade att ju större osäkerheter det är i projektet desto viktigare blir samarbetet. Det är också viktigt att välja en ersättningsform som underlättar samarbetet mellan aktörerna. Rekommendationerna i slutet till Trafikverket mynnade ut i att de bör undersöka hur de ska samarbeta med entreprenörerna och att utreda om ökningen av användandet av totalentreprenad har blivit lyckat.

Nyckelord: Kontraktstyp, upphandlingsförfarande, ersättningsform, samarbetsnivå, totalentreprenad, utförandeentreprenad, fast pris, rörligt pris, riktkostnad



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Rickard Holmberg & Erik Roos  
Gothenburg, 2013

# Glossary

The Act on Procurement within the Utilities Sectors	Lagen om upphandling inom försörjningssektorn, LUF
Bill of quantities	Mängdförteckning
Client	Beställare
Contracting authority	Upphandlande myndighet
Contractor	Entreprenör
Correctional and Additional Work (CAW)	Ändrings- och tilläggsarbete, ABT
Cost-plus	Löpande räkning
Design-Bid-Build (DBB)	Utförandeentreprenad
Design-Build (DB)	Totalentreprenad
Detail design	Projektering
Fixed price	Fast pris
Incentive	Incitament
Negotiated procedure	Förhandlat förfarande
Open procedure	Öppet förfarande
Prime production cost	Självkostnad
Project delivery method	Entreprenadform
Sub-contractor	Underentreprenör
Target cost	Rikt-kostnad
Tender	Anbud
Tender document	Förfrågningsunderlag
Tenderer	Anbudsgivare
Unit price	Mängdreglerade avtal, å-pris

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# 1 Introduction

*In this chapter the background for the thesis and the purpose will be presented. Furthermore the disposition of the thesis will be presented.*

## 1.1 General Background

According to Kadfors (2002) the construction industry has problems with high costs, low flexibility, poor relations between clients and contractors and a problem of not using the best knowledge of every member for the benefit of the project. The Danish researcher Flyvberg (2009) also states that the uncertainties regarding cost at infrastructure projects are high. Flyvberg (2009) has studied 260 different infrastructure projects around the world and found out that in nine out of ten the cost had been underestimated. The construction industry, compared with other industrial sectors, also has problem with low productivity (McKinsey & Company, 2012). Further, Cheok, et al. (2000), states that the construction industry has problem with low profitability, a shortage of skilled workers and a lack of investments in research and development. Furthermore, Cheok et al. (2000), states that the clients are dissatisfied with the level of service provided and the quality of the end product. This is due to several factors such as the labor intensive nature of the process, and the difficulty for the industry to adapt new technology.

Another problem stated by Cheok, et al. (2000) is the use of the traditional project delivery method such as Design-Bid-Build contract (DBB). DBB is a three party project delivery method in which the client enters into a contract with a consultant that provides the design services based on the requirements provided by the client. The construction is made by a contractor based on the design services from the consultant. (Ghavamifar et al, 2011) The authors suggest that the construction industry should continue to evolve the use of alternative methods such as Design-Build project delivery method (DB). In the DB project delivery method, the client awards a project to one contractor. The contractor is responsible for both the detail design and construction of the project. (Ghavamifar et al, 2011)

The thirteen most recent big infrastructure projects that are currently being built in Sweden is within budget and the time schedule. This is because of the increased responsibility for the contractors. In Sweden the trend is to move the responsibility to the contractor and reduce the client's responsibility (Byggvärlden, 2012). According to Simister & Turner (2001), the DB project delivery method encourages the contractor to find more innovative solutions. The contractors take more responsibility when a DB project delivery method is used compared with the more regular used DBB project delivery method.

## 1.2 The Swedish Transport Administration

The STA is a public client within the Swedish infrastructure sector. STA has responsibility for the long-term planning of all types of transportation in Sweden. They also build, operate and maintain all railways and roads that are owned by the state. STA was founded in April 2010 after a government decision to merge the authorities previous responsible for the railways (Banverket), the roads (Vägverket), the national public passenger transports (Rikstrafiken) and the financial support of the sea traffic (Rederinämnden). The merge also included the long term planning for the authority responsible for education and permits for the different traffic modes (Transportstyrelsen) and the authority responsible for the sea traffic (Sjöfartsverket). Also a part of the institute of transport and communication analysis (SIKA) was included in the merge (Trafikverket, 2013).

In order to increase the productivity and pace of innovations in Sweden, the Swedish government has made a petition that the Swedish Transport Administration (STA) should increase their use of contracts with the DB project delivery method. The goal is that in 2018, fifty percent of STA's projects should be performed according to DB project delivery method (Trafikverket, 2013).

Historically, the DB project delivery method has been used together with fixed price payment principles. However, in order to meet the requirement that the Swedish government has stated, STA need to focus on new payment principles and increased cooperation. Historically, the DB project delivery method has been used together with fixed price payment principles. However, STA has started to investigate the use of variable price payment principle with an economic incentive in order to be able to handle the more complex projects.

### **1.3 Purpose**

The main purpose of the thesis is to find out how the STA should combine the project delivery method, payment principle and cooperation level in different environments with different prerequisites. This will be achieved by evaluating how the client, called the Swedish Transport Administration (STA) and different Swedish contractors involved in rail infrastructure thinks about the different project delivery methods, payment principles, incentives and cooperation. By comparing their thoughts with the theoretical framework an analysis with recommendation will be made. Further, a sub-purpose is also to investigate how to use incentives and especially the economic incentive.

### **1.4 Outline of the thesis**

The thesis consists of seven chapters. It is recommended to read the thesis in chronological order, due to that the chapters are strongly correlated. This means that it is difficult to read selected chapters without having a comprehensive picture of all parts of the thesis. The Introduction, chapter 1 presents a general description of why the area of study is interesting, it also describes the purpose of the thesis and the focal contracting authority STA. Chapter 2 is the problem analysis. The problem analysis gives a deeper understanding into how the purpose is broken down into smaller sub-problems. Chapter 3 is the theoretical framework which presents the theory that has been used during the analysis. Chapter 4 is the methodology chapter which provides how the work has been carried out and how information has been gathered. Chapter 5 consists of the empirical findings from the interviewees that were made with the clients and contractors. Chapter 6 consists of the analysis which is based on the theoretical framework and the empirical finding. Chapter 7 consists of the conclusion and recommendations for further investigation regarding the problems identified in the problem analysis.

## 2 Problem analysis

The chapter provides a problem analysis together with a general background to enhance the understanding of the environment of railway infrastructure projects. Further, this chapter is aiming to identify a number of key issues with regards to project delivery methods, payment principles and project contracts at rail infrastructure projects. It begins with clarification about the actors and their connections. The different parts of the project contract are explained further in this chapter. Furthermore, the procurement process with the accompanying public procurement act is presented. Finally, the containing parts of the project contract are explained and from that the problems are identified. From this the investigation questions are derived.

A railway infrastructure project of considerable size consists of several sub-projects. It ranges from tunnels, bridges and tracks to information control systems.

### 2.1 Actors

Infrastructure and construction project are produced through a project process. At every step of the project process different actors are involved. In this section the key participants, which are part of almost every project, are briefly presented. The key actors are the client, the contractor and the consultant. The contractors in its turn employ sub-contractors. As can be seen in figure 1, the consultant can be employed of both the client and the contractor.

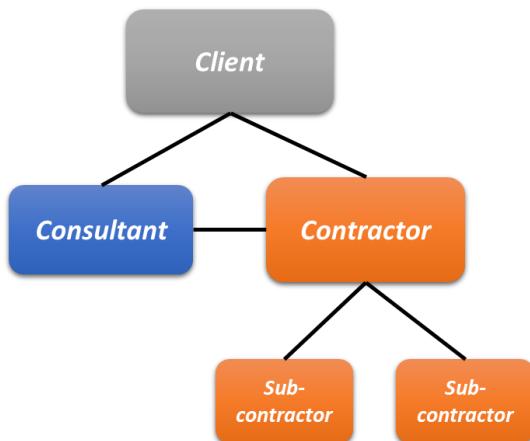


Figure 1, the main actors of rail infrastructure projects

However, the actors of main focus in the thesis are the public client STA and the contractors. The relation with the consultant is outside the scope because they are a third actor that is involved in another procurement process, which is of no interest for the decision of the project contract between the client and the contractor.

In an infrastructure project the *client* is the part who is responsible for the project. The client orders and procures the products and services needed to execute the project.

The largest client within the field of infrastructure in Sweden is the public client STA. The STA is a contracting authority, which aims to become a pure client organization. A pure client organization in this context means that the focus of procurement is shifted from procuring

technical solutions to procuring according to functional requirements (Trafikverket, 2012). As a public agent all procurement activities at STA obey under the public procurement act.

A *contractor* is the actor that executes the construction. The construction is procured by the client from the contractor. Further, the contractor works as a supplier to the client. When a public client such as STA is procuring, the procurement is subject to the act of public procurement. The contractor is always responsible for the construction of the project, which they have been assigned to by the client. The contractor in its turn often uses sub-contractors. The contractors are responsible for the sub-contractors. Depending on the contract, the responsibility for the contractors ranges from just making the construction to be responsible for the detail design and the construction.

At infrastructure projects a lot of activities are performed by *consultants*. It is a wide range of different activities, from political and environmental research, to more technical aspects. However, in this thesis the main activity performed by the consultants is the detail design of the project. The technical consultants for the detail design are procured by the client or the contractor, depending on the project delivery method. Further, as mentioned before, the interactions between the consultants and the other actors are outside the scope of the thesis.

To sum up, the interactions between the actors of interest for this thesis are between the client and the contractors. Figure 2, below, shows the actors of most interest to this thesis.

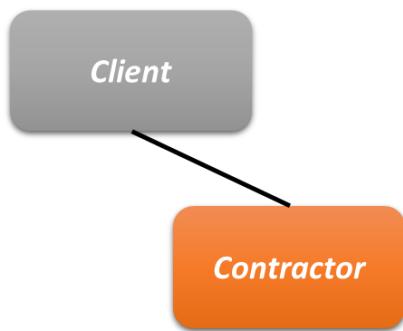


Figure 2, the interaction of interest to the thesis

## 2.2 Public procurement

According to Konkurerensverket (2012) procurement becomes a public procurement when public clients such as contracting authorities, country councils and municipalities procure works, goods and services. Public procurement corresponds to a significant part of a country's gross national product and therefore, the legislation is comprehensive. All public procurement is subject to the public procurement act, which is a framework for the procurement process at contracting authorities. The public procurement act is valid for all member countries in the European Union. The unifying of the public procurement act within the European Union was created to enhance the competition within the union and to encourage international actors to tender in national projects.

There are different subcategories for the public procurement act. For rail infrastructure the Act on Procurement within the Utilities Sectors, LUF, is used. It is described as a more flexible framework compared to other acts (Konkurerensverket, 2012).

## 2.2.1 Public procurement process at STA

The procurement process for LUF at STA is presented, in figure 3, below.

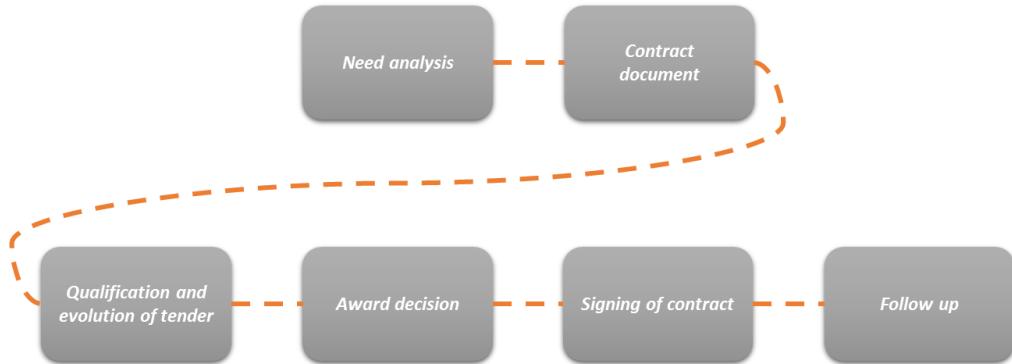


Figure 3, the procurement process (Trafikverket, 2013)

Before the contract document is formulated a needs analysis is performed. The needs analysis is a strategic analysis of the coming infrastructure project. The need analysis includes the project contract. The project contract consists of the procurement procedure, the project delivery method, the payment principle, and the level of partnering suitable in the given project. The criteria that are defined in the need analysis are formulated into a contract document. According to Konkurrensverket (2011) the contract document must include;

- Requirements on the supplier (economic standings, technical and professional ability);
- Technical specifications;
- Grounds for evaluation (lowest price or most economically advantageous tender);
- Commercial conditions;
- Administrative provisions for the procurement (e.g. last date for tenders and award procedure).

The potential contractors are selected, or pre-qualified, by STA and invited for negotiating. Depending on the size of the project different procedures are available. However, for large rail infrastructure projects the *negotiation procedure* is always used. Negotiation procedure is a procedure where the contracting authority invites pre-selected contractors for negotiation. The client may negotiate on the terms of contract with one or several of the contractors.

After the evaluation of the tenderer the winning bid is selected, and a notice is sent to all the tenderers so they are informed about the decision. The winning tenderer and STA signs the contract. Further, at this stage the tenderers which were denied the contract have a possibility to appeal the decision.

As mentioned above the project contract consists of several different parts, which will be explained further in the following sectors.

## 2.3 Procurement procedure

As mentioned above, this thesis is concentrated on large rail infrastructure projects and, hence, the procurement procedure used is the negotiated procedure. The negotiated procedure is a procedure where the contracting authority invites selected contractors and negotiates the terms of the project contract with one or several of the contractors.

The tenderers are evaluated according to *lowest price* or *economically most advantageous* tender. The options for the negotiated procedure are visualized below, in figure 4.

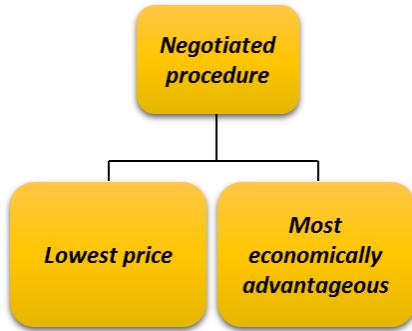


Figure 4, evaluation criteria for the negotiated procedure

STA evaluates the tenderers according to lowest price or most economically advantageous tender. If the principle of most economically advantageous tender is used, the evaluation criteria must be clearly formulated in the contract document (Konkurrensverket, 2011). The tenderer with the most economically advantageous tender is chosen based on price in combination with different factors that is important for the project. (Konkurrensverket, 2011). The selected factors chosen as award criteria are either weighed against each other or placed in a certain range from which they are prioritized. The criteria selected must be important factors for the given project. Further, criteria such as experience and competence are allowed to be used as award criteria, if these criteria are relevant for the given project.

#### Investigation question

During which circumstances are the lowest price respectively the most economically advantageous price suitable?

## 2.4 Project delivery methods

The choice of project delivery method is done in the early phases of a project. During the early phases, estimations about costs for the project, requirement and technical specifications are also executed. The infrastructure projects are typically outsourced to the private sector via various types of project delivery methods. The two methods mainly used in Sweden are Design-Bid-Build (DBB) and Design-Build (DB) project delivery method (Pakkala, 2007). According to Pakkala (2007) the use of project delivery methods differs between countries, in some countries the infrastructure project, regardless of size, is subject to only one project delivery method executed by one contractor. However, in Sweden, large infrastructure projects are divided into sub-projects using different project delivery methods. Hence, a big infrastructure project may consist of different project delivery methods.

The main difference between the two methods is which actor who is responsible for the different processes. (Albåge et al, 2011) The allocation of responsibility between the client and the contractor for the detail design is visualized below in figure 5, where the gray areas represent the responsibility of the client and the orange areas the responsibility of the contractor.

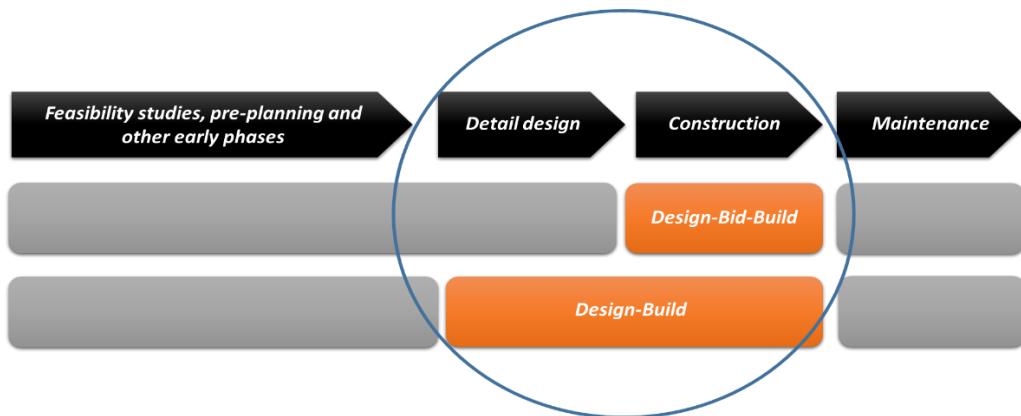


Figure 5, the two main project delivery contracts.

Other type of project delivery methods exist, which includes finance and maintenance of executed projects. Further, different variants of the two most common methods exist. However, the vast majority of the projects are executed with the DBB or the DB project delivery method.

The choice of project delivery method is complicated because of the different project delivery methods available, the unique characteristics of each project, and the large number of parameters affecting the selection of project delivery method (Ghavamifar et al, 2011).

To choose appropriate project delivery method and payment principle for a contract is no simple matter. Dada (2012) states that there is no project delivery method that suits in all situations; there is no “cure-all” method. The same argumentation is found in several research studies (Pakkala, 2007; Caltrans, 2008), there is no project delivery method that is the optimal solution for all projects. The choice of project delivery method is dependent on the unique requirements of a given project (Pakkala, 2007; Caltrans, 2008; Chan et al., 2008).

#### Investigation question

During which circumstances are the Design-Bid-Build respectively Design-Build project delivery method suitable?

## 2.5 Payment principle

There are two major payment principles, fixed price and variable price (Albåge et al., 2011). At construction works a wide variety of the two different payment principles exist. From the variable price the unit price and cost-plus payment principles are derived. Further, the target cost payment principle is derived from the cost-plus payment principle (Albåge et al., 2011). For the client, the selection of payment principle is a choice of how strong the economical driving forces for the contractor should be. It is also a choice of how to allocate the financial risks between client and contractors. Below, in figure 7, the different payment principles are shown.

*Fixed price* payment principle is a lump sum for the whole project. It transfers the risk towards the contractor. According to Berends (1999) the fixed price payment principle is suitable when the project cost is easy to define.

Using the *unit price*, the contractor gets paid per unit. As a variable price, the financial risk is pushed towards the client (Albåge et al., 2011). According to Nilsson (2011) the unit price

payment principle is most suitable when complexity is low and the bill of quantities is easy to define.

The *cost-plus* payment principle pays the contractor for all the expenses. According to Nilsson (2011) cost-plus payment principle is used when the project has high complexity and, because of that, the labor efforts together with the bill of quantities are hard to define. Further, a close relationship is needed in order to control the costs (Berends, 1999).

*Target cost* is a variant of cost-plus payment principle where the client and the contractor have an estimated cost for the project. If the target cost is exceeded, the actors share the additional cost. The same goes for the opposite situation, if the actual cost is lower than the target cost, the actors shares the profit. The estimated target cost is set by the client or the contractor. The actors can also set the target cost together. The sharing ratio differs from project to project. The target cost payment principle is a complementary to the other payment principles, aiming to create economical driving forces for the contractors and simultaneously reduce the risk for the involved parties (Chan et al., 2011).

All the payment principles can be combined with *incentives* or *bonuses*. The target cost is an incentive based payment principle, because it provides the contractor with economic incentives to reduce costs. Different bonus factors can be added to the project contract, regardless of selected payment principle. As can be seen in figure 6, bonuses can be based on different factors. Bonus factors are factors as completion time, quality and cost but also other, more subjective, factors such as cooperativeness.

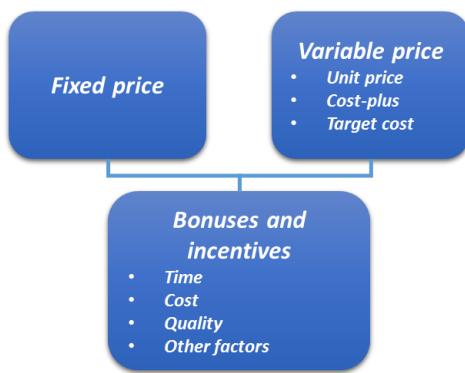


Figure 6, the payment principles and bonuses

The choice of payment principle is, as the choice of project delivery method, also dependent of the unique requirements of a given project. The procurement procedure and level of partnering are easier; they are more dependent on the actual choice of project delivery method and payment principle. However, they also depend on the circumstances and requirements of the given project.

### Investigation questions

When are the different payment principles suitable?

What are the optimum sharing ratios for the target cost in different environments?

How should incentives and bonuses be designed to contribute to project success?

## 2.6 Cooperation and Partnering

According to Dubois and Gadde (2010) the use of partnering has increased in the construction industry in recent years. Partnering is described as “an increasingly popular management tool aimed at reversing the negative effects of adversarial relationships in construction” (Wilson et al. 1995). According to Dubois and Gadde (2010) partnering is proven to be successful in several projects. The success regards control of costs, technical performance, and in satisfying customers. However, Hong and Shaokai (2007) state that partnering is not always proven to be successful. There can for example be a lack of continuous and honest communication, a lack of “win-win” attitude and unwillingness to compromise. These factors can cause ineffective partnering. In sum, construction partnering has proven to be successful in many cases but it is also shown to be unsuccessful in certain situations.

In Sweden the construction industry started the project *Renewal in the Construction Industry*, FIA. One important aspect of FIA was to increase the cooperation between the actors involved in infrastructure and construction projects. For deeper cooperation, i.e. partnering, STA uses the concept of FIA, which has divided the partnering into three levels. The aim of the partnering is to provide the contract with a moral extension (FIA Sverige, 2009). The higher level of FIA – the deeper the partnering is. The first level of FIA is the lowest level of partnering, but is a deeper cooperation compared to the cooperation defined in AB and ABT. Further, the elements of the first level are the foundation for the other levels. All elements in FIA level one is compulsory. The elements are common goals, workshops, joint risk management and openness on common issues. FIA level two consists of optional elements. The optional elements of the level two, together with the compulsory elements provide more structure, which are intended to more complex and large contracts and project assignments. At this level an alliance or joint venture, with all the actors (client, constructor and consultant) as participants can be created. The third level of FIA is strategic alliances. The strategic alliance is hard to combine with the act of public procurement. The strategic alliances are aiming to be used when several similar projects will be executed, and hence benefit from economies of scale. A strategic alliance, therefore, demands long term cooperation between the actors involved. However, a sub-project is one procurement activity and should be treated so according to public procurement act. There is not impossible to procure several similar projects at once but it more demanding and harder to combine with the act of public procurement. Below, in figure 7, the available levels of partnering according to FIA are shown.



Figure 7, the FIA partnering levels

### Investigation question

During which circumstances are partnering advantageous for the involved actors?

## 2.7 The project contract model

The project contract is the combination of the different procedures, methods, principles and partnering levels described in the sections above. This is the options for the STA when formulating and executing a project. In Figure 8, below, all the different choices of the procurement method are shown. It should be declared that this model is a simpler model than the reality. However, the elements of the contract model are the most commonly used by STA for rail infrastructure projects.

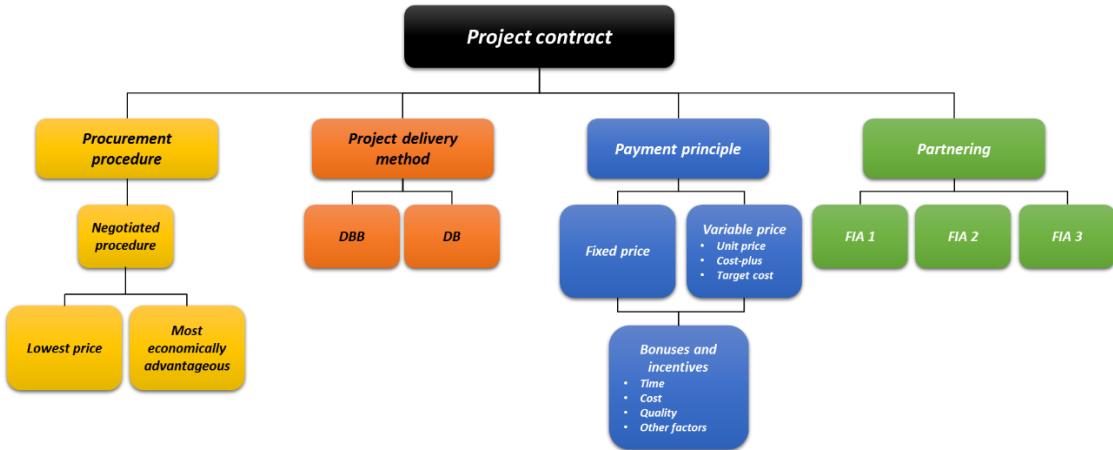


Figure 8, the different options for the project contract

### Investigation question

What are the deciding factors for the project contract?

## 2.8 Investigation questions

When the project contract is formulated there are three main factors to consider, described above. The overall problem to combine the project delivery method, payment principle and cooperation level in different environment with different prerequisites has been broken down into more manageable investigation questions in the chapters above. The investigations questions specifying what the focus needs to be on. Below, in figure 9, the questions are summarized.

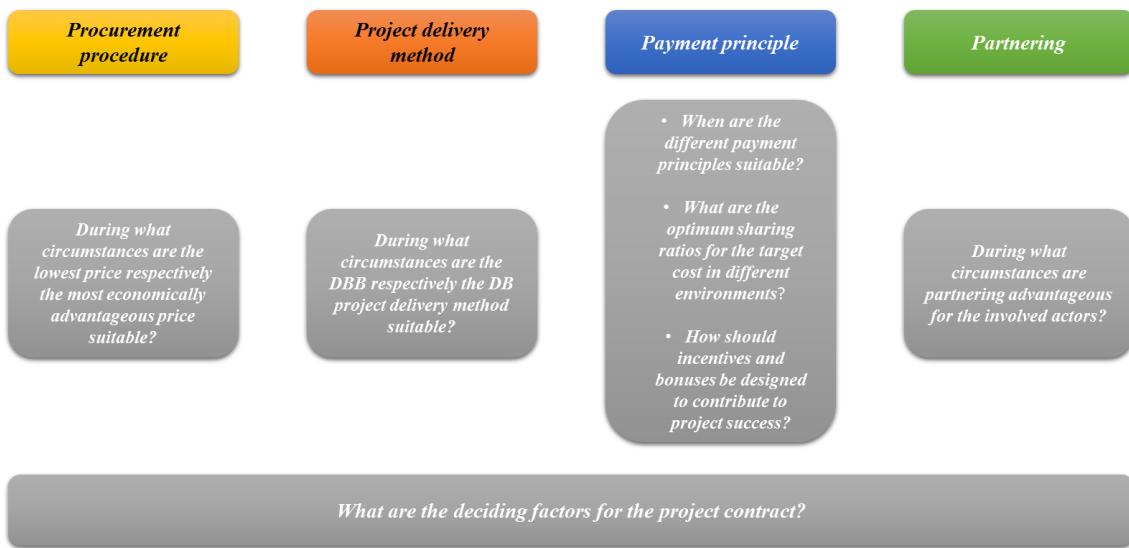


Figure 9, investigation questions

In the following chapter 3 the theoretical findings needed to investigate the research questions will be presented.



# **3 Theoretical findings**

*This chapter will present the theoretical findings that will guide the data collection. The theoretical areas presented here have been selected based on the research questions in chapter two. Together with the empirical findings it will create an underpinning for the analysis and solutions that will be proposed later in this thesis.*

## **3.1 Risks and uncertainties in infrastructure projects**

Infrastructure construction projects are large, uncertain and complex in several ways. That leads to that infrastructure projects are subject to more risks related to economic, social, political and environmental conditions than other types of construction projects (Charoenngam & Yeh, 1999). According to Nilsson (2011) a risk is defined as an uncertainty which is impossible to quantify in terms of probability that a certain event will occur. In an article about project risk management Ward & Chapman (2003) also argues that a focus in uncertainties rather than risks may enhance project risk management.

Charoenngam & Yeh (1999) argues that the amount and nature of risk in infrastructure construction projects depends on three factors; the contractual relationship between clients and contractors, the characteristics of the infrastructure project and how risks are allocated between the actors. Nilsson (2011) also states that a recurrent question in public procurement is how risks should be allocated. Every project has uncertainties regarding the real circumstances when the project is to be executed. Some risks are general, i.e. no matter who gets the contract the uncertainty is still there. The best example of general risk is uncertainties about ground conditions. Different project delivery methods and payment principles allocates risks differently between the contractors and the clients (Nilsson, 2011).

In a paper written by Simister & Turner (2001) the authors argues that there is no theory written about when and why a specific project delivery method or payment principle should be used. There is also a lack of theory in cases of when to involve the client in the project team and when not. However, it is a perceived understanding that the appropriate form of payment principle changes from fixed price and unit price to cost-plus as risk increases (Simister & Turner, 2001).

## **3.2 Procurement procedure**

The procurement directives of the European Union demands that public contracts are awarded to the lowest bidder or to the bidder with the economically most advantageous tender (Bergman and Lundberg, 2013). Within the European Union the tender evaluation method of economically most advantageous is more commonly used than the lowest price. The use of economically most advantageous tender evaluation method combines the price with a quality factor into a total score (Bergman and Lundberg, 2013). Wang and Yu (2012) argues that the economically most advantageous tender refers to the procurement method that selects the contractor most advantageous to the client by contemplating prices and other factors. Relevant factors mentioned by Wang and Yu (2012) are time, cost, image, appearance, operation and maintenance, managerial safety and environmental aspects.

The use of lowest price is suitable when a project is of low complexity and easy to calculate (Wang and Yu, 2012). According to Wang and Yu (2012) the lowest price selection has numerous benefits compared to the economically most advantageous tender. The benefits

include a simplified process of tender preparation and review, a more simple selection process, and the difficulty of protest by the bidders (Wang and Yu, 2012). Conversely, the lowest price also has some obvious disadvantages such as ignorance of quality, assumption of perfect specifications and plans, and assumption of minimum requirements to meet the client's need (Wang and Yu, 2012). There is also a risk of predatory bidding involved with the use of lowest price (Alexandersson and Hultén, 2006). Predatory bidding means that suppliers bid abnormally low, either accepting a financial loss or using Correctional and Additional Works (CAW) to make a profit.

According to Bergman and Lundberg (2013) the use of economically most advantageous tender evaluation method when selecting the suppliers can enhance the efficiency of public procurement. However, it also adds complexity to the selection procedure (Bergman and Lundberg, 2013).

### **3.3 Project delivery methods**

According to Shretseha et al (2012) the project delivery method is a process of designing any construction and facility. Further Shretseha et al (2012) states that the project delivery method is "a process by which the components of design and construction – including the roles and responsibilities, sequence of activities, cost of materials and labor – are combined to deliver a project". The project delivery method is the process which the construction project is comprehensively designed and constructed for the client including project scope definition, organization of designers, construction and various consultants, sequencing of design and construction operations, execution of design and construction, and closeout and start-up (Ghavamifar et al., 2011).

The construction sector is working with different project delivery methods (Shretseha et al, 2012). Further according to Pakalla (2007) there has been an increase in using different project delivery methods in the infrastructure sector the last ten to fifteen years. According to Ghavamifar et al (2011) there are three fundamental project delivery methods in the construction industry; DBB, DB and construction-management but as mentioned in chapter 2, in Sweden the two most used types are the DBB and the DB project delivery method (Pakalla, 2007). The DBB project delivery method is the traditional delivery method, which has been in use since the start of the industrial revolution. However, in recent time the DB project delivery method has increased in popularity (Pakalla, 2007).

The major difference between the two project delivery methods is the shift of responsibility towards the contractor (Albåge et al, 2011). Furthermore Ghavamifar et al. (2011) state that the different project delivery methods are distinguished by the way the contracts between the client, the consultant, and the contractor are formed. The allocation of risk also makes the same shift towards the contractor (Tsai and Yang, 2010). In the DB project delivery method there is also an increased feeling of cooperation and more opportunities to alternative solutions in form of design, innovations, constructability and project management (Pakalla, 2007). Although there is a greater feeling of cooperation in the DB project delivery method it still requires that the involved actors have a proactive attitude towards cooperation. (Rahola and Straub, 2013)

According to Chich and Ibbs (2011) the use of an appropriate project delivery system can significantly increase the efficiency and success rate of a construction project. As mentioned in chapter 2 the choice of the project delivery method is complicated because of the availability of different project delivery methods, the unique characteristics of each project,

and the large number of parameters affecting the selection of project delivery method. (Ghavamifar et al, 2011).

### **3.3.1 Design-Bid-Build (DBB) project delivery method**

As stated in chapter 1 the DBB project delivery method is the traditional project delivery method (Pakkala, 2007). DBB is a three party project delivery method in which the client enters into a contract with a consultant that provides the design services based on the requirements provided by the client. The consultant delivers plans and technical specifications for the project to the client. These documents are used as a basis in the tender documentation, where another contract is signed with a contractor. The contractor is bound by the specifications done in the detail design phase by the consultant. (Ghavamifar et al, 2011) Furthermore Hale et al. (2009) states that the DBB project delivery method is a project delivery method where the client have a contract with a consultant that provides the detail design based on requirements provided from the client. The deliveries from the consultant include plans and specifications for the construction of the project. These documents are used as a basis to a new contract with the contractor. The contractor who wins the contract will then perform the project according to the documents provided from the client. Therefore two separate contracts for the construction project must be used, those are including two tender documents and two procurement processes (Pakalla, 2007). The construction does not begin before the consultant has completed the detail design. (Kelley, 2013) Furthermore Hallowell and Toole (2009) state that all formal engineering design is thought to be completed during the design phase.

The role of the client is to preparing complete design and technical specifications (Caltrans, 2008). In the DBB project delivery method the client use the consultant as an agent to ensure that the construction is proceeding according to the detail design. (Kelley, 2013) The consultant has a duty to protect the owner's interest with respect to the delegated aspects of the construction project, (Berman, 1999) At the same time the contractor has an incentive to identify errors in the detail design so the contractor does not get responsible for defective construction. (Kelley, 2013) The consultant and the contractor do not have a direct contractual relationship. (Kelley, 2013) The separation of the consultant and contractor creates a system of check and balances between the two actors. Both actors are required to report errors to the client, so that the effect of the errors can be eliminated or minimized. (Berman, 1999) Although this balance create a better quality tool the DBB project delivery method is often criticized, because it creates a finger-point atmosphere between the actors which lead to an adversarial atmosphere between the actors. (Berman, 1999)

Contract using the DBB project delivery method is stated in the standard contract agreement AB. AB includes Terms and agreements regarding penalty, time and responsibility. The abbreviation is a Swedish standard contract agreement named "General Conditions of Contract for Building and Civil Engineering Works and Building Services" (BKK, 2004). The AB contract agreements is valid for the all the construction contracts, except the contracts using the DB project delivery method, which has a separate contract agreement. The purpose and aim of the AB is to maintain a reasonable balance between rights and obligations, seeking to find the optimal economic allocation of risks between the involved parties (BKK, 2004). AB contains agreements between clients and contractors at all stages of a project, from the very beginning until the completion of the project, including warranty time. By covering every phase of a project the AB aims to provide the client and the contractor with a mutual understanding about the execution and completion of the project.

According to Moore (2006) the advantages with DBB project delivery method are that it is the most familiar and established way of delivering a project, it is suitable for competitive bidding and lowest price and the detail design are complete to enable contractor bidding. Furthermore, Beehler (2003) states that it is easier to account the life cycle cost for the project. Kelley (2013), states that the role of the consultant and the contractor are well defined. The client's role is also well defined but can still be adjusted in order to match the client's interests and expertise. Since the client has a direct contractual relationship with the consultant. It is possible for the client to choose to select a consultant that fulfill the qualifications and is easy to monitor. Furthermore according to Simister and Turner (2001) the DBB project delivery method should be used when no need for early contract involvement is needed, and when the potential of innovations from contractors are limited. Mandell and Nilsson (2010) also state that DBB project delivery method is more suitable when complexity is low.

The disadvantages with DBB are, no early contractor involvement and conflicts can arise between the actors after the detail design is complete and the contractor is selected (Moore, 2006). According to Kelley (2013) because the consultant makes the detail design they cannot check with the contractor if the required material is available and to what price. The burden is heavier for the client since they are responsible for site security, material storage, and debris removal. It is not possible to overlap the design and construction; hence the construction time can be longer compared to the DB project delivery method. The effect of this can be a higher cost. A longer construction time also leads to that the project's possibility to generate revenue is delayed.

In table 1, summary of advantages and disadvantages is listed.

*Table 1 Advantages and Disadvantages using DBB project delivery method*

ADVANTAGES	DISADVANTAGES
Client control design	Contractor cannot affect design
Familiar and established way	Increases risk of disputes
Easy to tender	Loss of creativity
Maximum competition	Consultant and contractor do not interact with each other, which lead to an adversarial atmosphere
Possibility to account for the life cycle cost	Risk of longer construction time compared to DB

### 3.3.2 Design-Build (DB) project delivery method

As mentioned in chapter 1 the DB project delivery method is a project delivery method where the client awards the project to one contractor. The contractor is responsible for both the detail design and construction of the project. (Ghavamifar et al, 2011) Also, Kelley (2013) states that in a DB project delivery method a single entity is responsible for both design and construction, thus there are only two actors involved in the contract.

According to Kelley (2013) the detail design is done by the contractor in house or as a subcontract to a consultant. If a consultant is being used the contractor and the consultant mostly creates a joint venture where they carry out the detail design together to reduce the risks. It is important that the contractor estimate how long proposal time they need to be able to give an accurate proposal. If the proposal is not responsive to the client need it is a waste of time and

money. Even worse is if the client accept the proposal and the basic design does not meet the final design requirements. This can lead to big losses for the contractor. (Kelley, 2013)

Kelley (2013) advocate that the client often request proposal from several contractors. The client provides the contractor with basic requirements and performance criteria for the projects, but not in the same specified extent as in the DBB project delivery method (Hale et al., 2007). Hence, there is only one tender document for the complete project and also only one procurement process. For the involved actors, this demands that the costs are easy to estimate in an early phase (Caltrans, 2008). Kelley (2013) also state that the client must ensure that the performance criteria and basic requirements are accurately and completely. The client may retain a consultant to help define the scope of work. Furthermore, Budler et al. (2001) states that the single responsibility eliminates much of the finger-pointing common to the construction industry. According to Shrethsa et al, (2012) DB project delivery method is best suited for large and complex projects. Also Mandell and Nilsson (2010) argue that the DB project delivery method is most suitable when size and complexity are rather high.

The role of the client shifts to preparing detailed tender documents that communicates the client's expectations and demands regarding the project's requirements, physical components and performance (Caltrans, 2008). Although it is possible to define certain aspects it is important to not use over specification. Instead the client should focus on objectives, it should express characteristics for the final work and express as little as possible of how to achieve the final work (Marshal, 1999). The objectives are most effective when they describe requirements that can be measured. (Kelley, 2013) Further, after the award decision the client adapts to a monitoring role. Because, although the detail design is in the hand of the contractor the client needs to ensure that the detail design complies with the requirements stated in the tender document. However, the client has to avoid to actively controlling the contractor's detail design efforts (Caltrans, 2008). DB project delivery method proposals can be problematic for the involved actors. Often, the proposals contain very different design approaches, which will be problematic for the client to compare. Also the price proposal can differ a lot between the proposal design and the complete project. In order to reach the proposed price the quality may suffer.

The terms and agreement of the DB project delivery method are regulated in the standard contract ABT. The abbreviation ABT is translated into "General Conditions of Contract for design and construct contracts for building, civil engineering and installation works" (BKK, 2006). This means that DB contracts are subject to the ABT agreements. The purpose and aim of the ABT is to maintain a reasonable balance between rights and obligations, seeking to find the optimal economic allocation of risks between the involved parties (BKK, 2006). ABT contains agreements between clients and contractors at all stages of a project, from the very beginning until the completion of the project, including warranty time. By covering every phase of a project the ABT aims to provide the client and the contractor with a mutual understanding about the execution and completion of the project.

The advantages with the DB project delivery method are; In the DB project delivery method, the contractor is responsible for the design of the project, hence the contractors are able to come up with innovative solutions (Pakalla, 2010; Koppinen and Lahdenpera, 2004). Furthermore Simister and Turner (2001) states that then the uncertainty of the process is high the contractor can, by using a DB project delivery method, find innovative solutions. According to Koppinen and Lahdenpera (2004) the change orders are reduced in the DB project delivery method compared to the DBB project delivery method. According to Kelley (2013) the advantages are that there is a single point of responsibility for the whole project,

therefore it is less disputes since there will not be a three party dispute between the client, contractor and the consultant. Furthermore since the contractor is responsible for the design and the construction it is possible for the design, procurement and construction to overlap. As a result the overall construction time can be reduced.

The disadvantages are; according to Pakalla (2007) in general the quality of a DB project delivery method is equal to the quality of a DBB project delivery method. However Koppinen and Lahdenpera (2004) states that since the projects are schedule driven instead of cost driven the quality may suffer. Furthermore in the DB project delivery method there is a limitation in competition due to the fact that the contracts are often larger than in the DBB contract to be sufficient. The DB project also has high tendering costs which decrease the competition. (Koppinen and Lahdenpera, 2004) Kelley (2013) states that the client will not have the expertise from the consultant since, if there is a consultant he will be working for the contractor. Therefore it is hard for the client to control the contractor's performance. Furthermore Design-build is not suitable when the esthetic criteria's are important for the client, since the client cannot control the design.

The advantages and disadvantages are summarized in table 2 below.

*Table 2 Advantages and disadvantages in DB delivery method*

<b><u>Advantages</u></b>	<b><u>Disadvantages</u></b>
Increased capability for innovation	Potential risk for reduced quality
Contractors contribution in design	Limited competition due to large projects
Single source of responsibility	Limited competition due to high tendering costs
Minimal or no change orders	No input from consultant to the client
Alternative designs	
Less finger-pointing	
Possibility for the construction time to be reduced	

### **3.4 Payment Principle**

The payment principles are as mentioned in chapter 2 are either fixed or variable. The fixed price is a payment principle where the contractor is paid based on planned and performed work (Berends, 1999). The variable payment principle, cost-plus, is based on the real cost for the work done (Olsson, 2012). There is also a variant of cost-plus where it is possible to use cost-plus with a guaranteed maximum price (Chan et al., 2010). Depending on the environment, especially including risks and complexity, different payment principles are to be considered (BKK, 2007). Gordon (1994) argues that the client's decision regarding the payment principle should revolve around risk allocation.

The most concerned risk is the financial risk and, hence, the financial risk is the most important risk to consider. The client must choose a payment principle that most efficiently allocates the risk of the various parts of the project. Using fixed price to push all risks to the contractor is only recommended if the project is well defined. The alternative is to use the cost-plus payment principle that makes the client the risk carrier (Berends, 1999). Although a cost-plus payment principle is only recommended in extreme cases when the client is able to

control all costs of the project (Gordon, 1994). If the risks need to be shared between the actors the target-cost payment principle should be used. Target cost is seen as a risk-sharing payment principle (Chan et al. 2011). In table 3 below a more detailed view of the risk sharing between the payment principles is presented.

Table 3 Risk sharing between the different actors while using different payment principles (Albåge et al., 2011)

Payment principle	Risk allocation
Fixed price	Contractor
Cost-plus	Client
Target cost	Shared risk

### 3.4.1 Fixed price

Fixed price is the traditional mechanism for pricing construction work (Kelley, 2013). According to Berends (1999) fixed price is a payment principle where the contractor receives a specific fixed contract sum for the entire scope of work, a lump sum. The fixed price payment principle is suitable when the project cost is easy to define. The cost for the project is paid as one lump sum, which requires less administrative work from both the client and the contractor (Berends, 1999).

In the fixed price payment principle the cost-risk is carried by the contractor. If there are unforeseen price increases for labor or materials the contractor may incur a loss on the project (Kelley, 2013). Therefore, the client may have to pay the contractor a premium for carrying the risks; i.e. a risk premium. If the uncertainties are high, the contractor may require a high risk premium. Further, too high uncertainties may lead to a situation where few or no contractors at all tender for the contract (Berends, 1999). Furthermore Kelley (2013) states that the contractor bears the risk of price fluctuations on materials. The contractor is expected to use their experience and knowledge of the market to obtain materials at reasonable prices. If there is an unforeseen price fluctuations caused by for example a natural disaster, it is possible to put the risk on the client by using a so called *material price escalation* clause in the contract. In a fixed price payment principle, the contractor has an incentive to use the subcontractors that will perform the work for the lowest price.

If the final cost exceeds the contract cost, the contractor will be responsible for the loss (Ferguson, 2010). The contractor needs to be accurate in the detail design, due to the potential exposure that may occur from an inaccurate bid. The client, on the other hand, need to be accurate when he suggest a contract price. The client will pay an unnecessary high amount to the contractor if the actual cost of executing the construction project is significant lower than the award winning price. Ward and Chapman (1994) states that using fixed price in a complex environment, the contractor tend to seek additional payments from the client by performing Correctional and Additional Work (CAW). CAW is a decision from the European Union that is used to facilitate small changes in a project. As long as it is possible to make a change without the need to make a new contract CAW should be used (Bengtsson, 2012). Kelley (2013) states that the contractor can use CAW as an incentive in the contract. A result of this is that there can be an increase in disputes between the actors involved in the contract. The contractor may also try to save losses by reducing the quality, therefore fixed price tends to be most successful when the risks are controllable by the contractor and there are low uncertainties (Ward and Chapman, 1994). Furthermore Mandell and Nilsson (2010) states, by

using fixed price more risk and uncertainty are allocated to the contractor. However, according to Simister and Turner (2001), the higher risk and uncertainty carried by the contractors affects the contractors' possibility to make a profit.

In table 4, the advantages and disadvantages found in the literature is summarized.

*Table 4 Advantages and disadvantages with the fixed price payment principle*

Advantages	Disadvantages
One single cost for the project	Risk of Correctional and Additional Works
Less administration work during project	High risk-premiums at complex projects
	Requires accurate bid
	Risk for increased disputes

### 3.4.2 Variable price

Nilsson (2011) state that variable price can be divided into three different payment principles. Those are Unit price, Cost-plus and target cost. The unit-price and cost-plus is seldom used in big infrastructure projects because according to Albåge et al, (2011) it is impossible to control the costs of the payment principles.

The most regular used payment principle during DBB project delivery method is *unit price* (Nilsson 2011; SOU, 2012). During the detail design phase a bill of quantities is developed. The bill of quantities describes the activities that need to be carried out. The unit price is then based on the activities defined in the bill of quantities. The contractor submit tender and gets paid per unit (Nilsson, 2011). According to Byggledarna (2013), the contractors submit their unit-price for each post. There are both advantages and disadvantages with the method. The advantages are faster construction time compared to fixed price because the unit-price includes costs for the administration it works as an incentive to keep the costs down. As mentioned above it is a simple payment principle. The disadvantages are that it is hard to estimate the final costs and that it is hard to use on big and complex projects (Nilsson, 2011). The advantages and disadvantages of the unit price payment principle are summarized in table 5 below.

*Table 5 Advantages and disadvantages of unit price payment principle*

Advantages	Disadvantages
Simple payment principle	Hard to estimate the final costs
Faster construction time compared to fixed price	Hard to use on big and complex projects.

According to Nilsson (2011) the cost-plus payment principle is less common compared with unit price. In the *cost-plus* payment principle the client reimburses the contractor for all expenses, therefore, the cost-risks and the risk and benefits of the contractor's efficiency or inefficiency are borne by the client (Berends, 1999). The payment is variable for all work that is done plus a fixed fee that covers the contractor's overhead and profit. The fixed fee is usually a percentage of the construction cost. The key pricing term is the term which sets what costs that should be reimbursed to the contractor and which costs are included in the contractor's fee. Unlike the fixed price there is no incentive that requires the contractor to use

a subcontractor that performs the work for the lowest price (Kelley, 2013). According to Albåge et al. (2011) the cost-plus payment principle makes it possible for the contractor to add additional resources without any control from the client. This make it hard to predict the final cost, in other words the client lose the financial incentive that they had in fixed price but, instead the client do not have to pay any risk-premium. In order for the cost-plus payment principle to work as intended, a trust-based relationship or cooperation between clients and contractors are needed (Berends, 1999).

Using the cost-plus payment principle is time saving because it does not require that the client precise the work in detail, this leads to that the construction can start earlier (Rosenfeld and Geltner, 1991). As mentioned above, the cost-plus payment principle makes the client the risk carrier (Berends, 1999). This makes the payment principle suitable and also commonly used in projects of high complexity; i.e. when the outcome of the project is hard to estimate (Bajarai and Tadelis, 2001).

In the table 6, below, the advantages and disadvantages of the cost-plus payment principle are summarized.

*Table 6 Advantages and disadvantages using cost plus*

Advantages	Disadvantages
Flexible in case of variation in work content	Hard to control the work
Time saving	Hard to predict final cost
No risk premiums	Requires cooperation

According to Chan et al. (2011) the *target cost* payment principle is described as a risk-sharing payment principle, it is a variant of cost-plus that makes it possible to use cost-plus with a guaranteed maximum price. Hence, it is a variable price payment principle. The target cost offers a strong financial incentive to save costs and to make the contractors work efficiently. Further, the quality is also increased since the target cost payment principle does not over-emphasize on price and sacrifice quality (Chan et al., 2011).

Furthermore Chan et al. (2011) states that using target cost payment principle, the client and the contractor share gains if the final actual cost turns out to be lower than the target cost. If the final actual cost turns out to be higher than the actual target cost they will instead share the loss. Therefore the target cost is a unique arrangement that transfer the fixed price payment principle to the cost plus approach.

The target cost payment principle is based on shared risks between the client and the contractor. Hence, the target cost payment principle requires a relationship between the actors involved in the project. (Chan et al., 2011)

According to Kadefors and Badenfeldt (2009) contracts using the target cost payments principle are used when there is a high level of uncertainty. High level of uncertainties makes it hard to apply fixed-price contracts. Further, the cost-plus payment brings no cost control at projects with high uncertainties. Those circumstances are generally the case in large complex projects (Kadefors and Badenfeldt, 2009).

Figure 10 graphically illustrate how the target cost is divided between the contractor and the client. The loss or gain is shared between the parties based on an agreement in the contract. The sharing ratio decides how loss and gain are shared (Olsson, 2012).



*Figure 10 the sharing ratio in the target cost payment principle (Olsson, 2012)*

Badenfeldt (2007) argues that there is a lack of clear preferences about sharing ratios. This can be seen as an indication that an important function of target cost is to provide openness and indicate trust. Therefore a sharing ratio should be based on the basis of previous experiences of working together. Further, it indicates that long-term relationships have an important impact on the sharing ratio. To state the sharing ratio the involved actors has to present information, not only about the project but also about each other. The information about each other should cover areas about competence, experience and, also knowledge and experience about the target cost.

Kadefors and Badenfeldt (2010) and Badenfeldt (2007) states that by using a high share ratio there will be a tangible effect for motivation. However, there is a risk that it can have a negative impact on the project quality. The target cost should never be less than 50 percent in favor of the contractor, because it decreases the contractor's motivation to reduce the actual cost (Badenfeldt 2007).

Furthermore Chan et al. (2010) argued that the major problem with the implementation of target cost is the definition of scope of change. The scope of change is causing potential disputes when the client and the contractor are pulling in different directions to achieve their own objectives. Therefore the scope of contractor's work need to be well defined in the contract, but in order for target cost to work as intended the changes and variations should be kept to a minimum.

Target cost is still a rather new payment principle, which might lead to difficulties for the organization to adjust to the new payment principle. In order for target cost to work, the client and the contractor need to have organizations that accept cooperation. By having a close cooperation a clear and fair allocation of risks can be achieved and it will also be less contractual disputes and better teamwork (Chan et al., 2010).

According to Bajari and Tadelis (2001) target cost payment principle should not be used when there are difficulties in establishing fair cost targets. The reason for the difficulties is that there is a risk that the negotiation will spoil the relationship between the client and the contractor.

In the table 7, below, the advantages and disadvantages of the cost-plus payment principle are summarized.

*Table 7 Advantages and disadvantages using target cost payment principle*

Advantages	Disadvantages
Risk sharing	Demands administration

Financial incentives for both actors	Requires cooperation
Creates teamwork	

### 3.4.4 Incentives, bonuses and penalties

In large projects, one important factor in making effective management arrangements is to align the different motives of the consultants and contractors with the motives of the client. This is mainly determined by the details of the contract between the involved actors. In order to reach this alignment, the client's objectives and motives must be clear and consistent. A good way to align the separate motives among the actors is the use of incentives. (Bower et al., 2002)

Incentives in the construction sector are subject to performance against specified criteria (Berends, 1999). Incentives play an important role in construction contracts (Ashley and Workman, 1986). Chan et al. (2011) argues that it is important that all incentives are of sufficient value to motivate the contractor (Chan et al, 2011). Further, Ashley and Workman (1986) argue, the role of incentives is to motivate the contractor to adopt the client's project objectives. Also, Bower et al. (2002) states that effective motivation in contracting requires adoption of the client's project objectives by the contractor. According to Bower et al. (2002) incentives plays this role in contractual relationships. Further, they states that incentives utilized by the client are supposed to promote the contractor to embrace the objectives of the client.

The main incentives areas are cost, time schedule, quality and safety (Arditi and Yasamis, 1998). Bower et al. (2002) also states that the incentives, broadly, are categorized as cost, technical or performance, and, schedule and delivery. Further, Bower et al. (2002) argues that incentives, applied correctly, can focus the contractor and client on the appropriate business objectives, which will lead to successful result of the project.

Bower et al. (2002) states that incentives for a project also must be aligned with key business success opportunities. The incentives should be objective. Further, the incentives should be measurable and using relevant benchmarks. Furthermore, Bower et al. (2002) states that the basic principle for the client of using incentives within the contract is to take advantage of the contractor's general objective to maximize its profit by giving the contractor the opportunity to increase the profit if the contract is performed efficiently.

Further, Bower et al. (2002) argues that contracts using incentives requires a clear and precise objective of what is to be achieved. This can create a relationship with higher cooperation between the contracting parties involved.

According to Kadefors and Badenfeldt (2009) incentives can be split into two different motivation factors. Extrinsic and intrinsic, the extrinsic motivation means financial compensation, externally imposed constraints (deadline) and social rewards. The intrinsic motivation means doing something because it is interesting, enjoyable, meaningful or challenging. Financial compensation is used to improve performance significantly on assignments that are important. A risk by using financial compensation is that the performance may decrease if the contractor only works to earn the monetary reward. The contractors may respond different to an incentive. Either they feel trusted by the client for giving them an opportunity to earn money, or they feel untrusted by the client. Incentives always work better in combination with an intrinsic motivation.

Kadefors and Badenfeldt (2009) states that incentives have three roles in the behavior between organizations:

1. *Incentives as sources of extrinsic motivation* – The power of an incentive to directly influence the motivation of an organization or an individual that is in focus. This is often taken for granted by involved parties. The risks here are that the contractors are rewarded for behavior that not reflects the organizational goals.
2. *Symbolic roles of incentives* – An incentive can have a symbolic role for the cooperation both positive and negative depending on the intention of the incentive. Furthermore incentives can through their symbolic associations legitimize collaboration between the client and the contractor.
3. *Incentives as process generators* – Reward design and performance assessment can lead to processes where involved actors can develop shared knowledge and mutual trust which is good for cooperation. However the resulting communication should not be perceived because it leads to negative process effects.

### **3.5 Partnering and cooperation**

The concept of partnering originated in the USA, to prevent legal disputes between the different actors of a project (Barlow et al., 1997; Broome, 2002). Partnering is a term used to describe the cooperation of the actors within an infrastructure project. The relationship between the actors of a project may vary from sharing common goals to participate in an alliance.

The concept of partnering started to prevent legal disputes. Generally, partnering has not been used as much in Sweden as in Anglo-Saxon countries (Kadefors, 2002). According to Kadefors (2002) this is due to the opinion that Sweden by tradition has a good informal cooperation between clients and contractors. However, in Sweden other benefits like shorter lead-times, lower total cost and a better finished product have been discovered in the concept which has increased the interest and also the use of partnering (Larsson, 1999).

As mentioned in chapter two Dubois and Gadde (2010) states that, in recent years, attempts has been made to implement processes that have been successfully used in other industries to the construction industry. One of the processes is partnership. The increase is made to meet the goals of involved parties, which is both incentives and benefits (Yan and Lu, 2007). For example the Construction Industry Institute concluded that successful restructuring “requires changing traditional relationships to a shared culture without regard to organizational boundaries” (CII, 1991: iv). This culture is an important feature of the types of relationship that is covered by the umbrella called partnering (Dubois and Gadde 2010). Partnering is described as “an increasingly popular management tool aimed at reversing the negative effects of adversarial relationships in construction” (Wilson et al. 1995).

According to Dubois and Gadde (2010) the highest level of partnering is called high-involvement relationship and is based on long-term relationship. To adopt high-involvement relationship in the construction industry is proved to be complicated. The main reason for that is that firms in the construction industry normally strive to avoid dependency on specific business partners. By getting too dependent on one business partner the client can get too

locked in into specific technical solutions. The client wants to encourage competition in order to stimulate supplier performance (Gadde and Snehota, 2000).

Relationships in construction are “typified by market-based, short-term, interactions between independent businesses” (Gann, 1996). Moreover, Thompson et al. (1998), states that economic efficiency in the construction industry is achieved through a competitive tendering procedure, where little attention is paid to relational elements of a business transaction. Bennet and Jaynes (1995) differentiate between specific project partnering and long-term partnering identified as strategic partnering. The strategic partnering is intended to last over several projects unlike the specific project partnering which is intended to last for just one project. In the construction industry it is quite normal that the partnering is focused on the specific project partnering level, due to that this is where the interaction among the actors needs to be most intense (Dubois and Gadde, 2010).

As stated in chapter 3.4.4 Kadefors and Badenfeldt (2009) claim that long-term relationships can be achieved through the application of incentives in order to change motivation, expectation and attitude. Further, Bresnen and Marshall (2002), states that transformation of partnering is assumed to be achieved through the application of techniques, such as routine-based selection procedures, formalized team-building and financial incentives. However several scholars state that strategic partnership cannot evolve in this way. A long-term relationship should evolve through informal and social aspects which overtime evolve to into an atmosphere featured by cooperation. However, in the construction industry this means that it is needed to bypass the traditional tender procedures (Green and McDermott, 1996). Dubois and Gadde (2002) conclude that the loose couplings in the permanent network and the tight couplings in temporary projects in the construction industry is due to the inherent complexity in the construction projects.

Partnering is proven to be successful in several projects regarding controlling costs, technical performance, increasing productivity, reduced costs, reduced project time due to earlier involvement of contractors, improved quality through focus on learning and continuous improvement, improved client satisfaction, enhanced responsiveness to changing conditions, greater stability that helps companies to deploy their resources more effectively and in satisfying customers compared to projects using other methods. (Dubois and Gadde, 2002)

However, Hong and Shaokai (2007) state that partnering is not always proved to be successful. There can for example be a lack of continuous and honest communication, lack of a “win-win” attitude and unwillingness to compromise. These factors can cause ineffective partnering. Furthermore, Dubois and Gadde (2010) state some more drawbacks with partnering. The main problem is the unwillingness of the client to fully commit to the partnering agreement. Further, there is also a problem with the involved actors to develop the attitudes that is required for making the partnering effective. In sum, construction partnering has proven to be successful in many cases but it is also shown to be unsuccessful in certain situations.

As mentioned before in chapter 2.6, Cooperation and Partnering, construction partnering has not always been proven to be successful. Simister and Turner (2001) states that partnering is best suited in projects with high uncertainty of the product and process, due to that the client and contractors are able to share the project risk and uncertainty through cooperation. Furthermore Simister and Turner (2001) state that the uncertainty of a process is related to

restrictions in cost, time, quality and the function of a project. In table 8 the advantages and disadvantages are summarized.

*Table 8 Advantages and disadvantages with cooperation/partnering*

Advantages	Disadvantages
Easier to control costs	Lack of continuous and honest communication between actors
Better technical performance	Lack of a “win-win” attitude
Increased productivity	Actors unwillingness to compromise
Reduced costs for the involved actors	Unwillingness of the client to fully commit to the partnering agreement
Reduced project time due to earlier involvement of contractors	Problem with the involved actors to develop the attitudes that is required for making the partnering effective.
Improved quality through focus on learning and continuous improvement	
Improved client satisfaction	
Enhanced responsiveness to changing conditions	
Greater stability that helps companies to deploy their resources more effectively	
Satisfying customers compared to projects using other methods	

### **3.6 Factors influencing the selection of project contract**

As mentioned before the choice of appropriate project delivery method and payment principle for a contract is no simple matter. Dada (2012) states that there is no project delivery method that suits in all situations; there is no “cure-all” method. The same argumentation is found in several research studies (Pakkala, 2007; Caltrans, 2008,), there is no project delivery method that is the optimal solution for all projects. The choice of project delivery method is dependent on the unique requirements of a given project (Pakkala, 2007; Caltrans, 2008; Chan et al., 2008).

As mentioned before the situation for the payment principles is similar. However, according to Simister and Turner (2001) conventional wisdom is that fixed price and unit price are preferable at projects with lower uncertainties. As uncertainties increases, the most preferable payment principle tends to be cost-plus (Simister and Turner, 2001). Hence, the choice of payment principle is also dependent of the unique requirements of a given project.

There are several studies that state different factors influencing the choice of project contract (see e.g. Khalil 2001, Sayegh, 2007). Some of the most important factors for our study will be presented further. According to Khalil (2001) there are several different factors influencing the choice of project contract. Khalil (2001) group the factors into three different categories: project characteristics, client's need and client's preferences. Every category has several sub-functions which will be explained further. The project characteristics include the clarity of scope, if the scope is well-defined it is possible to use the DB project delivery method, if the definition is evolving the DBB method is preferred. It also includes time-schedule. If the time is crucial the DB project delivery method should be chosen before the DBB project delivery

method. Furthermore, the complexity is included in the project characteristics. This means that if the project is a standard, repetitive design or a unique and complex design is a factor that determines the selection of project contract. If the design is complex the DBB projects delivery method is preferred and in a standard design the DB project delivery method is preferred.

The next category is client's need, the client's need may vary from project to project and the different project contracts can meet those requirements in different ways. The last category is client's preferences. The client's preferences include which of the actors who have the responsibility. Some clients prefer the DB project delivery method where they get single point responsibility for both design and construction errors. Some clients prefer the DBB project delivery method instead. It also includes which actor who has the control of the design. Depending on how much control the client wants of the design different contract types can be used. For more control DBB project delivery method should be used and if the client wants to push design control to the contractor DB project delivery method should be used. Further, it includes the client's involvement after award of the contract. The client must determine how much involvement they want to have after the award of the contract. Some clients have high expertise in-house and want to involve it in the project and some clients may not have the expertise, hence they will give the responsibility to the contractor.

Sayegh (2007) has listed several important factors based on interviews with clients involved in public procurements. The fifteen most important factors are quality, single control, level of control, early estimates, within budget, importance, on schedule, single construction control, risk, ensure lowest cost, adversarial relationships, ensure shortest times, professional input and complexity. The most important factor is to ensure the quality, the single point of control is on the second place, that means that the client prefers the project delivery method that reduce the

Furthermore Simister and Turner (2001) also identified four important factors for decision of project contracts. The authors studied three large infrastructure projects in northern Europe. One of the projects had been divided into twelve subprojects. Each of the subprojects had used different project delivery methods and payment principles. From the choices made, Simister and Turner (2001) identified four different factors influencing the selection of project delivery method and payment principle. The four different factors are; Complexity of the project, where the complexity is related to the uncertainties of the process. The second factor is the Uncertainties of the product (what will be delivered). When the uncertainties of the product are low, the product is clearly understood and the contractor takes responsibility for determining the best method of delivering it. The higher the uncertainties of the product are, the more effort is needed to specify the product in the tender documentation and the number of processing variations will increase. The third factor is the uncertainties of the process. When the uncertainties of the process are low, the process of the delivery is clearly understood and the contractor takes responsibility for determining the best method of delivering it. The higher the uncertainties of the process are, the harder it is to determine how the product should be delivered. Therefore it is hard to determine a final detail design early in the project. Uncertainty of a process is related to restrictions in cost, time, quality and the function of a project. The last factor is the ability of the client to contribute to the resolution of problems. The ability of the client to contribute is the deciding factor for when the client can contribute to the project in a partnering. If the client cannot contribute to the partnering they

are just in the way. According to Turner and Simister (2001) these factors can be related in different ways. Depending on how they are related different project contracts should be used. Below are the factors mentioned summarized in table 9.

*Table 9 Factors influencing the choice of project contract*

<b>Factors influencing the choice of project contract</b>		
The project characteristics	Importance	Complexity of the project
Client's need	On schedule	Uncertainties of the product
The client's preferences	Single construction control	Uncertainties of the process
Quality	Risk	Ability of the client to contribute to the resolution of problems
Single control	Ensure lowest cost	
Level of control	Adversarial relationships	
Early estimates	Ensure shortest times	
Within budget	Professional input	

The theoretical framework has been structured from the project contract model that has been presented in chapter 2. To be able to know how to use it the characteristics of the different paragraphs will be combined with the factors influencing the choice of project contract. In order to find out what the Swedish infrastructure sector's opinion about the different parts of the project contract and what factors that is important in Sweden the following chapter 5 will present empirical data from interviews made with actors involved in the Swedish infrastructure sector. To be able to combine chapter 3 with chapter 5 a methodology chapter is presented.

# 4 Methodology

*This chapter will describe the research method which has been used in the thesis. The chapter will explain how the research has been approached, how the interviews have been performed and how the data has been collected.*

The both authors of this thesis attended in August 2011 the master's program Supply Chain Management. The master's program is completed through this thesis.

The Supply Chain Management master's program has provided the authors with a general perspective on purchasing and supply chain management. The foundation of the thesis is laid by the master's program and, further, literature studies have brought the authors with a more specific focus and also helped to identify the research area.

## 4.1 Qualitative research method

To answer the investigation and research questions and to fulfill the purpose of the thesis a qualitative research method was used. Qualitative research is a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data (Bryman and Bell, 2003). Further, qualitative research aims to observe social phenomena from the respondents' viewpoint (Jha, 2008). Furthermore, Bryman and Bell (2003), states that qualitative research is common at market analysis. In this thesis we study the actors' different opinions regarding the containing parts of the project contract, which makes the qualitative research method suitable.

A qualitative research study can be criticized for being too impressionistic and subjective. The criticisms usually mean that qualitative findings rely too much on the researcher's views about what is significant and important and, further, due to the frequently strikes up between the researcher and the people studied (Bryman and Bell, 2003). Further, Bryman and Bell (2003) mentions that qualitative research is also sometimes criticized for lack of transparency. I.e. because, from qualitative research it is sometimes difficult to establish what the researcher actually did and how the researcher reached the conclusions of the study. However, when a deeper understanding for a subject is desired the qualitative research study is suitable (Bryman and Bell, 2003). That is also why it is used in this thesis.

According to Bryman and Bell (2003) the qualitative research consists of five different main methods;

- Participant observation
- Qualitative interviewing.
- Focus groups
- Language-based approaches to the collection of qualitative data, such as discourse and conversation analysis.
- The collection and qualitative analysis of texts and documents.

In this thesis we use, as mentioned above, the qualitative research method. As mentioned above, a deeper understanding was desired. Because of that the data is collected mainly by interviews and therefore a qualitative interviewing is used. According to Bryman and Bell

(2003) the qualitative interviewing is a very broad term, which describes a wide range of interviewing styles.

In this thesis the semi-structured interview has been used, which will be further explained in the section about data collection.

## **4.2 Literature review**

In order to gather relevant knowledge, an extensive literature review has been conducted. To gain a brief understanding of the subject, the literature review began with articles and newspapers about large rail infrastructure projects and, also, articles about purchasing activities for contracting authorities. In the beginning of the process the main purpose of the literature review was to get a deeper understanding and a knowledge base of the area of subject. The literature review then shifted focus to gather relevant theory to create a theoretical framework that was used to support the analysis. According to Eriksson and Wiedersheim-Paul (2008) the collected information should be based on quality, availability and cost. The main concern is the quality of the information. However, availability and cost may also be central matters in the research (Eriksson and Wiedersheim-Paul, 2008). The information has been collected from prominent scientific journals through search engines such as Google Scholar and the Chalmers Library's Summon. So, the information collected is of good quality.

Key words were identified and searched for within, for example, the areas of public procurement, uncertainties and risks of infrastructure projects and capital investments in infrastructure. All the literature has been critically reviewed throughout the research process.

## **4.3 Research process**

Bryman and Bell (2003) have suggested a number of sequential steps for the qualitative research process, which provide researchers with a structured way of working. Below, in figure 11, the main steps of the qualitative research process by Bryman and Bell (2003) is presented.

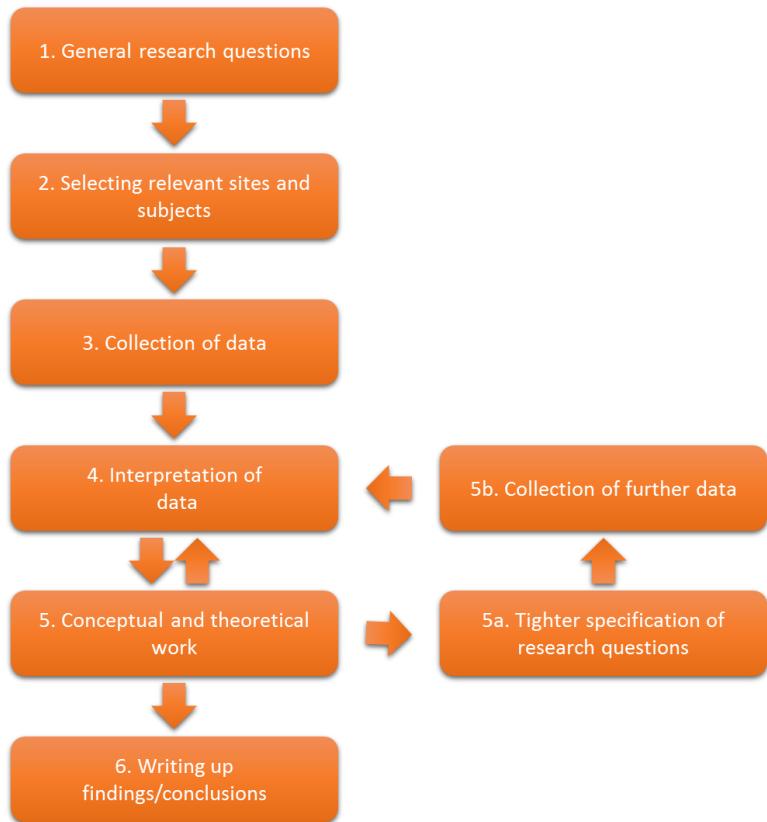


Figure 11, the qualitative research process (Bryman and Bell, 2003)

During the work of this thesis the main steps of Bryman and Bell (2003) have been followed. In the beginning the research question was defined in broad terms and a template for the interviews was created. As mentioned above, the problem definition was not clear from the beginning. So, the work started with general interviews with different individuals to gather information about the problems connected to the procurement process. Further, to gain understanding and knowledge general articles about infrastructure project and public procurement were gathered.

The following phase, which was to select sites and subject was also carried out early. For the data collection large rail infrastructure projects were selected. The projects were executed in recent time within Sweden. Respondents were relevant individuals from both the contractors as well as the client organization STA.

The collection of data was an ongoing process. The more insight and knowledge gathered, the more the aim of the thesis was sharpened. This brought the need of complementary interviews to be held. Further, this is also true for the gathering of theory. During the process theory was added, but also revised and removed depending on the relevance for the thesis.

Finally, the data collected was analyzed and from the findings the conclusions were drawn.

## 4.4 Data collection

The method used for data collection and data analysis is one of the most central and important phases during a research study. Further, for a research study to be scientific, the collection of data needs to be clearly and systematically described (Eriksson and Wiedersheim-Paul, 2008).

The data collected is primary data. Primary data is data collected for the very purpose of a research study, through interviews, observations and similar (Eriksson and Wiedersheim-Paul, 2008). In this thesis the primary data is collected through interviews.

The interview style used is the semi-structured interview. The semi-structured interview typically refers to a context which the interviewer has a series of questions that are in the general form of an interview guide but is able to vary the sequence of the questions. Further, the interviewer most often has some opportunities to ask supplementary questions in response to what are seen as significant replies (Bryman and Bell, 2003). Hence, the formality is lower and the degree of freedom for the interviewer is higher compared to the structured interview. Furthermore, according to Bryman and Bell (2003), the flexibility of the qualitative semi-structured interview enables the researcher to adjust the emphasis in the research as a result of significant issues that emerge during the interviews. It is also common that in qualitative interviews, the interviewees are interviewed more than once.

This thesis has, as mentioned above, used the qualitative semi-structured interview as research method. The semi-structured interview was chosen because it gives the respondents the opportunity to speak more freely and to develop their answers (Bryman and Bell, 2003). The respondents are personnel from both the actors. The respondents consist of five clients and five contractors. All of the respondents have great experience from large infrastructure projects. Below, in the table 10, the division of the interviewees is presented.

*Table 10, the amount, wide and depth of the interviews*

Interviewee	Total respondents	Respondents General background	Respondents Deeper interviews	Respondents Project specific
Client	5	5	4	3
Contractor	5	5	5	3

All the interviewees, regardless if client or contractor has been asked general questions regarding the background of project contracts in large rail infrastructure projects. Further, more into depth interviews have been conducted with four of the clients and all five of the contractors. Furthermore, three of the clients and three of the contractors have been asked project specific questions. For three different projects, the involved clients and contractors have been asked project specific questions. This can be seen as case studies. According to Yin (2003) the qualitative semi-structured interview suits well also in case studies.

All the interviewees from the client side were at the time of the interviews employed by the STA. The interviewees from the contractor side were, with one exception, at the time of the interviews employed by large, internationally active, construction firms. The exception of the contractors was from a large, but not internationally active construction firm. Further, four of the contractors were active in the construction of infrastructure industry and one in the industry of electric and information system for infrastructure. All the interviewees, regardless of side, have great experience of Design-Bid-Build (DBB) and Design-Build (DB) project delivery methods.

All interviews were recorded and both the authors attended. To tape-record and then transcript the interviews is important for qualitative researchers, for the detailed analysis required in qualitative research and to ensure that the respondents' answers are captured in their own terms (Bryman and Bell, 2003). Further, Bryman and Bell (2003) argues, if only notes are

used, it is easy to lose the phrases and language used. Furthermore, the tape-recording enables the researcher to be responsive to the interviewee's answers, and to easily follow up the answers. Each interview was approximately two hours, except the interview with the client who only responded regarding general background. The interviews were held at the interviewees' offices. The guidelines for the interviews are found in the appendices. The guidelines were used in order to ensure that the collected information from the interviews was consistent.

## 4.5 Trustworthiness

According to Bryman and Bell (2011) trustworthiness is an alternative to reliability and validity when assessing the quality of a qualitative research study. The trustworthiness is made up of four criteria:

- credibility
- transferability
- dependability
- confirmability

The credibility of a research refers to if the readers should accept the study's result. According to Bryman and Bell (2011) the establishment of credibility of findings requires both ensuring that research is carried out according to good practice and submitting findings to the members of the social world who were studied. The latter is because the investigators need a confirmation that they have understood that social world. For this thesis, several interviews were conducted, with equal number of respondents from both sides, in hopes of finding commonality in the answers. Further, at all interviews both authors have been present. Furthermore, all interviews have been recorded. So, when the both authors have made different interpretations there has been a thorough discussion about the different views. If the uncertainty has been too high, the respondents have been re-interviewed.

According to Bryman and Bell (2003) another issue is the defensiveness from the respondent that can occur. To avoid defensive behavior and withdrawal of statements the names of the interviewees are not mentioned in the thesis. Only the number of the interviewees from each actor is mentioned.

The transferability of a study refers to if the findings of the study can be transferred into other studies. Qualitative research most often involves an intensive study of a small group, or of individuals sharing certain characteristics. Because of this, the characteristics of qualitative findings tends to be focused on contextual uniqueness and significance of the aspect of the social world being studied (Bryman and Bell, 2003; Bryman and Bell, 2011). In this thesis the theoretical and empirical findings should be the same if collected at another time. However, the contextual fact that STA is under the act of public procurement may complicate the transferability.

The dependability refers to the external review of the work. According to Bryman and Bell (2011) the researcher should adopt an auditing approach. This implies ensuring that complete records are kept of all phases of the research process – in an accessible manner. In this thesis, all empirical data have been recorded and saved. Further, the supervisors at STA and Chalmers have been frequently consulted for advice. Furthermore, the input from the

supervisors has also guaranteed us that the proceedings were done in a proper manner. This ensures a good dependability for the results.

Confirmability is concerned with ensuring that the researcher can be shown to have acted in good faith. It should be obvious that the researcher has not allowed personal values or theoretical approaches influence the conduct of the research and findings deriving from it (Bryman and Bell, 2011). In a research values should have no influence on the outcome. However, it is almost impossible for a research study to be fully objective. As mentioned above, the researchers of this thesis were open to advice and steering from the supervisors. However, the authors made great efforts to stay independent. The outcome of the research was the authors' outcome and also the authors' responsibility alone.

# 5 Empirical findings

*In this chapter the findings from the respondent personnel from the client, Swedish Transport Administration (STA), and the contractors are presented. The chapter begins with the procurement procedure and project delivery methods. It continues with the payment principles and incentives. The chapter ends with a section about the both actors view regarding cooperation and risks and uncertainties.*

## 5.1 General information about STA

The turnover for STA was approximately 29 billion SEK in 2012 and STA had around 6900 employees in 2012. STA is divided into central functions and operational divisions. The central functions are: purchasing and logistics, strategic development, finance and controlling, personnel, legal affairs and plan review, communication and information handling and IT. The operational divisions are: society, traffic management, maintenance, investment and large projects. The organizational chart for STA is shown in figure 12. This thesis is carried out within the central function of purchasing and logistics and the operational division large project, which together are responsible for the procurement of large and complex projects (Trafikverket, 2013).

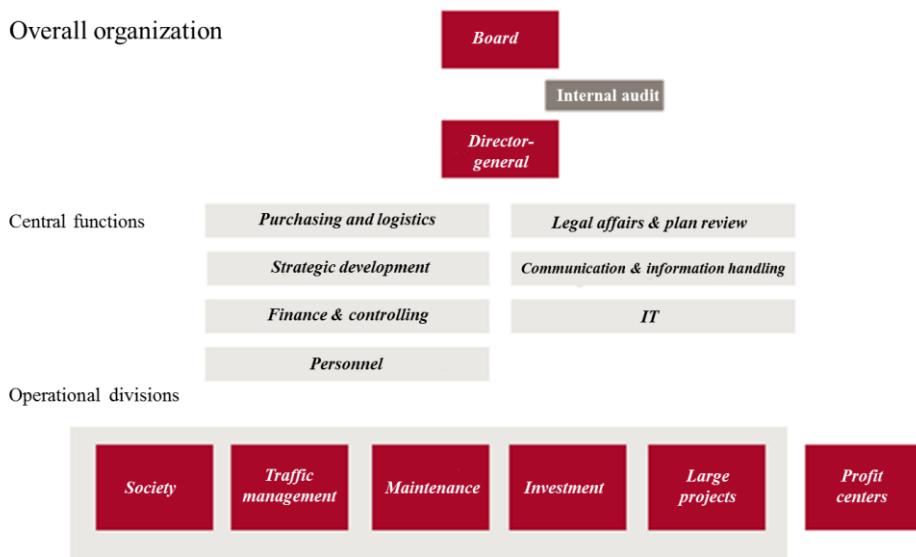


Figure 12 Organizational chart of Swedish Transport Administration (Annual report, 2013)

## 5.1 Procurement procedure

As mentioned in chapter two, the STA always uses the negotiated procedure when the calculated cost for a project is above the threshold value. Both the clients and contractors stated that the negotiated procedure is a quite well-functioning procedure. Using the

negotiated procedure, the STA has two options regarding the evaluation of the tender. The award decision of the tenders is based either on the lowest price or the economic most advantageous tender. STA has an aim of selecting 20 percent of the tenders as lowest price.

According to the interviewees the lowest price suits well when complexity, risk and uncertainty are low. One stated “*maybe a bit exaggerated, but there is no need of finding other factors to evaluate when no other factors exist. At small projects with little risk there is no point of using other factors besides the lowest price*”. This view was expressed similar by almost all respondent actors.

For larger projects subject to higher complexity and risk the STA most often uses the most economic advantageous tender. The potential contractors are pre-qualified through a data-base and selected from certain factors that ensures that the invited contractors are capable of manage the given project. The potential contractors are then evaluated through different factors during the negotiating procedure. The approach are quite similar regardless of project delivery method, the same factors can be used when evaluating the tenderers. However, when the DB project delivery method is used there are different project solutions to evaluate, which is not the case when the DBB project delivery method is used. Further, the contractors argued, although the economic most advantageous tender are awarded, the price is always an important and present factor when the STA evaluates the tenders.

The negotiated procedure is restricted by LUF. Both the clients and contractors stated that the use of LUF enables the client to base the award decision on fair and transparent factors. However, two of the contractors argued that LUF can be used in a more flexible way. One of the interviewees said “*The procurement procedure is restricted by LUF, no doubt about that, but LUF is a flexible framework and can also be used in a much more flexible way. The STA is sometimes just using the LUF as an excuse for using a narrow framework*”. Further, the contractors argued that there are regional differences at STA regarding how flexible they are in the approach towards the LUF.

## 5.2 Project delivery methods

The respondent clients and contractors have experience from working with both the Design-Bid-Build (DBB) and Design-Build (DB) project delivery methods. The actors from both sides argued that one project delivery method is not better than another, the preferred project delivery method depends on the context of the given project. There is consensus among the actors that the choice of method should be based on the environment of the project. According to the respondents the choice of project delivery methods depends on a variety of different factors. The most important, mentioned by all actors, are the complexity of the project and the level of risks and uncertainties. Also the size and possibility of alternative solutions are mentioned as important factors.

The interviewed client was more familiar with the use of DBB project delivery method and some of the interviewed purchasers thought that the petition to increase the use of DB project delivery method would be changed to a lower number in the future. All the interviewed contractors thought that DB project delivery method was the future of public procurement.

### 5.2.1 DBB project delivery method

The DBB project delivery method is, according to the interviewees at STA, suitable when a project has low complexity and the possibility of other, alternative solutions is low. Further, at

a small non-complex project the planning and pre-design often, almost, reach the level of detail design and, by that, the contractor has few options to be innovative. This view is also shared among all the contractors.

The respondent from the client side also stated the DBB project delivery method is suitable when the complexity and risks are high. The reason mentioned is that the client do not want to push too much risk and uncertainty to the contractor. One of the interviewees argued “*too much risks and complexity just makes the project uncertain and vulnerable, which would create a lot of Correctional and Additional Works (CAWs) and in worst case legal disputes – if we are not in charge*”. The clients and contractors also argued that a project in an urban area with high complexity and risk, with a lot of disturbance and other factors affecting the environment, is better performed with the DBB project delivery method. However, the one of the respondent argued “*the DBB project delivery method is the traditional method, which may be used of old habits. The DB project delivery method could probably be used in the same environment but we are used to go with the DBB project delivery method*”. Furthermore, the contractors argues that it is not the project delivery method who is the number one success factor at projects with high complexity, risks and uncertainties. According to the respondent contractors, it is rather the cooperation between the actors during the project of high complexity and risk that determines if a project delivery method is considered successful, not the project delivery method itself.

The tender document at a project subject to the DBB project delivery method contains the detail design. This implies that the contractors’ need of time to submit the tender are less compared to the DB project delivery method. Hence, the administrative costs, at least at the tendering phase, are lower for the contractors during the DBB project delivery method.

All the contractors argued that the DBB project delivery method inhibit the opportunity for the contractors to be innovative and limited their degree of freedom, because the project’s detail design is already decided in the tender document. To not be able to influence the detail design is seen as a big disadvantage of the DBB project delivery method from the contractors’ point of view. One of the contractors also stated that “*I rather take the responsibility for the detail design if it gives me the opportunity to influence it*”. However, the contractors stated that when the detail design is controlled by the client, the contractor can relax and just follow the detail design, because if there is something wrong with the detail design it is the client’s responsibility. All changes from the original detail design will create correctional and additional works, which will be the client’s financial responsibility. Therefore, it is of great importance for the client that the detail design in a DBB project delivery method is comprehensive enough when a project is subject to high complexity and risk.

The DBB project delivery method, according to the clients, generates a high degree of control. To be responsible and to do the detail design in-house together with the consultants makes it possible to specify the exact requirements for the project, i.e. into a very detailed level. This brings the advantage that, when doing the detail design, technical specifications regarding function as well as life cycle cost can be considered. However, two of the respondents argued that there is a risk that the detail design is exaggerated when it is performed in-house. The two respondents from the client side further argued that the contractors have greater experience of similar projects and knows the needed level of detail design better.

Furthermore, DBB demands an organization with high competencies regarding detailed technical specifications. This is mentioned, by the clients, both as an advantage and a disadvantage of the DBB project delivery method. It is an advantage in respect of the broad range of expertise available in-house. However, two respondent argued, the DBB project delivery method demands a large client organization without any possibility to downsize the organization.

In table 11 the advantages and disadvantages with DBB project delivery method based on the interviews with the actors are summarized.

*Table 11 Advantages and disadvantages with DBB project delivery method*

Advantages	Disadvantages
Familiar and established way	Limited opportunity for innovation
Low tendering cost, due to complete detail design	Limited degree of freedom
Technical specification regarding functions are easy to define	Risk of being used due to old habits
Possibility to control the life cycle cost	Risk for over-specification of detail design
Broad range of expertise in the client organization	In need of a large client organization

### **5.2.2 DB project delivery method**

The STA has an aim of executing 50 percent of the project using the DB project delivery method. According to both the clients and contractors the aim is, without any doubt, reachable. However, there were some of the interviewees that argued that such an aim is not relevant. Because, the respondents argued, the project delivery method should be chosen depending on the project's environment and not on a need of reaching a target.

According to both the clients and contractors the DB project delivery method has great potential used in the right context. There is, however, not a completely unified view regarding the advantages of the DB project delivery method.

Firstly, the most important aspect, mentioned by all the interviewed clients and contractors, is the potential gain of innovative solutions. At projects with an easy defined result, but with several options to deliver the result, the DB project delivery method is believed, among all the actors, to be the most preferable. Because, the respondent clients argued, the contracting authority gets easy access to the market expertise, and innovative solutions provided by the contractors. The DB project delivery method let the contractors, the market actors, to compete in innovation capability and competitiveness. The DB project delivery method is popular among all respondents, but it is more popular in the perspective of the contractors'.

In the DB project delivery method, the contractor is responsible for the detail design. The respondent contractors argue that by making the detail design by themselves, the degree of freedom increases. As the degree of freedom increases, so do the possibilities to find innovative solutions and, further, the opportunities for the contractors to use the creativity and competency within the own company. One of the contractors emphasized that: "*in order to increase the interest in the construction industry and to be able to be an interesting employer, the change towards DB project delivery method is crucial*".

Since the contractors are responsible for the detail design in DB, the contractors time to tender are longer compared to the DBB project delivery method. Further, all contractors carries out a detail design and the detail design will be more detailed the more complex a project is. This is a problem according to the contractors. Because, the more detailed the detail design needs to be, the higher the cost for the detail design for the contractor is. Although STA pays all contractors an amount to cover a part of the detail design, the amount is not as high as the actual cost for the detail design, according to the contractors. However, the contractors appreciate the gesture from STA. One further problem, mentioned by one international contractor, is that the tender document is written in Swedish. The international contractor has a detail design department but they need to translate the documents into English, which demands valuable time from the tender time.

The DB project delivery method is most preferred when the function is easy to define, but the execution of the project can be performed in several different ways; i.e. when the degree of freedom for the contractor is high. An example mentioned by several of the respondents is a bridge. The function is easy to define and there are several different processes to reach the final product. However, there is a risk that a project solution meets the requirement regarding the function but not the subjective requirements of the clients, according to one respondent client. The contractors, in its turn, argue that it is important that the requirements' regarding the function does not turn into technical specifications. Several of the respondent contractors stated that this is a common situation. The STA tends to, according to the contractors, move towards technical specifications and requirements instead of just the functional requirements. This decreases the degree of freedom for the contractors and, hence, the opportunities to be creative and to find innovative solutions. Further, two of the contractors stated that STA, when using the DB project delivery method tends to set unreasonable functional requirements. One of the contractors said "*the STA have a lot of skilled technical specialists, who are used to be in control. When there is a shift towards the DB project delivery method the STA have problem to let go of this control. Often the STA instead set unreasonable functional requirements that are not measurable and, for us impossible to estimate the cost for. They simply don't know what functional requirements to set. By this the STA increases the risks and the uncertainties for us in the projects. This sometimes results in that we refuse to participate as a tender.*"

The projects needs to be of considerable size to enjoy the benefits from the DB project delivery method. This is most emphasized by the contractors, who argued that if the project size is too small, the degree of freedom is decreased and, hence, no of the benefits from the DB project delivery method will be delivered. The client also states that projects must be of a considerable size. However, the clients argue that if the projects are too large the competition decreases. Because, if the projects are too large the potential contractors are reduced to just a few, no smaller contractors could carry the risk of such large projects. Further, the projects should be calculable, i.e. the actual cost of the projects should be easy to estimate.

The DB project delivery method needs one less procurement activity, because the contractor is responsible for the detail design and, hence, no procurement of the consultants needs to be executed by the client. This is time saving for the client. It is also argued, by both clients and contractors, that the contractors are more experienced regarding the detail design, i.e. the contractors knows the amount of detail design needed for a particular project.

While using DB, the responsibility is shifted from the client towards the contractor and, hence, the responsibility of the quality is the contractor's. The client states requirements regarding functions in the tender document but it is hard to control if the used technical solutions are the best in the long-term. Hence, there is a risk of high life cycle cost. One of the respondent clients also argued "*what you inspect is what you get*", and inspections are more difficult to do when the DB project delivery method is used compared with the traditional DBB project delivery method.

The increased use of DB project delivery method provides an opportunity to downsize the client organization. If this is an opportunity or risk are the respondent clients not unanimous about. One stated "*the organization can be downsized and, hence, more efficient. The knowledge within the organization needs to be transferred from technical specialists to functional specialists, which in the transition will be a problem but not in long-term*". However, another respondent argued "*by transferring to use only DB project delivery methods we risk to lose the competencies within the organization and, in the long-term, we have to ask ourselves what kind of organization we want to be. Should it, in the extreme case, just be a director-general procuring mega-project from the contractors*"?

In table 12 the advantages and disadvantages with DB project delivery method, where both actors have the same thoughts are summarized.

*Table 12 Advantages and disadvantages with DB project delivery method*

Advantages	Disadvantages
Foster innovation ability of the contractor	Costly to tender
Foster creativity ability of the contractor	Risk of unreasonable functional requirements
Make use of the competence of the contractor	Risk of high life-cycle cost
Increases interest in the infrastructure sector	

## 5.3 Payment principles

According to all interviewed actors, the choice of payment principle, as the choice of project delivery method, depends on the project's environment; i.e. the complexity and size of the project and the risks and uncertainties, but also on the selected project delivery method. The payment principle should be used to reduce risks and facilitate the work during the project. The respondent client and contractors agree that the most common payment principles in large infrastructure projects are the fixed price payment principle and the target cost payment principle. The more risks and uncertainties there are in a project, the harder it is to use the fixed price payment principle. Instead of fixed price payment principle the interviewed actors recommended the use of the target cost payment principle. Cost-plus without incentives are rarely used in large infrastructure projects, due to that it is difficult to control the costs of the project.

### 5.3.1 Fixed Price

According to the respondent procurers at the contracting authority STA and the respondent contractors, *fixed price* is the payment principle that is, most often used together with the DB project delivery method. It has proven to function well together with DB, according to the respondent. This is mainly because the DB project delivery method has been used at easy

calculable projects, where the cost is quite easy to estimate for the client. The fixed price in the tender of the contractor is then easy to compare with the calculated cost of the project. Combining the DB project delivery method with the fixed price payment principle pushes the responsibility to the contractors.

One of the contractors gave a typical example where fixed price payment principle is used in combination with DB delivery method; “*A bridge, where it is easy to estimate the costs for the client and where he is interested of saving money on different solutions. The project delivery method should be DB in combination with fixed price payment principle.*” According to the contractors the functional requirements for a bridge are easy to define, therefore, the detail design is easy to set. The contractors believe that they can improve the solution with new innovative alternatives. The alternative solution will save money for the involved actors and will have a better technical solution. The contractors think that even if a bridge is a complex construction the easy defined functional requirements reduce the risks hence, fixed price is manageable.

According to the respondents, fixed price should not be used when projects are exposed to high risks and high uncertainties of the process. Because, using fixed price payment principle in this type of environment will only result in high risk premiums. If the project is exposed to excessively high risks, they will either give an excessively high bid or choose to not bid at all. If the fixed price payment principle in the tender is set too low. It will result in that the contractor will try to find correctional and additional work in order to improve their profit. The respondent client believes that the contractor try to find as many correctional and additional work as possible.

The contractors state that by using fixed price they have an opportunity to earn more money. However, the risks will increase in comparison to target cost, where the risks decrease and the surplus decrease. Using fixed price also leads to a greater chance to lose money, compared to the target cost payment principle. If the expenditures exceed the contract amount, the contractor must bear the cost overrun in a fixed price payment principle. In a target cost payment principle the sharing-ratio reduces the cost overrun.

Fixed price payment principle has lower bureaucracy because the contractors only have to account for one post. The interviewed contractors stated that they prefer the fixed price payment principle in order to avoid the bureaucracy. One contractor even said “*too much bureaucracy will make the contractors annoyed and instead of getting an increased cooperation, the two actors will start to work against each other, instead of striving towards the same goals*”.

In table 13 the advantages and disadvantages of fixed price payment principle, where both actors have the same opinion are summarized.

*Table 13 Advantages and disadvantages of fixed price is summarized.*

<b>Advantages</b>	<b>Disadvantages</b>
Efficient in project with well-defined functional requirements	Risk of high risk-premiums
Decreased bureaucracy	High risk-premium
One single cost for the project	Risk of increased correctional and additional

### 5.3.2 Variable Price

In a variable price payment principle the contractor have to account for all posts in the project. The variable price payment principle is used in situations where complexity, uncertainties and risks are high. As mentioned above in the fixed price section, according to the respondents, this is mainly because a fixed price would result in high risk premiums in the tenders from the contractors.

The use of cost-plus payment principle together with the DB project delivery method is unusual. None of the respondent had an example of a DB project delivery method combined with a cost-plus payment principle. The cost-plus payment principle together with the DB project delivery method would not present any incitements for savings for the contractors, and according to the interviewees, the client loses the control of the actual cost. Hence, it is more common to combine the DBB project delivery method with the cost-plus payment principle. According to the interviewed contractors' cost-plus without any incentives are rarely used in a large infrastructure project due to loss in efficiency and control of the costs for the involved actors. The only cases the respondent had experience of the use of variable cost payment without an economic incentive is in non-complex, small projects where the cost for the project is easy to estimate. It could also be used as a supplement for a bigger infrastructure project such as a bridge. In this case the road over the bridge is paid according to variable price payment principle.

The *target cost* payment principle is an attempt to combine the cost-plus payment principle with fixed cost payment principle in order to reduce risks for the contractor. According to the respondent procurers at STA it is an efficient way to get strong driving forces of the construction work. The interviewed contractors stated that target cost is used to reduce risks and promote cooperation. Target cost payment principle promotes cooperation because the economical posts are shared between the actors. Open books is often used for easier control of the economical posts, however, the use of open books is not mandatory.

The interviewed clients and contractors have little experience of target cost. However, they had one example where target cost is used in a current infrastructure project in Sweden. The target cost payment principal is being used in combination with DBB project delivery method. The project is a part of a tunnel project in Stockholm where STA and one of the interviewed contractors are using a project specific company. The project specific company is made to facilitate the cooperation for the three actors, the client, contractor and the consultant. The project is using target cost due to the reason that the project need to be flexible to changes and because the risks are high. To be able to handle the changes the three actors sit down together and plan the detail design. The interviewed contractors think that it would be possible to use DB project delivery method in this type of project as well. The contractors thought that the project would even work better since it will be easier to control the target cost payment principle.

The interviewed contractors state that it is important that there are rules for the handling of payments in the target cost contract. The rules should regard payments for all the posts. What costs that should be included in the fixed administration cost and what costs that should be paid according to the cost-plus payment principle. The rules will help to reduce the risks for unnecessary discussions that often occur during a variable price payment principle.

The actors have different opinions of when the target cost should be changed. The client wants to change the target cost as little as possible in order to keep the incentive intact. The contractor think that the target cost should be changed in order for the risk sharing to work as intended. The contractors also think that STA should establish rules for the adjustment of the target cost. The rules are needed to avoid unnecessary discussion about when and how much the target cost should change. One contractor stated: "*There is a difference between if the client adds one more bridge to the project or if he add one more screw to the project. To avoid unnecessary discussions about every change that occur during the project, it is important to set the rules for the change of the target cost.*"

The target cost is set by the client or the contractor. If it is the client who determines the target cost, the contractor is selected by other factors than the price. If it is the contractor who in the tender competes with the target cost, the price is one, but not the only, important factor. According to the interviewees, both clients and contractors, it is important that the target cost is not set too low, because, if the target cost is set too low there is no chance or small chances to reach it. Also, the contractors will lose the economic incentive that is one of the cornerstones in the target cost payment principle. The target cost can be set based on the calculated cost. The calculated cost can be estimated through the bill of quantities. The bill of quantities then proves as a basis from which the contractors can find their own target cost and use in the tender. The contractors prefer that the target cost is set by the client based on suggestions from the contractor.

One of the contractors had experience from a project where all contenders suggested a target cost based on the detail design. The client then set the target cost based on a weighted value that was based on the contenders suggested target prices. To win the project the contender who had the lowest fixed administration cost won. The opinion from the contractor was that; "*the contenders who had defined a higher target cost had to move their difference in their target cost to the administration cost, in order to reach the final target cost. This led to that they had less chance to win the bid. The contractor thought that this was unfair because the reason for a higher target cost could for instance be, that the contractor had planned to spend three more months at the site and now had to cut down it with three months. In order to lower their administration costs*"

The target cost payment principle has a sharing ratio. The sharing ratio decides how profit and loss should be shared. To set the sharing ration is difficult, but the respondents, both clients and contractors, agree that the sharing ratio for the contractor has to be quite high for the profit, and lower for the losses. According to the contractors, the sharing-ratio has mostly been 50/50 for both surpluses and loses. Except one of the contractors who had experienced another sharing ratio where they did not get any money back if they came over the target cost and 50/50 if they came under, however, they got covered for the fixed administration cost. In excess of the individual target cost they also had a shared incentive for the entire project. However, the contractor thought that the sum was so low that the incentive was pointless. The compiled view from the actors where that the distribution of the sharing-ratio was not that important as long as it was fair for the project

The respondent contractors think that the risk sharing in a target cost payment principle has a great advantage compared to fixed cost. By sharing the losses the economic risk in the project is reduced, however, one of the respondent contractors though that the target cost where not

better than the fixed price because they had to share the surplus with the client. He stated: “*I think it is being falsely called an incentive because, I do not really think that it is an incentive when we have to share the bonus with the client.*”

Another contractor thought that the contractor should be chosen earlier in the project based on factors that were important for the project. When the client has chosen his contractor, they should together define a preliminary target cost that is within the budgetary limits. When the detail design is done the client and the contractor should define a new adjusted final target cost that is based on the detail design.

In table 14 below the advantages and disadvantages of variable price, where both actors have the same opinion are summarized.

*Table 14 Advantages and disadvantages of variable price*

Advantages	Disadvantages
Allocate the risks between the actors (target cost)	Increased discussions about payment and posts
Promote increased cooperation	Client lose control of the actual cost (cost-plus)
Easier to handle complex, risky and uncertain environment (target cost)	Loss in efficiency (cost-plus)
Flexible to changes	
Efficient way to get strong driving force (target cost)	

## 5.4 Incentives, bonuses and penalties

Historically STA has been using penalties instead of incentives. However, lately there has been a shift towards a use of incentives instead. The incentives aim to promote cooperation, teamwork and to get the actors to strive against the same goals. The interviewed contractors state that the incentives motivate them to put an extra effort on crucial parts of the project. The contractors like incentives, an incentive gives them opportunities to earn extra money, therefore the contractor put extra resources on incentive areas.

According to the respondent, both client and contractors, in most of the projects there is a package with incentives that are important for the project. The content differs between projects. The incentives are based on what preferences that is important for the project. Examples of incentives are quality, environment, time and cost.

Penalties have the same function as the incentives, but in the opposite way. The contractor has to pay a fee if the contract agreement is broken. Whether to use incentives or penalties depends on the projects environment. As one of the respondents argued “*If there is low risk and uncertainties, and the due date is clearly set there is no need for incentives or bonuses. Just build the product or project. Incentives or bonuses are no aim in itself, we as client also must benefit*”. According to the interviewed contractors the incentives tend to be subjective. I.e. that it is up to the client to decide whether the contractor fulfil the incentive or not. The Client thinks that the contractor often strive to get as many bonuses as possible. One purchaser on STA stated that: “*contractors want to have as many bonuses as possible, it is important for us as a client to not just give away bonuses*”.

The most common incentive, according to the respondents, both client and contractors, is time incentive. The time incentive is easy to monitor and also preferable because it brings value to all actors. One contractor said that “*the time incentive is a very good incentive it trigger the contractor to be effective. One of our projects finished one year earlier thanks to the time incentive.*” However, as the respondents from the client argued, there is no benefit for the client if one sub-project is finished before the time-schedule if none of the other sub-projects are. So, they argued, the time incentive should also be a cooperation incentive, that depends on the whole project. The contractors like the idea to use cooperation incentives, but as one of the contractors stated “*there is a risk that by using cooperation incentives. There is an increased chance of contradictions if to many stakeholders are involved in an incentive.*”

Furthermore the contractor thinks that a presumption for the incentive to work is to not divide the construction into to many contracts. A cooperation incentive will require that the client control and set up rules for how the incentive should work. The contractors think that the biggest drawback with a cooperation incentive is that it will be hard to help the other contractors, because, the contracts are different to each other. To move machines and employees to other contracts need planning and access to restricted areas, which require more bureaucracy, time and money. One of the contractors also stated that he do not want to take responsibility for another contractors failure of doing his work.

## 5.5 Partnering and cooperation

The cooperation activities within STA are divided into three categories; FIA 1, 2 and 3. The third level is a strategic alliance which is hard, or impossible, to use in combination with LUF.

According to the interviewees the cooperation between the actors is crucial for project success, at least when the project are exposed to high complexity, risks and uncertainties. The respondents further argued that there is always some cooperation in every project. As one stated “*we use FIA but it is not the level and the associated activities that are important, it is the mutual understanding and the goal alignment*”.

The interviewed client and contractors agree that cooperation reduces the risks of the project and also the disputes between the involved actors. Cooperation will help the actors to reach common goals and help the actors to share the risks. One of the clients’ respondent argued that cooperation of high degree, partnering, aims for the same benefits as the DB project delivery method but in a more difficult way; i.e. for the client to get access of the innovative solutions available at the market. One of the interviewed purchasers at STA was talking very warmly about the partnering concept and thought that using more partnering projects where more important than the use of DB project delivery method. He stated that “*the biggest success factor in all projects he had been involved in had been the increased cooperation between all involved actors*”.

The contractors think that increased cooperation should be the next step for STA as an organization. One contractor stated that “*the key to success is not the different project contract types but cooperation.*” Another contractor said that if there is a complex project, the client should not lock in himself in what type of project contract to choose, but instead involve a contractor early on premises that are important to the project and from that choose the appropriate project contract. However, one of the interviewed contractors stated that not all projects had been successfully used partnering. A successful partnering is depending on a

good relationship between the actors. If the involved actors have a problem to cooperate there can be an increased bureaucracy which will not gain the project.

One of the contractors stated that: “*The choice of DB product delivery method in combination with cost-plus is a good step to increase the cooperation but it is possible to take it further*”. Two of the interviewed contractors wanted to use an alternative project delivery method that they had chosen to call “partnering”. The partnering project delivery method is using either DBB project delivery method or DB project delivery method but the key to the success is to involve the contractor as early as possible. The more risks there are in the contract, the more important it is to involve the contractor earlier. The contractors think that cooperation is good in all contracts but is especially good when target cost payment principle is being used. The respondent contractors stated that the more things the actors need to share in a project, the more important it is to have cooperation.

## **5.6 Factors influencing project contract**

It is a wide consensus among the respondents, both procurer from the client and contractors regarding the benefits and drawback of the both project delivery methods and the different payment principles. The both actors argued that the choice of project delivery method and payment principle depends on the context of the given project. Both clients and contractors agreed that it should be the context of the project that determines the project delivery method, the payment principle and the level of cooperation. The interviewed actors argued that the factors that decided what project contract to use where several different factors. From the client point of view the most important factors where the risks and uncertainties and the projects need to have opportunities to find new solutions. The contractors also thought that these factors where important. However, they also stated that Size and complexity where of great importance.

### **5.6.1 Risk and uncertainties**

All the interviewed contractors have similar attitude towards risks and uncertainties. The contractors are aware that in all projects risks and uncertainties will be present. The risks and uncertainties are different depending on what and how the projects will be executed. For example two of the contractors mentioned that uncertainties regarding automatic control system are larger compared with more regular construction work such as concrete work. According to the interviewed persons, this is because of the rapid technological development in the sector of information systems which together with the long project time may put the technology out of date. The client argued that the risks and uncertainties where of great importance when they had to choose what kind of project delivery method they wanted to use. Some of the purchasers argued that if the risks and uncertainties where to high they did not want to let go of the control by for example using the DB project delivery method. The contractors thought that it was still possible to move the risks to the contractor as long as the cooperation where high enough. The interviewed purchasers showed more respect for the risks, that is that they wanted more control of it than what the interviewed contractors showed.

According to all the interviewed persons, procurers from STA as well as the contractors, goals alignment between the parties involved affects the treatment of risks and uncertainties in a positive way. Further, the price model is a good tool to fend off different uncertainties.

However, regardless of the price model the risk should be managed and owned by the party who has the greatest possibility to affect it. If the risks are too great many of the contractors said that they probably avoid tendering or demands a large amount of money to manage the risks. However, the contractors are aware of the risks and also open to manage the risk as long as they are defined. One contractor said; "*To manage a risk in a good way is an opportunity for us to gain profit, but we must be aware of the risks. It is the uncertainties who are the greatest risks*". The contractors argue that there is a difference between risk and uncertainty. The potential risks are identified and the probabilities for the risks to occur are estimated and calculated by both clients and contractors. The more potential risks identified the more risk premiums added by the contractors and the risk for cost overruns increases. The risks increase with size and complexity. The uncertainties in a project is according to the contractors for example external influences, stakeholders, internal influences, influences from the environment, it could also be uncertainties of the product, for example if the product need to be changed a lot during the project. The client on the other hand argues that the uncertainties should be seen as a risk. The more uncertain a project is the more risks the client sees in the project.

### **5.6.2 Size**

As mentioned before the contractor think that a DB project delivery method always have to be of a significant size to gain the benefits from the DB project delivery method. Both the client and the contractor think that a big infrastructure project should be divided into smaller sub-contracts, however they still think they should be of significant size in order to gain all the benefits from the contractor. Also if a project is too large the competition will decrease. One contractor stated "*In the discussions with STA we always stress that there should not be too many sub-projects. By using too many sub-projects the size will be too small.*" Therefore we will not be able to contribute with our experience and innovations. He continued to state that "*It is also important to not have too few sub-projects. If the project is too big it will be very few contractors that have the strength to construct the project.*" Therefore the competition will be very low. The client also stated that it is important to not have one contractor that construct the whole building. "*By only using one contractor we will get to few contenders and we will be looked into one big contractor*".

### **5.6.3 Complexity**

All interviewed actors said that complexity is hard to define exactly and that there is a lot of different factors that decide how complex the project is. However, according to the interviewed actors, the complexity of an infrastructure is about the design of the contract, if a contract involves a lot of different sub-contracts that are handled by sub-contractors the complexity increase. The size of the project, the bigger the project is the more parts there is in the project hence, the complexity is higher. The uncertainties of the process also increase the complexity. When there are a lot of uncertainties of how to deliver the project the client stated that they find the project more complex.

### **5.6.4 Opportunity to innovative solutions**

The interviewed client stated that one of the main reasons to start using DB project delivery method was to gain an increase of innovative solutions. The interviewed contractors also stated that the opportunity to come up with innovative solutions was very important in the infrastructure sector. As mentioned before the degree of freedom increases for the contractor

and the opportunity to get more young people interested in the infrastructure sector also increases. In order to gain result from innovative solutions the project must be complex and of significant size. If the project has a well-defined bill of material there is not any use to have an innovative solution to the project. The most used example from all interviewed actors where the use of innovative solutions in the construction of a bridge. The reason for this is that it is easy to define the functional requirements for the bridge. The contractors often have better knowledge about how to build the bridge cheaper and better. They also gave an example on a project where there is no use of an innovative solution. A typical example is a road or a traffic circle. The bill of material for these kinds of projects are well defined and there is not possible to have different design solutions therefore there is no need of innovative solutions.

The information that is gathered in chapter 5 will be used in the next chapter 6 together with the theoretical framework in chapter 3 in order to solve the research questions stated in chapter 2.

# 6 Analysis

*This chapter analyzes the findings from the interviews in relation to the theoretical findings. The findings are used in a selection matrix to present different project contracts depending on the factors that influence the choice of project contract.*

## 6.1 Factors influencing project contract

The theory listed a lot of different factors that influence the choice of project contract. Some examples where as seen in chapter 3.5 Quality, single control, level of control, early estimates, if the project is within budget, risks and uncertainties and complexity. However, from the interviews with the actors we found out that the following deciding criteria for project delivery method, payment principle and level of cooperation in Sweden is the most important criteria: These factors were also identified in the theoretical findings.

- Risks and uncertainties
- Complexity
- Size
- Opportunity to innovative solutions

Below, the factors are described more into depth. Also the dependencies of the different factors are described.

### 6.1.1 Risks and uncertainties

During the interviews it was obvious that the risk is a major determinant in the choice of project delivery method, payment principle and level of cooperation. This was also supported in the theoretical findings, although not by all authors. One author stated that risks are identified as an uncertainties and one actor divided risks from uncertainties. According to the theory and the interviews, it is important to allocate the risk in a clear manner, and the risks should be carried by the actor who best can affect it. By choosing an appropriate project contract it is possible to allocate the risk to the correct actor.

Based on the interview and the theoretical framework, we are confident that the higher the risks are, the greater the need for cooperation between the actors are. To have a chance to avoid cost overruns in projects subject to high risks there is a need of goal alignment and mutual understanding between the actors, and hence, a high level of cooperation.

As mentioned in the theory a risk is defined as an uncertainty which is impossible to quantify in terms of probability that a certain event will occur. However, the contractors stated that the uncertainties are separated from the risks, because the risks are possible to estimate if they are clearly defined. However, we believe that the uncertainties and the risks are related to each other. They are related because when the uncertainties of the process and the product are high, the risks are also high.

The risks regarding the uncertainties of the process can be related to how to deliver the project. As mentioned in the theory, the more uncertainties of the process there are, the harder it is to determine the final design. Therefore, the risks in the beginning of a project with high uncertainties will be very high. When the uncertainties regarding process are high, the complexity is also high, and also the opportunity for the contractor to find innovative

solutions. To push more responsibility toward the contractors during these circumstances may seem unfair. However, the contractors argue that they are willing to carry these uncertainties. Further, it is already under these circumstances the contractors today have increased responsibility.

Uncertainties regarding the product are about the project itself. A product can be a tunnel, a signal system or just the railway. The functional requirements of the product or project are easy to define in some cases, and a lot harder in other. When the functional requirements are easy to define, we consider the uncertainties of the product as low. Therefore, the risks are also low, due to that the detail design and the final design will be similar. When the functional requirements are hard to define, and subject to a lot of potential changes during the project we consider the uncertainties of product as high. There is a difference of the products regarding technology as well. Concrete constructions are not under the same rapid technology development such as information systems. For information systems there is a risk that the technology specified in the pre-planning is out of age when installation is to be executed. Hence, there is a high uncertainty regarding the product. When the uncertainties of the product is high there is an increased risk because there can be a lot of differences in the final design from the detail design.

We have already stated that when both the uncertainties of process and product are high the risks are high. In such an environment the project delivery method can be either Design-Bid-Build (DBB) or Design-Build (DB). However, as mentioned above there is a need of high level of cooperation. If the FIA levels are used, there should be FIA 2 cooperation under these circumstances. Through the cooperation the actors can handle the uncertainties together and avoid problems that may occur during the project.

### **6.1.2 Complexity**

The complexity of a project is proved to be an important factor when deciding the project contract according to the respondent. During the interviews it was clear that the clients and the contractors identify a project, as a project subject to either high or low complexity. High complexity is defined as a project with a lot of different subcontracts and subcontractors. Also if there are a lot of uncertainties of the process the complexity will be higher. Low complexity is defined as a project that is of small size with no or only a few subcontracts and subcontractors. The uncertainties of the process is also low that means that it is easy for the client to define the project.

To handle the complexity of a project the level of cooperation, the project delivery method and the payment principle is important. As mentioned above, when the complexity is high the uncertainty of the process is high, and also the opportunities for the contractors to find innovative solutions. The complexity and uncertainty of the process is correlated because a project with a lot of uncertainties in the process is complex to handle. If there is unclear conditions about how to deliver the project, the project is identified as a complex project. To handle the high complexity it is important to have a high level of cooperation. In fact the higher the complexity is the greater the need for cooperation. If the complexity is high, it is of importance to use a payment principle that facilitates the handling of the complexity and encourages cooperation. The payment principle that best facilitate the handling of the complexity and encourages cooperation according to the interviews and the theoretical framework is the target cost payment principle.

In projects of high complexity the construction can be hard to define and need changes during the project. If the environment of the project is subject to a lot of uncertainties, the complexity increases. Infrastructure projects are often big and there can be several sub-contractors involved in the projects that need to be coordinated. E.g. the drilling has to be done before the concrete work can begin; if the drilling is delayed the concrete work cannot be started.

Projects of low complexity do not have a lot of uncertainties of process, and the projects are usually small with few sub-contractors and are therefore easy coordinate. Projects with low complexity are the opposite of the ones with high complexity. In a project of low complexity the detail design is easy to define. Further, the planning and pre-design often, almost, reach the level of detail design. In this type of projects with low complexity there is no need for innovative solutions. Furthermore this leads to that the cooperation level in this type of projects are low.

### **6.1.3 Opportunity to innovative solutions**

As mentioned in the interviews and in the theory it is important to involve the contractors in the detail design of the projects in order to gain innovative solutions. This will, according to the theory and the interviews, increase the productivity of the infrastructure sector. The importance of the innovative solutions increases when there is a complex and uncertain process. The reason is that there is greater chance that the contractors have better knowledge of the project in this type of project contract.

When a project contract has the possibility to be delivered by a lot of alternative solutions there is a major benefit to let the actors of the market, the contractors, to compete with innovative solutions. This is also stated by the theory and by all the interviewees from both actors. In a project subject to high complexity and high uncertainties regarding the process the opportunities for the contractors to find innovative solutions increases. Hence, the opportunity to innovative solutions goes hand in hand with complexity and uncertainties regarding the process. As mentioned in the theory and in the interviews to gain the most of the innovative solutions the DB project delivery method should be used. The payment principle should be chosen based on how complex and uncertain the project is. If the project does not need any innovative solutions the choice should be DBB project delivery method.

The need of partnering is not influenced by the opportunity to innovative solutions. Instead it can suffer from an increased partnering due to an increased dialog between the client and the contractor.

### **6.1.4 Size**

Large capital investments such as infrastructure projects are often of considerable size. To divide a project into sub-projects is a common approach. According to the interviews with the actors, it is of great importance that the size of the sub-projects still are of considerable size if the client wants to get access to the innovative solutions available at the market. However, if the size is too large there is a risk that the competitiveness decreases. Sometimes it is not needed to have a large size project. This type of projects is often smaller sub-projects that are easy to define with low complexity and low uncertainties. In this type of projects it is possible to use the simplest form of project delivery method, payment principle and with low level of partnering. During the interviews it became obvious that with increasing size, the complexity and the uncertainties of the process increase. Hence, also the opportunities to find innovative

solutions for the contractors increase. In this type of projects the DB project delivery method is preferred in most cases.

The greater the size of the project is, the greater the need for increased cooperation is. This is due to that there is a lot more parts to handle. Therefore, in order to control all parts of the project an increased cooperation is needed.

## 6.2 The selection matrix

As mentioned above, in section 6.1, we have identified four factors that affect the choice of the project contract. The factors are complexity, risk and uncertainties, size, and opportunities of innovative solutions. We also explained the dependencies among these factors that we discovered during the interviews and with help from the theory. Above, as mentioned, our findings showed that the risk is divided into two types of uncertainties. Further, complexity and size goes hand in hand with uncertainties of process and opportunities for innovative solutions. Based on these factors we have created a selection matrix in order to be able to categorize different projects contracts depending on the factors that influence the choice of project contracts. The theory and the interviews has helped us to know what type of procurement procedure, project delivery method, payment principle and partnering level that should be used in different quadrants of the selection matrix. How these factors are related will be explained further in the following paragraphs.

The matrix is a two by two matrix. The horizontal axis is defined as the uncertainties of product. As mentioned above one part of the risk is included in this definition. The vertical axis is defined as the uncertainties of process. As mentioned above the uncertainties of process include a part of the risk, the complexity, opportunity for innovative solutions and the size of the project. The axis is divided into low uncertainties and high uncertainties. The matrix is divided into four quadrants, where the factors have different impacts on the project contract. As can be seen in figure 13 the quadrant is numbered. Below, each quadrant is presented with the suitable contents of a project contract

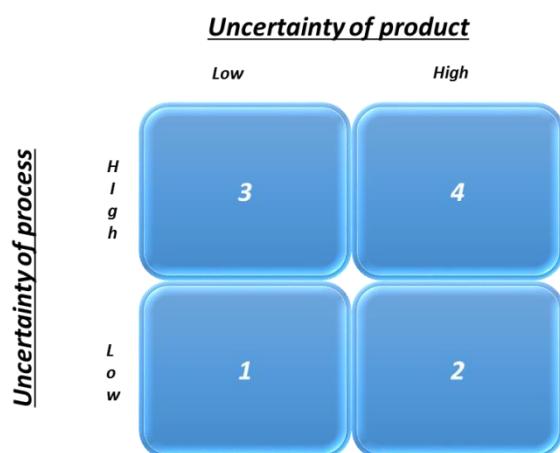


Figure 13, the selection matrix

### **6.2.1 Quadrant 1 Small contracts**

In the first quadrant, in the lower left corner, we have characterized as projects with low uncertainty of process, low uncertainty of product, low complexity, and small size with few alternative solutions for the contractors to be innovative. Hence, such projects are subject to low risk. Further, because of the low complexity the detail design is quite easy to execute and quite similar to the pre-planning. This implies that the contractors are “locked-in” with a certain process for the execution of the project. Furthermore, the bill of quantities is easy to define at projects with these circumstances. During all these circumstances there is no need to use the DBB project delivery method. Hence, there is no need for innovation solutions, the clients are able to handle the project with good results, and, the client can handle the low risks.

Using the DBB project delivery method brings a risk for the client that the detail design executed by the client is over specified. However, that risk is low during the circumstances of projects in this quadrant. A lot of the detail design is, as mentioned, already performed in the pre-planning phase. Using the DBB project delivery method there are less barriers for the contractors to participate in the tendering. The procurement procedure is, as always, negotiated procedure but there is no need for the contractors to perform a detail design and, hence, the cost for the contractors to participate in the tendering process is low. By this the potential contractors responsible for the execution of the project increases and so does the competition. During the negotiated procedure, the lowest price should be used to decide the winning tender. As mentioned in the interviews the STA has an aim of procuring 20 percent of the projects with the lowest price as deciding factor. The lowest price is, as stated by the clients during the interviews and in the theory, most suitable where the complexity and uncertainties are low, which are the case during the projects placed in this quadrant.

The allocation of risks with the payment principles are unnecessary during the circumstances given in this quadrant. Because, the risks are low, hence, there is no need to shift the responsibility of the risks towards another actor. Regardless the choice of payment principle, the risk-premium will be low. As mentioned above the bill of quantities is easy to define at projects with these circumstances. Therefore unit price payment principle is suitable for project in this quadrant. Since the bill of quantities is easy to define, the risks that the final cost will exceed the calculated cost are minimal. Further, there is an option to mix the variable payment principles; i.e. using unit price for the man-hours and machines but cost-plus for the material used in the project. The reason for this is that STA minimizes the risk that low quality material is being used. Because, the use of low quality material may increase the life cycle cost for the STA. Furthermore, there is also an option to use the fixed price payment principle. However, by using fixed price it is a risk that the winning tender is set too low by the contractor. To cover up the losses, the contractor may try to find correctional and additional work. Also, when the fixed price payment principle is used, there is an option to combine it with the cost-plus payment principle for the material, for the same reasons as mentioned, with the combination of variable payment principles, above. The fixed price payment principle should be used during the projects in this quadrant when the bill of quantities is not defined. Although, the bill of quantity is easy to define in projects with given circumstance there might be occasions where it is not defined and then the fixed price payment principle suits better. To combine the payment principles with incentives is of low benefit for the projects placed in this quadrant. We believe that penalties are better suited then

incentives or bonuses in this environment. Because, the low uncertainties and complexity makes the project “easy” to construct and it is just for the contractor to follow the detail design. Hence, if there are delays or problems at the project it should be the responsibility of the contractor.

Due to the given conditions in the quadrant, there is no need for close cooperation as partnering. Every project has some cooperation, through regular building meetings or similar activities. With increasing uncertainties regarding process and product, and increasing complexity the need of deeper cooperation increases. Hence, with low uncertainty and complexity, as in the projects here, a close cooperation such as partnering seems unnecessary. A cooperation through partnering will just demand time, and organizational resources from both the client and the contractor, too no or low benefit for the project.

In figure 14 the choice of project contract in quadrant one is shown.

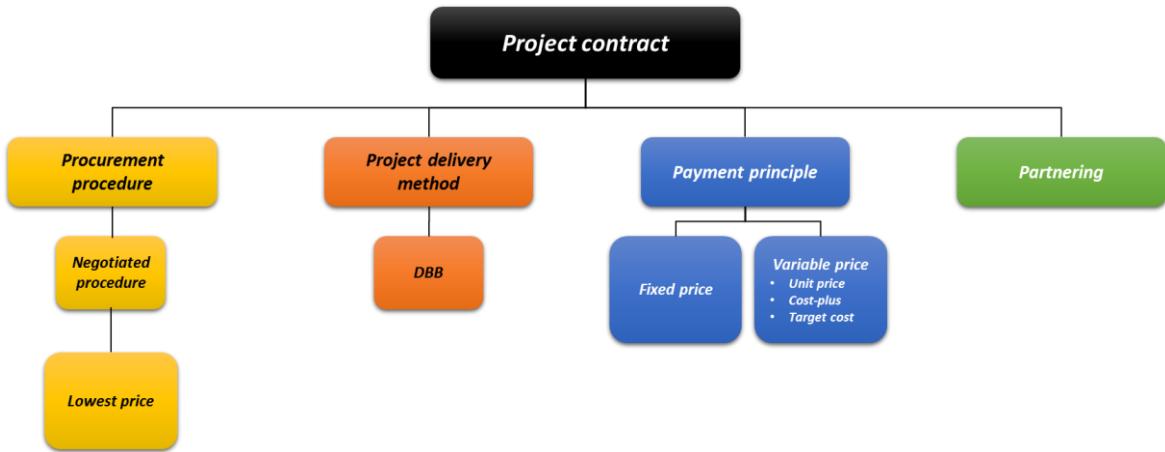


Figure 14 the choice of project contract in quadrant one

An example of a construction that is suitable in quadrant 1 is a railway. A railway is easy to define, it has a standard bill of quantity. The client has probably done this kind of project many times before, therefore, the competence to make the detail design at the client. A railway will have the same bill of quantity and detail design in all type of environment. It is used on the countryside, through tunnels, on bridges etc. In figure 15 a railway through a tunnel is shown as an example of a railway in infrastructure projects.



Figure 15 A railway through a tunnel

### 6.2.2 Quadrant 2 Technical products

The second quadrant, in the lower right corner, we have characterized as projects with low uncertainty of process, high uncertainty of product, low complexity, and small size and with few alternative solutions for the contractors to be innovative. Due to high uncertainty of product, there will be a higher need of involvement from the contractor.

During the interviews it became clear that information system and similar products for infrastructure projects belongs in this quadrant. The interviewed contractor working with this type of project stated that information systems have low complexity but the product have a rapid technology development. This makes this quadrant a bit more difficult to explain and to find “pure” projects suitable in this quadrant. That is because this quadrant is almost product specific, while the others are general for different projects. Further, we found out that the uncertainty of product does not depend on the functional requirements. The uncertainty of the product is derived from the technical requirements of the products. Therefore, it is important that the client has technical expertise regarding the given project and, more specific – the product – during the negotiating. Due to the uncertainty of product, the award decision should be based on the most economic advantageous tender.

Although, the complexity of the projects and the uncertainties of the process are low, with few opportunities for alternative solutions, we believe that the most suitable project delivery method is DB. As stated above, this is because the rapid technology development for products used in the projects placed in this quadrant. The contractors better know what to use, and there is no risk of an exaggerated detail-design. Further, the contractors are not “locked-in” with technical requirements in the detail-design that are out of date. However, we believe this need an awareness of the client for what the project really needs regarding technology. Because, the contractors are early adopters of the technology and sometimes the technical interest of the specialist at the contractor will add unnecessary costs for the client.

There is a possibility of using the DBB project delivery method, and it would be more suitable considering the low complexity and uncertainty of process. Further, the main argument to use the DB project delivery method – to gain benefits from the innovative solutions available at

the market – is not valid here. However, during the interviews it was obvious that it is custom to use the DB project delivery method under these circumstances. There are other benefits of shifting the responsibility towards the contractor, and the risks are not considerable.

The payment principles most suitable is fixed price or target cost. Because of the low uncertainty of process and the low complexity, the risk present comes from the product itself. Using the DB project delivery method together with the fixed price payment principle the risks are pushed towards the contractor which prevents the contractor from using unnecessary expensive technology. However, this might also result in that the contractor avoids new, better suited, technology. Because of the uncertainty of product, there is, as mentioned, a need of client involvement. With the needed involvement of the client, the target cost payment principle should also be sufficient. The sharing-ratio of the target cost in quadrant two should be 50/50 between the client and the contractor. The reason for the distribution to be 50/50 is that the risks are considerable but not extreme. It is also stated in theory that the sharing ration regarding the gains should never go under 50 percent from the view of the contractor. To gain the most economic benefit of the target cost, the target cost should be set by either the client or in consensus between the client and the contractor. We believe that there is a risk that the situation will be similar as with the fixed price if the contractors set the target cost. I.e. the contractors sets the target cost to low and the actual cost will become higher then target cost and, hence, the economic incentive will disappear.

With the high uncertainty of the product there is, as mentioned above, a need of a closer cooperation during projects placed in this quadrant. The level of cooperation is dependent on the payment principle, and our findings states that the use of target cost needs a closer cooperation, especially when used together with the DB project delivery method. However, regardless of the chosen payment principle it is of great importance that the client is aware of the actual needs regarding the product. Hence, the need of cooperation cannot be ignored if fixed price payment principle is used. The cooperation should range from a bit deeper than traditional cooperation too an even closer form, the form of a lower level of partnering such as FIA 1.

In figure 16 the choice of project contract in quadrant two is shown.

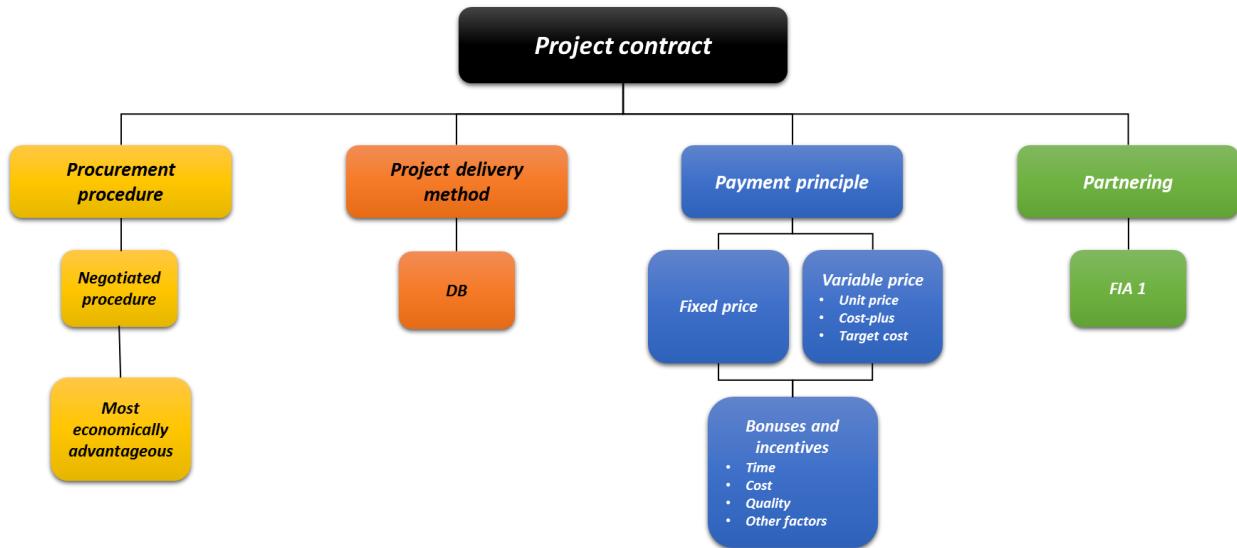


Figure 16, the choice of project contract in quadrant two

As mentioned above, quadrant 2 is best suited for information system. A typical information system that is used in infrastructure projects is Supervisory Control and Data Acquisition which is shortened to SCADA. SCADA is a system for monitoring and steering of processes. It is believed that the contractor should have control over this kind of infrastructure project, because he has better knowledge than the client and contractor. In figure 17 a SCADA system is shown on the computer

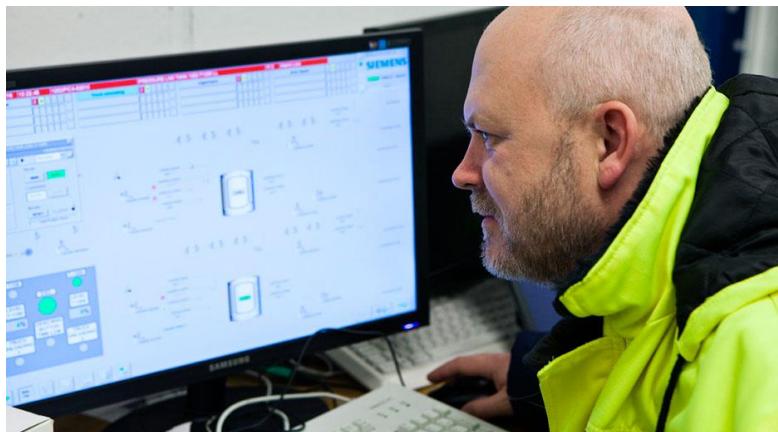


Figure 17 a picture of SCADA

### 6.2.3 Quadrant 3 well defined functional requirement

The third quadrant, in the upper left corner, we have characterized as projects with high uncertainty of process, low uncertainty of product, high complexity and with opportunities for the contractors to find alternative and innovative solutions. In this quadrant the functional requirements are easy to define. However, the detail design can be executed in several ways. With this stated there are a lot of benefits to gain from using the DB project delivery method.

There is considerable risk in this quadrant, because the process has high uncertainty. To use the DB project delivery method, and by that let the contractors carry the risk may seem unfair but we are confident that this is the quadrant where the most benefits from the DB project delivery method can be achieved. Although, the uncertainty of process is high in this quadrant, there are different levels of the height. This means that risks in projects are

considerable, and sometimes too high for the contractor to handle alone. However, we think that in this quadrant the DB project delivery method should always be used, the potential for the contractors to deliver alternative solutions is too great to ignore. If the risks are too high for the contractors to handle, they should instead be allocated towards the client with the use of a suitable payment principle.

The procurement procedure will, as always, be executed through negotiated procedure. During the given circumstances the most economic advantageous price should be selected. To use the lowest price would ignore the innovative solutions that some contractors may provide. The price, however, should still be an important factor but not the determinant one. Factors to be considered are not only project specific; it can also be regarding the projects environment. If, as an example, a bicycle and walking bridge is to be built over a railway track, the contractor may find a solution to build the bridge without stopping the railway traffic which is of great importance for STA. So, the functional requirement should be clearly stated, without decreasing the degrees of freedom for the contractors.

The payment principle should allocate the risks between the actors, to the actor who can handle it best. To use a fixed price payment principle together with the DB project delivery method pushes the risks towards the contractor. However, by using fixed price payment principle in combination with DB project delivery form, there will be increased possibilities for the contractor to affect the project and the contractor's degree of freedom increases. Increased degree of freedom gives the contractor opportunity to find innovative solutions for the project. Further, the possibility to gain profit from the project increases for the contractor. At the same time, innovative solutions may decrease the actual cost compared to the calculated cost. Hence, a "win-win" situation may arise for the involved actors. As mentioned in quadrant one, using fixed price payment principle, there is a risk that the contractors winning tender is set to low by the contractor. To cover up the losses, the contractor may try to find correctional and additional work. The higher the uncertainties of the process are in a project, the higher the risk-premium will be. If the risk-premiums are too high the contractors will either not bid for the project or offer an unreasonably high price. To lower the risk-premium, a variable cost payment principle can be used. Under the circumstances given we believe that the target cost payment principle is the suitable choice. The target cost payment principle will allocate the risks from the contractor towards the client and, hence, lower the risk-premium. The sharing-ratio and which actor that set the target cost in quadrant three should be similar to quadrant two. The sharing-ratio should be 50/50 both for loses and gains. The reason for the distribution to be 50/50 is that the risks are considerable but not extreme. It is also stated in theory that the sharing ration regarding the gains should never go under 50 percent from the view of the contractor. As stated in quadrant two to gain the most economic benefit of the target cost, the target cost should be set by either the client or in consensus between the client and the contractor. We believe that there is a risk that the situation will be similar as with the fixed price if the contractors set the target cost. I.e. the contractors sets the target cost to low and the actual cost will become higher then target cost and, hence, the economic incentive will disappear.

With the high complexity and the uncertainty of the process there is a need of a closer cooperation during projects placed in this quadrant. The choice of payment principle is also an important determinant for the level of cooperation. If the target cost payment principle is used, the bureaucracy will increase compared with the fixed price payment principle. Hence,

the need for cooperation will also increase with the target cost. This is also natural, because the target cost should be used when the uncertainties are higher. Nevertheless, cooperation between the actors will be needed regardless of the payment principle. The cooperation should range from traditional cooperation with mutual understanding and goal alignment, to a lower level of partnering such as FIA 1.

The use of incentives and bonuses are more important when fixed price payment principle is being used. The incentives are used by the client in order to encourage the contractor to put more effort on crucial parts of the project. We believe that the time incentive is always useful in this type of project. As mentioned before the infrastructure projects are often divided into sub-projects. A time incentive should benefit the whole project and not just the sub-project. It is important that the incentive not become an aim in itself as stated by the interviewees from the client side. However, there must also be an incentive for the contractors responsible for the sub-project. The incentive is a driving force and if the incentives or bonuses are too dependent on other sub-projects the contractor will lose the driving force. Therefore, it is important that the contractor has an incentive or bonus for its own project. During these circumstances we believe that the incentives should be based on sub-projects as well as on the whole project. Time incentives are useful in almost all projects. However, every project is unique with its own project specific incentives. To state what incentives to use, except of the time incentive, are beyond the scope of this thesis. Whatever choice of incentive, it is important that the contractors have a feeling that they can affect it and that client has the feeling that it contributes to the project as a whole.

In figure 18 the choice of project contract in quadrant three is shown.

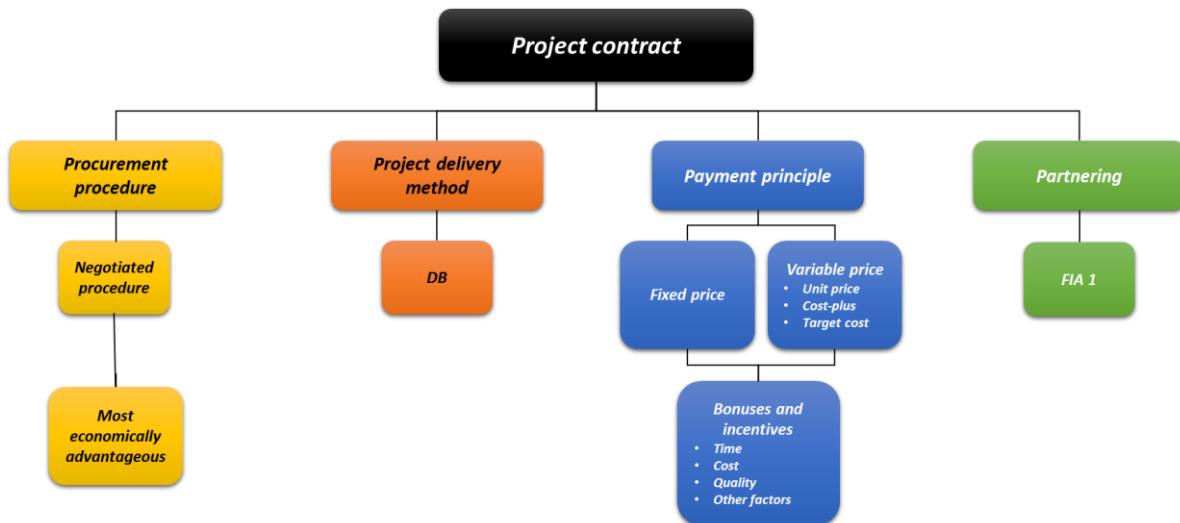


Figure 18 the choice of project contract in quadrant three

A typical infrastructure project in quadrant three is a bridge. The functional requirements for a bridge are easy to define and there is a great advantage to use the contractors' inputs to find a better innovative solution. By finding better solutions it is possible to save money and the time schedule required to build the project. A bridge can be built in many different ways and it is likely that the contractors have better experience of how the detail design should be made. An example that is planned to be built in the nearest future is the new Göta älvbron. Göta älvbron is a bridge that connects the island Hisingen with Göteborg mainland. In this project the client let the contractors come up with different solutions and the winner of the contract

will build the project according to DB project delivery method. In figure 19 an example of two of the finalists for the project is shown.



Figure 19 Example of two of the finalists in the Göta älvbron project

### 6.2.4 Quadrant 4 complex and uncertain projects

The fourth quadrant, in the upper right corner, we have characterized as projects with high uncertainty of process, high uncertainty of product, high complexity and with opportunities for the contractors to find alternative and innovative solutions. In this quadrant the functional requirements are hard to define. The detail design is hard to specify because of the high uncertainties in both the process and the project. During the given circumstances, the choice of project delivery method is not the most important factor. Instead the importance should be on cooperation and a payment principle that promote cooperation.

The procurement procedure will, as always, be executed through negotiated procedure. Depending on the risks of the project, the procurement procedure will be treated different. The higher the risks are the earlier the contractor should be involved in the project. If a project has very high risks, we suggest that the client choose a contractor early in the procurement procedure. The contractor should be chosen based on factors that are important for the project. Examples of factors are; experience, size of organization, turnover etc. These factors will help the client to choose a contractor that is able to perform the project. The risks with choosing a contractor early is that if it turns out that the contractor is not able to perform the project, time and money will be lost. If the risks are high but slightly lower, the contractor should be chosen according to the same procedure as in quadrant three. Mentioned in quadrant three are that, the most economic advantageous price should be selected. The uncertainties are too high to use the lowest price. The price, however, should still be an important factor but not the determinant one. Factors to be considered is not only project specific, it can also regards the projects environment the functional requirement should be clearly stated, without decreasing the degrees of freedom for the contractors.

The project delivery method in this quadrant can either be the DB project delivery method or the DBB project delivery method. The choice of delivery method will be based on which actor that should have the major responsibility of the risks and uncertainties. The need of innovative solutions should also be considered when choosing between the different project delivery methods. Since both uncertainties are high, the risks in this quadrant are of significant large size. Therefore in order to handle the risks both project delivery methods are in need of close cooperation and a payment principle that help to handle the risks.

The circumstances in quadrant four are similar to the circumstances in quadrant three, however the risks are even higher in quadrant four, due to that the product is uncertain as well. Therefore the choice of payment principle in quadrant four need to allocate the risk between the actors. To use a fixed price in this quadrant pushes the risks towards the contractor. As mentioned in quadrant one, the higher the uncertainties of the process are in a project, the higher the risk-premium will be. Therefore during these circumstances a fixed price is not a possible choice. To allocate the risks the target cost payment principle should be used. The target cost payment principle will allocate the risks between the actors. The sharing-ratio in the target cost payment principle under the circumstances given in quadrant four, should give a higher gain for the contractor if the project cost succeeds to go under the target cost. The sharing range should be 60-80 percent in favor to the contractor. If the project cost exceed the target cost the ratio should be 50/50 or lower in the perspective of the contractors'. The reason for the distribution to be as stated is due to the high risks in this type of projects. The higher the risks are the higher the ratio should be, in order to motivate the contractor to handle the risks. During these circumstances the target cost should be set in in consensus between the client and the contractor, due to the close cooperation.

With the high complexity and the high uncertainties of the process there is a need of close cooperation. Also the more things that need to be shared between the actors, the greater is the need for cooperation. Therefore, a project with target cost in this type of circumstances is in need of close cooperation. To gain close cooperation we recommend that the actors should create a project specific company. The project specific company will be placed close to the project. It should be used to facilitate the cooperation for the involved actors. By sitting under the same roof, the actors have the possibility to discuss and handle problems that occur during the project. By having a close cooperation we believe that the target cost gets less bureaucratic. Because, the actors share the same budget they will share the same economical posts. Hence, there will not be any discussions about which actor that are responsible for what part. The cooperation in this quadrant can be compared to FIA 2.

By using a project specific company the incentives should be shared in the same way as the target cost sharing-ratio. The use of incentives in quadrant four are similar to the use of incentives in quadrant three. The time incentive is useful in this type of project as well. The specific incentives are also important in this type of project. As mentioned in quadrant three, whatever choice of incentive, it is important that the contractors have a feeling that they can affect it and that client has the feeling that it contributes to the project as a whole.

In figure 20 the choice of project contract in quadrant four is shown

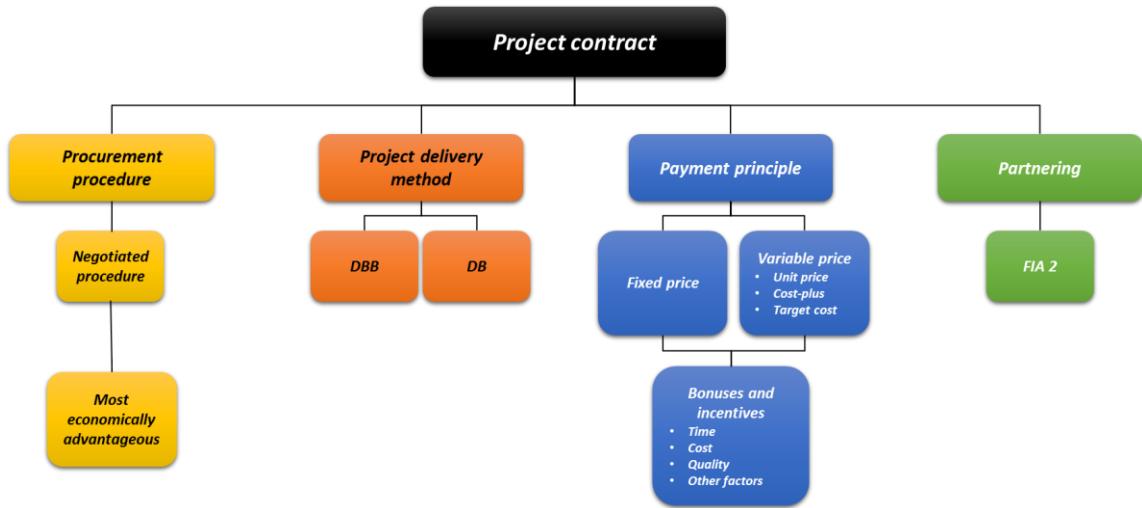


Figure 20 the choice of project contract in quadrant four

In quadrant 4 a typical example of an infrastructure construction is an underground station. An underground station is very complex with a lot of uncertainties both on the process and the production. Often an underground station needs to change the design during the project. The reason for this can be stakeholders that want to add or change something, uncertain environment. The construction itself is also very complex and therefore a partnership is needed in order to reduce risks and handle the complexity and uncertainties. As in quadrant 3, quadrant 4 also has an example from a project that fits well in this quadrant. In the infrastructure project citybanan, STA and the contractor have a project specific company for one of their subcontracts which include an underground station. In this specific project they are using DBB project delivery method. As seen in figure 21 there are a lot of different factors to consider when building an underground station the construction can include different levels of railways, it can be built under another station etc.

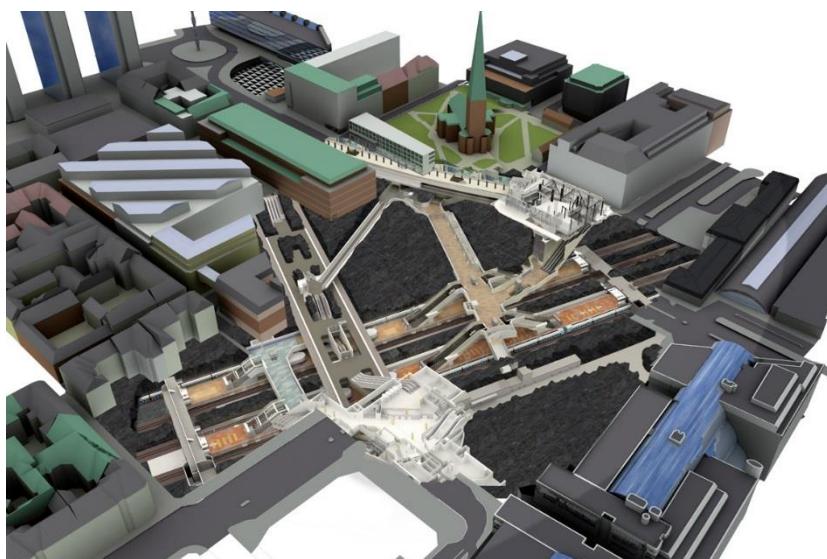


Figure 21, Underground station at the Citybanan project in Stockholm

### 6.2.5 Conclusion of the selection matrix

In figure 22 the suggested project delivery method and payment principle is presented. *Quadrant one* should use DBB project delivery method in combination with either fixed price

or variable price. The choice of DBB is based on the simplicity in quadrant one and the choice of payment principle depends on if the bill of quantity is made or not.

*Quadrant two* should use DB project delivery method in combination with either fixed price payment principle or target cost payment principle. The choice of DB project delivery method is based on the rapid technology development in this quadrant. The choice of payment principle should be based on how much risks there are. If the risks are manageable by the contractor the choice should be fixed price, with increased risks the choice should be target cost.

*Quadrant three* should use DB project delivery method in combination with either fixed price payment principle or target cost payment principle. The choice of DB project delivery method is based on the opportunity for the contractor to deliver innovative solutions. Fixed price is the payment principle we recommend because the functional requirements in this quadrant is rather easy to define. However, if the risks are too high we recommend that target cost should be used in order to reduce the risk-premium.

In *quadrant four* the choice of project delivery method can be either DBB project delivery method or DB project delivery method. Since the risks are significantly high there will be a requirement of cooperation and a payment principle that allocate the risks between the actors. The project delivery method should be chosen based on which actor that should have the major responsibility of the risks and uncertainties. The need of innovative solutions should also be considered when choosing between the different project delivery methods. Since the risks are significantly high there is only one alternative of payment principle and that is target cost. In order to be able to handle project in this square we think it is required to use a Project specific company. Below, in figure 22 the selection matrix with the suggested project delivery method and payment principle is shown.

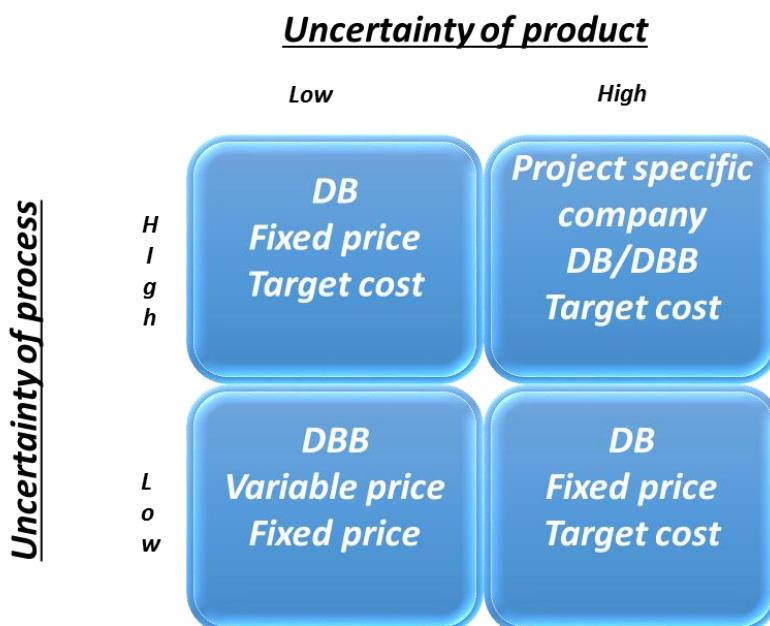


Figure 22 Suggested parts of the project contract in the different quadrants



# 7. Conclusion and Recommendations

*This chapter presents the conclusions based on the investigations questions in chapter 2. The conclusion will be followed by some recommendations for future work in the subject.*

## 7.1 Conclusion

The following conclusion is based on the research questions given in chapter 2 and is shown in figure 23

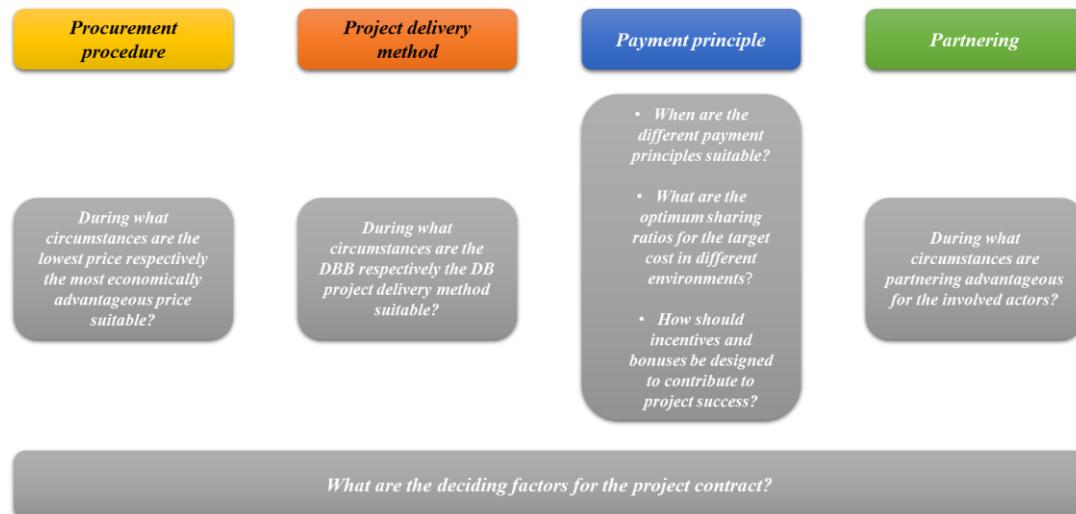


Figure 23 investigation questions

### 7.1.1 Procurement procedure

The lowest bid should be used in 20 percent of STA's projects. As stated in both theory and by the actors the lowest bid should be used in projects where the complexity is low, the uncertainties are low and the project is of a small size. This is due to the simpler tendering process that is required for a lowest bid contender. There is no need to have a most economical advantageous if the construction is simple since there is no need of improved quality or other specific criteria. The three other quadrants should use most economical advantageous because in these projects there is a greater need to choose a contractor based on both price and other deciding factors that will be important for the project. The most important factor that we found out in the interviews is the time aspect. All interviewed actors said that the time incentive is the most important incentive and by using most economical advantageous it is also possible for the client to choose a contractor based on factors such as time. Therefore, it is possible to find a contractor that most likely will finish the project in time. To summarize, the simpler projects should use lowest bid procurement procedures and all other projects should use most economical advantageous.

### 7.1.2 During what circumstances are the DBB and DB project delivery method suitable

When a project has several different solutions regarding the delivery of the construction process, there is a unified understanding among clients and contractors that the DB project delivery method is the most suitable. The DB project delivery method promotes innovations, which also is supported in the theory. So, when the available solutions are few or just one,

there is no motive to use the DB project delivery method. Hence, the DBB project delivery method should be used. When the situation is the opposite, with several available solutions, the DB method should be used.

The respondents from the client organization argued that if complexity is too high, the risks are also high and hence, there is not fair to push too much responsibility towards the contractors. The DB project delivery method would thereby expose the contractors for large risks. However, the contractors argued that the complexity alone is not the problem. Further, the contractors also stated that complexity gives them opportunities to really deliver innovative solutions. The risks are not a problem as long as they are clearly stated and fairly allocated. As one contractor argued "*it is the uncertainties that are the real risk, the other risks can we handle if they are defined*". In projects with high complexity together with high risks and uncertainties the DBB project delivery method have, traditionally, been used by STA. During the interviews two cases was mentioned by the respondents where the projects had high complexity together with high risks and uncertainties. In both cases the DBB project delivery method has been successfully used. However, in both cases the level of cooperation was high, and it was the cooperation that was the success factor, not the project delivery method.

The size of a project, which is closely related to the complexity, also matters considering project delivery method. The contractors and the client all agrees that to benefit from the advantages of the DB project delivery method the projects has to be of considerable size.

As mentioned above the risks and uncertainties also determine the selection of project delivery method. Also mentioned above, together with complexity, contractors and the client have somehow a dissimilar view regarding how the risks and uncertainties should be treated. The client claims that with high risks the DBB project method should be used. The contractor, however, do not entirely agree. The DB project delivery method can advantageously be used during projects with high risks. The contractors can make profit from handling the risk, but the risk must be defined. This is also supported in the theory by Simister and Turner. The risks and uncertainties, however, vary in all projects. If the risks and uncertainties are large and hard to define, there will be problematic to push the responsibility towards the contractors. It will, with no doubt, result in extreme risk premiums. The success factor in such environment is a deep cooperation.

### **7.1.3 When are the different payment principles suitable**

The fixed price payment principle together with the DB project delivery process is best suited when there is high complexity, high uncertainties of process and the uncertainties of the product are low, and hence, there are opportunities for alternative and innovative solutions. By having low uncertainty on the product, the functional requirements are easy to define and, hence, the projects actual cost are quite easy to calculate. By using the DB project delivery method in combination with the fixed price payment principle the risks are pushed towards the contractor. However, the contractors are able to carry the risks as long as the functional requirements are clearly defined. By using the fixed price payment principle the degree of freedom for the contractor will increase. By increased degree of freedom the contractor have the possibility to find innovative solutions that may decrease the actual cost compared to the calculated cost. Hence, a "win-win" situation may arise for the involved actors. However, if

the risks and uncertainties for a project are considerable, the risk-premium will be considerable, and the fixed price payment principle is not the best suited.

A risk with the use of fixed price payment principle is that the contractor sets its tender too low, and the actual cost for the project cost exceeds the calculated project cost. In this case there is an increased risk that the contractor will start looking for correctional and additional work in order to not lose more money. Further, the fixed price payment principle in combination with the DB project delivery method might lead to that the contractors try to gain more money by reducing the quality on the construction. Therefore, it is important during the negotiating procedure of projects with high complexity to focus on other factors rather than on the price.

The variable price or unit price payment principle should be used when the complexity is low and there are low uncertainties and risks. The reason for using unit price in this type of project is that: there is no need for risk allocation, the bill of quantity is easy to define and, hence, there is no risk that the final cost will exceed the calculated cost. During the mentioned circumstances, the unit price is best suited in combination with the DBB project delivery method. The reason for this is that the detail design is easy to define for the client; the pre-planning is almost similar to the detail design. Further, there are few options for alternative and innovative solutions for the contractors.

If a project has high complexity and high uncertainties, there is a possibility of using another variable price payment principle; the cost-plus payment principle. However, using the cost-plus payment principle there will be no incentives for the contractors to find cost-efficient solutions and no incentives to reduce the costs. To use a variable price payment principle in a more complex environment demands some kind of incentives, such as the target cost.

The target cost payment principle should be used when the project has high complexity, the uncertainties of the product and the uncertainties of the process are high. The high complexity together with the high uncertainties implies that the risk is considerable. Because of this, it is important to use a payment principle that allocates the risks between the actors. We believe that target cost can be used in combination with the Design-Bid-Build (DBB) project delivery method and the Design-Build (DB) project delivery method. The choice of project delivery method should be based on which of the actors that should have the major responsible of the risks and uncertainties. However, target cost is always useful if there is a need for cooperation and risk allocation.

Target cost can be seen as a cooperation payment principle. In order for target cost to work at its best some sort of increased cooperation should be used. The reason for this is that the target cost payment principle let the actors share the risks and opportunities, and if there is low or no cooperation it is a lot harder for the client to monitor the project.

The greater the risks and uncertainties are, the more need for cooperation there is. If the risks and uncertainties are very high, the projects benefit from earlier involvement of the contractor. If a project has very high risks, we suggest that the client choose a contractor early in the procurement procedure. The contractor should be chosen based on factors that signal that the contractor is capable of managing the given project. Examples of factors are; experience, size of organization, turnover etc. The client and contractor would benefit from, together, doing the detail design and to determine the target cost. Although the STA obey

under the act of public procurement, the close cooperation is possible within the framework of LUF. However, the risk is that the chosen contractor cannot deliver the given project, or the contractor and the client cannot agree regarding detail design and target cost. In such cases the contractor placed number two in the negotiating procedure should be chosen. Valuable time and money, however, have been spent.

Using target cost payment principle increases the bureaucracy. This is as the major disadvantage with target cost payment principle. It is of great importance that the rules are defined for what posts that should be paid according to variable price and what costs that should be fixed administration costs. Further, there is also a problem with the adjustment for the target cost. In order for target cost to work as intended, the rules about when to change the target cost must be clearly stated. Therefore, it is important to state the specification of when the target cost should change already in the detail design.

The target cost should be set in consensus with the contractors. The reason for this is that there is a risk that the situation will be similar as with the fixed price if the contractors set the target cost. I.e. the contractors sets the target cost to low and the actual cost will become higher than target cost and, hence, the economic incentive will disappear. This risk was also mentioned by the contractors and clients.

#### **7.1.4 What are the optimum sharing ratios for the target cost in different environments**

Depending on how high the uncertainties are, hence the risks, different sharing-ratios should be used. The higher the risks are the greater the need for a greater gain for the contractor. Since the risks are high there must be a considerable incentive for the contractor. The incentive need to be considerable in order to give the contractor a motivation to achieve the target cost. The range in this case could actually be as high as between 60-80 percent in favor for the contractor. The risk with a high gain for the contractor is that the quality may suffer because the contractor may reduce the quality in order to get under the target cost. If the project cost exceed the target cost the ratio should be 50 percent or lower in the perspective of the contractors'. With lower risks the gain-ratio could be lower as well, but never lower than 50 percent. Because, than it is a risk that the economic incentive will be lost. The findings from the interviews and the theory state that the sharing-ratio is different from project to project.

Sharing-ratios for complex projects with high uncertainty works best, and are easiest to determine, if the actors has worked together in the past and, hence, know how to work with each other. This is a bit problematic to combine with the act of public procurement, but, it is by no means impossible. As mentioned, the award decision can be based on factors such as experience, organizational size, turnover etc. The sharing-ratio for a less complex project with lower uncertainties is easier to settle and also; it provides the contractors with experience.

#### **7.1.5 How should incentives and bonuses be designed to contribute in the project success**

Incentives or bonuses are a good way to encourage the contractor to put more effort on crucial parts of the project. If and what kind of incentives to use depends on the specific circumstances of the project. It is also important that the bonus don't become an aim in itself, the bonus should bring benefits for all actors involved.

The time incentive is a bonus that can be used under almost all circumstances. Further, it can bring benefits for all actors involved. As mentioned before, large infrastructure projects are often divided into sub-projects. It is important that the time incentive benefits the whole project and not just the sub-project. However, there must also be an incentive for the contractors responsible for the sub-project. The bonus or incentive is a driving force and if the incentives or bonuses are too dependent on other sub-projects the contractor will lose the driving force. Therefore, it is important that the contractor has an incentive for its own project. During these circumstances we believe that the bonuses should be based on sub-projects as well as on the whole project. The distribution of the bonuses between the sub-projects and the whole project should be settled by the client together with the contractors.

As mentioned above, every project is unique with its own project specific incentives. To state what incentives to use, except of the time incentive, are beyond the scope of this thesis. Whatever choice of incentive, it is important that the contractors have a feeling that they can affect it and that client has the feeling that it contributes to the project as a whole.

In cases when it is low uncertainties and complexity it is more suitable to use penalties instead of incentives. The project is “easy” to construct and it is just for the contractor to follow the detail design. Hence, if there are delays or problems at the project it should be the responsibility of the contractor.

### **7.1.6 During what circumstances are partnering advantageous for the involved actors**

The need of partnering increases with the uncertainties. Although we recommend that there should be some kind of cooperation in all type of project contracts. In the projects with low uncertainties we recommend a cooperation level with weekly meetings between the actors.

With increased uncertainties of process the increase there should be an increase of cooperation. Depending on what choice of payment principle that is chosen there is a different need for cooperation. As mentioned earlier the cooperation should be higher using target cost payment principle than when using the fixed price payment principle. When both uncertainties are high the cooperation should be high. We recommend the use of partnering. The higher the uncertainty level is the earlier the actors should be involved with each other. In the most extreme cases we recommend that the actors should form a partnership before the project contract is designed. This should be done in order to handle the project’s uncertainties in the best manner. To be able to get the correct contractor the client should choose the contractor based on soft values that are important for the project. In this type of project we recommend that the actors create a project specific company, the project specific company should be located close to the construction site and all involved actors should sit down together and handle the problems during the project.

### **7.1.7 What are the deciding factors for the project contract**

There are many factors influencing the choice of project contract. But as mentioned in chapter 6 the most important factors for the Swedish infrastructure sector are Risk and uncertainties, complexity, opportunity to innovative solutions and size. As seen in the matrix many of these factors affect each other and therefore we have minimized the factors to two different factors. Those are uncertainties of process and uncertainties of product. Depending on how high these two factors are the choice of project contract should be different.

## 7.2 Recommendations

Some of the following acknowledged and initiatives brought forward might already be known by STA. However, the following recommendations can be used as a support for the STA in its development work.

- **Partnering.** The next step for STA to investigate is how to improve their partnering in their projects. Although STA has developed their partnering level quite much already there is still room for improvement. As we recommended in quadrant four, it is possible to involve the contractor even earlier in the purchasing process. In order to handle this in the correct way, we recommend STA to investigate how to manage this. It could be done as a master thesis from other students or by an outside consultant firm.
- **Investigate if the change to DB project delivery method is successful.** In the following years, STA has to investigate how the new development of having more DB project delivery method projects has worked out. Maybe the percentage of DB should not be as high as they thought, or maybe it should be higher? It is important to look into the strategy change and not just accept the new strategy.
- **Investigate how DB project delivery method works in other countries.** Furthermore this study is made in the Swedish infrastructure sector. In for example Great Britain the DB project delivery method has been used for many years. It can be interesting for STA to investigate how the DB project delivery method is working in other countries.
- **Create a template to choose the correct project contract.** STA should aim towards creating easily understandable templates to be able to choose the right contract form for the right situation. We believe that our template is a good way to categorize the different alternatives that is possible to choose between to get a successful project contract.
- **Keep the friendly aura.** STA should continue with their friendly relationship towards the contractors. During the interviews with the contractors they stated that they really liked the way STA worked with them. By involving the contractors that suits the negotiated procedure as early as possible, it is possible for the contractors and the client to sit down together and discuss how the project should be managed in the best way.

The change towards DB project delivery method is a very good start to improve the productivity in the infrastructure sector. It is an important modernization for the construction sector. Hopefully it will be possible to increase the attractiveness of the construction industry and help to get younger people interested in the industry. It is important to get younger thought and opinions in order to get a modern and interesting construction industry.

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# Appendices

## Appendix I – Guideline for interviews with actors

### *General*

*What are your tasks?*

### **Project contract – general**

- How do you proceed when you place a bid?
- Can you describe which elements the tender includes?
- Are there different procedure depending on the contract?
- Any problems?
- Time required?
- In-house design?

### **Design Build project delivery method - general**

- What risks do you see with the use of the Design Build project delivery method?
- What advantages do you see with a Design Build project delivery method?
- What are the disadvantages with Design Build project delivery method?

### **Payment Principle**

*Personal experience of payment principle*

- Most common form of payment principle of the various project delivery methods?
- What risks do you see with the various payment principle?
- How often do you complement selected payment principle with incentives?

*Do you have experience with target price of incentives for the various project contracts*

- In particular; Design Build project delivery method in combination with target cost?
- How is the target cost determine? By the contractor or by the client? What do you prefer?
- What incentives are used most frequently?
- What do you consider to be the main advantages and disadvantages of the target cost with incentives?

*What type of payment principle do you prefer in combination with Design Build project delivery method?*

- Why?

### **Design Build project delivery method**

*If Design build project delivery method will be used in a project with uncertain conditions*

- Which payment principle do you prefer?
- Why?

## **Cooperation/Partnering**

*Does your projects usually involve cooperation or partnering??*

- In addition to AB/ABT
- Did you use workshops, open books etc.?
- Did the cooperation work as intended?