Framework for Structuring Procurement Contracts

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Abstract

The aim of this paper is to propose a new structure for classifying contract types and payment methods. Concerning the procurement contract types the first important feature is the stepwise structure with three main steps in the contract design: (1) should the contract only include construction or both construction and operation/maintenance? (2) Who should do the detailed design of the premise? (3) How many contractors should the client use? An important new feature of the structure is that in both step 2 and step 3 there is a continuum of alternatives. Concerning the payment methods the structure is primarily based on how the project specific risks are shared.

Keywords: Procurement, Contract, Construction sector, Infrastructure projects

1. Introduction

In many countries there have been discussions about productivity problems and cost overruns. Changes in procurement, from Design-Bid-Build (DBB) contracts to Design-Build (DB) contracts and/or to contracts where construction and maintenance are bundled, as for example in Public Private Partnership (PPP), have been proposed as ways to create incentives for innovation and for taking life-cycle cost into account (Mandell & Nilsson, 2010).

A survey done by Eriksson and Laan (2007) shows that for the majority of projects procured as DBB-contract, the client together with their consultants makes the detailed design. In this case design could also be handled in-house by the clients using their own staff (SOU 2009:24). On the other hand, in a typical DB-contract the general characteristics of the end product are specified by the client. This can theoretically be done in a number of ways, for example referring to earlier products ("we want a standard type of this") or by specifying general characteristics of the house; "we want a residential building in 7 floors with x square meter and fulfilling basic legal quality demands" or by specifying various functional characteristics of the object (see e.g. Bejrum & Grennberg, 2003 or Mattsson & Lind, 2009). The fundamental difference between DBB-contract and DB-contracts is who has the responsibility for the detailed design; in the first one the responsibility lies with the client and in the second one the responsibility has moved to the contractor. However, in both cases the client, typically, has the responsibility for the operation and maintenance phase, but for example in PPP-projects construction, operation and maintenance is bundled to one contract (Leiringer, 2003; Lind & Borg, 2010). It is argued that this kind of contract (DB-contract and PPP) gives the contractor a higher degree of freedom and the possibility to use new solutions to cut cost and recourses (Ng & Wong, 2007).

The starting point for this article is the belief that a clear terminology and clearly structured arguments are very important for a deeper discussion about the problems in the construction sector. Our aim is to present a new and simple framework for describing and analysing alternative procurement and payment systems. As will be clear in section 2, there is no consistency in the definitions in leading textbooks. The focus in this article is contracts in infrastructure projects, like roads and railways with typically a public client.

The paper is a conceptual paper based on a selective sample of literature. The books chosen in section 2 are chosen because they are leading text-books in construction management[1].

The structure of the paper is as follows. In the next section there is a closer look at how contracts and payments forms are described and categorized in leading textbooks (Gould & Joyce, 2011; Ritz & Levy, 2013; Winch, 2010). In section 3 our proposed framework is presented and in section 4 some general reflections about the choice of procurement contract and payment methods are presented, while reflections on choice of contract type and payment mechanism are presented in section 5. General conclusions can found in section 6.

2. How Contracts are Structured in the Selected Literature

It is common in the selected literature to start with a rather long list of procurement contract types without a clear system: DBB contracts, DB contracts, performance-based contracts, PPP contracts and other. Each contract is seen as a rather unique entity with specific

[1] Based on interviews with Swedish lecturers in the area.

characteristics, often graded in terms of additional commitment for the contractor for each type of contracts.

A second thing to note in the selected literature is that there is no common terminology for the whole problem at hand. The American literature seems to primarily talk of *Project Delivery Method* (see Gould & Joyce, 2011 and FHWA, nd) while Winch (2010) writes in terms of *Ways of procuring*. Ritz & Levy (2013) uses the term *Contract Executing Approach*.

Contract type refers to payment method in Gould and Joyce (2011) but this is called *Contract format* in Ritz & Levy (2013). In FHWA (nd) *Procurement Method* refers to selection criteria when choosing contractor, which is called *Ways of procuring* in Winch (2010).

Below, the basic terminology recommended is *Procurement contract type* and *Payment method*, where the first refers to how tasks are allocated between different actors and the second refers to how the contractor is paid.

2.1 Procurement contract type

The tables below and comments after the tables summarize how the procurement contract types are structured in the different sources. We first look at Gould and Joyce (2011).

Table 1: The structure in Gould and Joyce (2011, Chap. 4)

Name	Description
Design Bid Build	The client hires a designer (architect), who prepares a design and complete contract documents. With correct documents the client either conducts a bidding process or negotiates with a specific contractor. The contractor is then responsible for construction and delivering of a complete project. Both the architect and the contractor have the possibility to choose sub-contractors. The contractor is solely responsible for execution of the work.
Design Build	The client hires a firm, i.e. a contractor that will perform both design and construction. The contractor has the possibility to hire sub-contractors and architects for design.
Construction Management	The client hires both a construction management firm and a designer (architect) and has solely responsibility to hire individual construction contractors. The construction manager can have different knowledge and can be put in place at different stages. It's free for the architect to hire sub-contractors.

In the text Gould and Joyce (2011) also talk about:

- Concession contracting (p 34): DBFO (Design Build Finance Operate), and BOOT (Build Own Operate Transfer).
- Innovation in project delivery (p 91) where they mention PPP as a way to finance and BOO (Build Own Operate); DBO (Design Build Operate) and DBF (Design-Build- Finance) as further examples.

The structure presented in Winch (2010) is presented in Table 2. It is described in terms of *formation of the project coalition*.

Table 2: The structure in Winch (2010, Chap. 5)

Name	Description
Separated	The client hires suppliers and (designer) architects and competitive tendering for sub-contractors. The architect is then responsible for select the trade contractors who will execute the site work. The architect is responsible for the co-ordination of the contractors but not for any failings. A version is that the client hire a general contractor that take over the responsibility of the execution of the project on site.
Integrated (Turnkey)	The client hires a single contractor for both design and construction stage on a competitive tender basis.
Mediated (construction project manager)	The client hires architects and a construction manager who will be responsible for managing the trade contractors on site. The contractors are selected on the basis of a competitive tender organized by the construction manager. The arrangements and terminology vary considerably depending on the clients or the construction managers different responsibility of the stages,
Unmediated	When a client has a high level of in-house project management capability and has the knowledge and possibility to hire sub-contractors.

Winch (2010) also talks about four basic types of privately financed procurement (p 43): Concession, Private Finance Initiative, Public private partnerships, and Company limited with guarantee.

In Table 3 the contract structure in Ritz and Levy (2013) is presented.

Table 3: The structure in Ritz and Levy (2013, Chap. 2)

Name	Description
Traditional	The client hires a separate designer and a single general contractor that have the possibility to hire sub-contractors.
Turnkey	The client have two options, the first option is design-build where a single engineering contractor have the responsibility for both the design and construction. The general, contractors hired by the engineering contractor, in turn have the possibility to either hire sub-contractors or use own working forces. The second option is that the client instead hires an engineering construction manager with the responsibility of the design and construction, that in turn hires the designer and an construction manager that have the responsibility for the construction and possible sub-contractors.
Owner builder	The client is responsible for design and construction and has the option to either use in-house competence or hire sub-contractors.
Construction Management	The client has two options. Either the client hires a separate designer and a general contractor that acts as a construction manager and acts as an agent for client services and have own hired sub-contractors. Or, the client hires a designer, a construction manager that acts as the client´s agent and individual construction contractors.

In the text Ritz and Levy (2013, p 51) also mention Build Operate Transfer (BOT) as another alternative.

The FHWA (nd) presents the following structure.

Table 4: The structure in FHWA (nd)

Name	Description
Design Bid Build	Client hires separately for design and construction services and keeps high level of control and risk. The contractor's involvement is restricted to the construction phase. The client needs to completely define the scope.
Design Build	The client combines design and construction under a single contract. The contract can also cover design-build-maintain, design-build-warranty and design-build-operate. The owner has the possibility to define a scope of work but opportunity for innovation. Often used for projects that is complex in nature or having a high sense of urgency. The contractor's involvement has the span from just after the pre-design and ends at least after the warrant have expired.
Construction Management	The client hires a Construction Manager to act as a construction advisor during the pre-construction phase and as a general contractor during the construction. Transfer cost and risk to the construction manager. The client has the control of the scope and design during the process. The contractor's involvement has the span from just after the pre-design and ends when the warrant has expired.
Public Private Partnership (PPP)	The client hires a developer that takes part in financing project in return for ability to collect toll revenues, or pursue development rights. The developer is responsible for integrated delivery of design, construction, and operation and maintenance for an in advance specified time period.
Alliance contracting/ Integrated project delivery (IPD)	The client and at least one service provider, e.g. constructors, consultants and designers, collaborate on the delivery of a project. The client collaborates with the industry to allocate risk.

It can be seen that there are three procurement contract types that come back in several of the classifications. *Design-Bid-Build* can be found explicitly in two of the four classifications, and it seems to be the same as what is called *Separated* and *Traditional* in the remaining two. *Design-Build* is also found in two of the tables and is called *Integrated* and *Turnkey* in the other two. *Construction Management* is found in three of the tables. What Winch (2010) calls *Unmediated* seem to be similar to what Ritz and Levy (2013) calls *Owner Builder*. Several of the books include some form of PPP as a fourth alternative, but others see PPP as something outside the classification that they just comment upon in the text.

2.2 Payment methods

Concerning payment methods, the tables below summarize the main alternatives, as described by the authors.

Table 5: The structure in Gould & Jayce (2011, Chap. 4)

Name	Description
Single fixed price	Also called lump-sum is a contract where the contractor has accepted to deliver a specified amount of work for a specific sum of money. Once the contract is sign, both parties have to live with the terms.
Unit price contract	The client and contractors agrees on the price that will be charged per unit for the major elements. The client often provides estimated quantities and the contractor calculating the final price according to the information with addition for the contactors overhead, profit and other

	project expenses. The final contract price is not known until the last work has been done.
Cost plus a fee	A contract where the contractor is reimbursed by the client for every work costs and also receives an additional agreed-upon fee or a fee that is a percentage of costs.

Table 6: The structure in Winch (2010, Chap. 6)

Name	**Description**
Fee based	Cost-reimbursable contract also seems to cover unit-price contract.
Incentive contract	Can be both a fee based- and a lump-sum contract and varies in shape. The uniting part is the attempt to have positive incentives within the contract to motivate to fulfil performance by gainsharing between the parties.
Fixed price	A contract where the price is fixed for an agreed amount of work. It could be that the contractors price is fixed or an after-measurement when the quantity of work to be done is not known in advance.

Table 7: The structure in Ritz and Levy (2013, Chap. 2)[2]

Name	**Description**
Cost-plus (a number of versions)[3]	The client agrees to pay the contractors for the cost of the work plus a fee, very often calculated as a percentage of the cost. This contract can be complemented with a guaranteed maximum, guaranteed maximum and incentive, or guarantees maximum and provision for escalation.
Bonus (a number of versions)	Bonus related for example to time, completion and/or performance.
Lump sum (a number of versions)	Contract where the contractor prepares their bids according to completed set of plans and specifications. No more no less than stipulated in the documents should be included.
Unit price contracts	The client and contractors agrees on the price that will be charged per unit for the major elements. The client often provides estimated quantities and the contractor calculating the final price according to the information with addition for the contactors overhead, profit and other project expenses. The final contract price is not known until the last work has been done.

In this case there is also a lack of common structure even if some forms come up a number of times. *Fixed price* is mentioned by all three, and *Cost-plus* and *Unit-price* contract is mentioned by two. The general impression here is also that there is no common structure in how the alternatives are presented.

3. The Proposed Basic Framework: Procurement Contract Type

We believe that similarities and differences between procurement contract types become clearer if a stepwise procedure is used, in other words a structure where one dimension at a time is introduced. The following framework is based on three steps: determining what is to be procured, who should do the design and how many contractors are used.

[2] They also discuss convertible contracts used in joint ventures which is not relevant here
[3] Here we also include what they call Time and materials.

Step 1: What is procured – only construction or a bundled contract with construction and operating/maintenance

One confusing thing, especially in the FHWA (nd) framework, is that "delivery methods" do not concern different ways of "delivering" the same type of object, but also that the composition of the object differs between the methods. The first "delivery methods" only concern a "premise" – for example a road or a tunnel - while the last method concern building an object *and* operating/maintaining it for a considerable number of years.

In the proposed framework the *first* step for the client is to decide whether a contract that delivers an object should be chosen or whether a bundled contract that includes both construction and operation/maintenance should be chosen. It can be seen in the other works above that PPP- or BOT-projects are not integrated in their basic framework but instead mentioned in the text without a clear relation to the basic framework. Here they are integrated in the same framework as the traditional contracts that only concern a premise. Figure 1 below illustrates this first step.

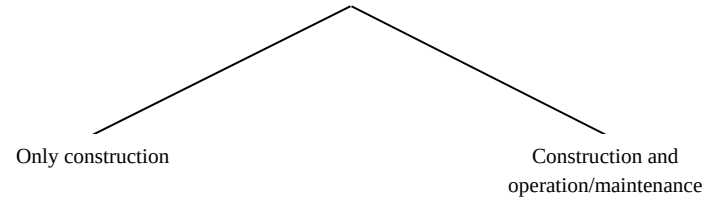

Figure 1: Initial decision when procuring a contract in the infrastructure sector.

Step 2- Version 1: Who is doing the design?

The line drawn between DBB and DB contracts concerns who has the responsibility for the detailed designs of the facility. This is the same distinction as the one drawn between what Winch (2010) calls *Separated* vs *Integrated* contracts, and what Ritz and Levy (2013) call *Traditional* vs *Turnkey* contracts. In the first type the detailed design is the client's responsibility and in the second type the detailed design is the contractor´s task. This is illustrated in Figure 2 below.

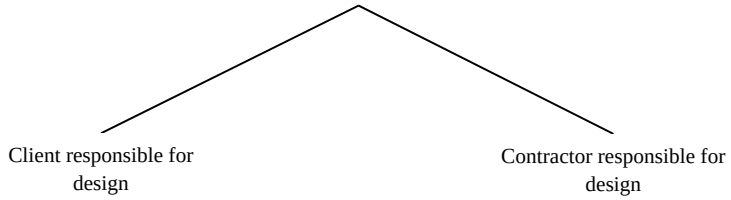

Figure 2: Step 2 - who makes the detailed design: version 1

In the literature the distinction related to who makes the design is only used for pure construction contracts, but the same distinction can actually be made for the bundled contract also. The client may have a clear view of exactly the kind of facility they want and how it should be managed, but still write a bundled contract. The study presented in Borg (2011)

indicates that in the (few) Swedish PPP-projects that has been carried out there were very little innovations and that the contractor to a very large extent used techniques that the client earlier had used in DBB-contracts. The choice of bundling construction and operation/maintenance can be motivated by other arguments than giving the contractor freedom concerning the design, for example efficiency in the operation of the facility. Combining Figure 1 and Figure 2 therefore gives four basic options, but as will be argued in the next section, the real world options do not fit neatly into this framework.

Step 2 –version 2: Who is doing the design?

Nyström *et al* (2014) shows that one cannot assume that just because a contracts is called "a DBB-contract" and another is called "a DB-contract", there is actually more degrees of freedom for the client in what is called a DB-contract. That article also makes it clear that in most DB-contracts there are detailed technical specifications concerning a number of aspects of the premises. In order to simplify repairs or handling of spare-parts, the client might have very specific demands concerning some components but leave other things open. The responsibility for the detailed design is in practice divided between the client and the contractor. It is therefore more correct to talk about a continuum of contract forms than to talk about 2 alternatives (client vs contractor responsible for design). This is illustrated in figure 3 below with an arc between the two extreme points, where in one extreme the client makes detailed design choices for all components and in the other extreme the client only formulates rather general functional demand (capacity of a road, maximum track depths etc.). Each point on the arc represents a specific division of responsibilities for the detailed design.

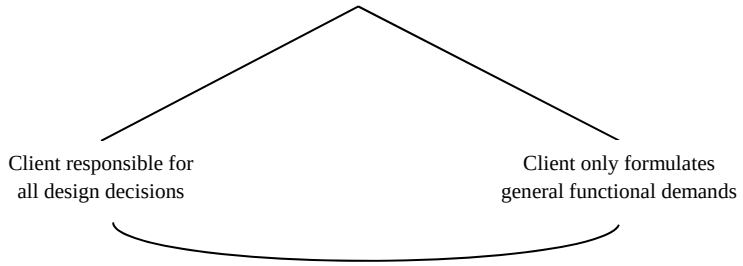

Figure 3: Step 2 who makes the detailed design: version 2

If the client is responsible for a design decisions there is a further subdivision concerning whether the design department is an in-house department or whether independent consultancy firms are contracted for doing the design work. As an example it can be mentioned that Swedish Transport Authority (STA) has gone from an in-house design departments to almost complete outsourcing during the last 15 years. This could be added to as a "step 2b" in the diagram, but it is not done here in order to avoid a too complicated diagram.

External or in-house project manager: Construction Management

In especially the American literature, Construction Management (CM) is described as one of the basic procurement strategy. In Sweden, this is not seen as a specific "delivery method" or contract form when infrastructure procurement (Eriksson & Hane, 2014), but as a more pragmatic issue of whether to have an in-house project manager or whether to hire an external project manager. The STA for example uses a mix of this and sometimes a combination of external and internal project managers in the same project.

It can be noted that sometimes in the literature the CM is described as having a role that make the construction manager almost the same as a contractor. The construction manager is described as being responsible towards the client, and the construction manager hires sub-contractors. The large contractors in Sweden, like Skanska, PEAB and NCC, currently describe themselves as CM-companies, as they to a large extent use subcontractors. In this way they can reduce their fixed costs and risks. The comparative advantage for the company is then in putting together the right team of companies for the specific task.

In our proposed framework CM is for these reasons not seen as a specific procurement contract type. How the contractor structures their work is up to them and not part of the procurement contract type.

Step 3: One or several contractors

In the models above it has been assumed that there is only one "general" contractor, but this is of course not necessary. It the literature above there where models like the one Winch (2010) calls "Unmediated" or what Ritz and Levy (2013) call "Owner builder", where the client hires several contractors that carry out specific tasks.

Also here there is a continuous scale concerning the number of subcontractors, from one general contractor to a large number of separate subcontractors, see Figure 4 below.

It is important to see that a divided model with several subcontractors is possible also in the case where both construction and maintenance are included in the contract. In that case using a number of contactors means that each one is responsible for a set of components of for example the road. An example can be that one company is responsible for building and maintaining electronic information systems in a tunnel, while another is responsible for road in the tunnel. Even if the typical case in a PPP-project is that there is one (general) contractor, this is not theoretically necessary.

Partnering

As described in Nyström (2005) and Eriksson (2010), partnering can be given a number of more specific interpretations. Their view, and the view here, is that partnering should be seen as a way to carry out a certain project in a more collaborative way – opening up for adjustments during the project – and that this means that Partnering should not be seen as specific procurement contract type but as something that can be implemented in any procurement contract type.

The complete model

In figure 4, all the different dimensions are included and the idea is then that a specific procurement contract can be seen as a specific point in this diagram. Notice that bottom part of the figure should be read as that there, for each point in the arc between client responsible for design and contractor responsible for the detailed design, there is a choice between a continuum of number of contractors.

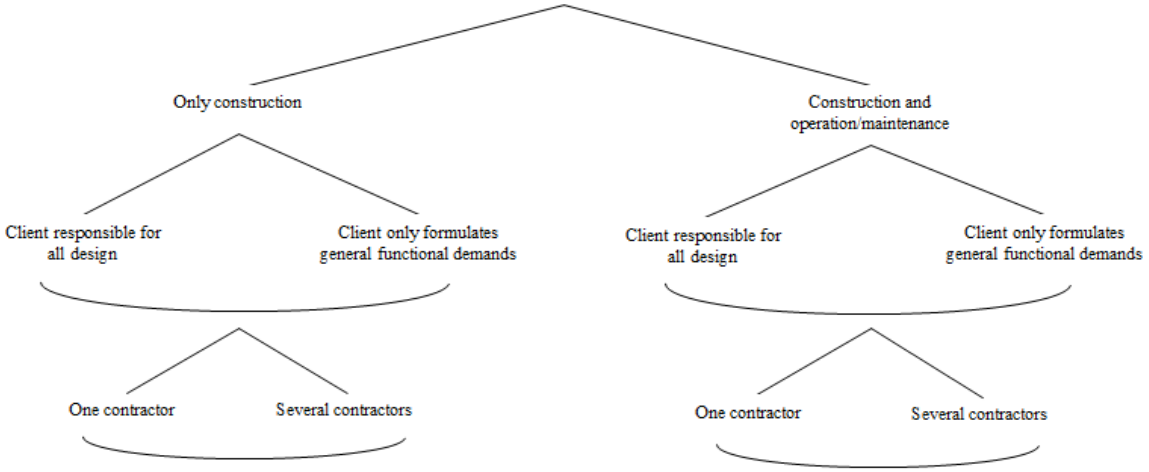

Figure 4: The complete model

4. The Proposed Basic Framework: Payment Method

We propose that the payment methods are divided into two main categories in relation to whether there is any project-specific risk sharing or not. It will be argued that bonuses in relation to time of completion and to higher quality can be introduced in all payment methods and therefore bonuses are discussed separately. Here we only include payments where the public client pays the contractor, and the risk that the client will not pay according to the contract will not be discussed as that can happen in any type of contract. For a PPP-project it is also possible with payment methods where the user pays for using a road/rail but these will not be discussed here. However, some special issues in contracts where construction and maintenance is integrated will be discussed below.

4.1 No project specific risk sharing

Here there are at least three subgroups

1. Fixed price: all risk is borne by the contractor/contractors
2. Fixed price with general indexing (e.g. consumer price index, or a general construction price index): All risk except changes in the general price level borne by the contractor.
3. Cost-plus contracts: all risk is borne by the client.

4.2 Project specific risk sharing

The cost in a project will depend on prices for various inputs and how much of the different factors of production that is needed (see Brunes & Lind, 2014). Especially in more complex projects there are uncertainties in both dimensions and various ways of sharing these risks exists.

- Unit-price contracts: In this case the prices of different types of work is fixed in the contract, but at least for some dimensions there are “variable quantities” which means that the contractor is paid according to the actual quantities but with the agreed price per unit. This means that the risk in relation to prices is born by the contractor (unless there are correlated with a general index used), but the risk related to quantities is borne by the client.

- Sharing in cost increases/cost reductions (Cost sharing). In this case the basic idea is that there is an "agreed price" but if the actual cost is higher than this, a certain share of this is paid by the client. If the actual cost is below the agreed price, then the price paid by the client is reduced by a certain share of this saving. This means that both price and quantity risks are shared.

4.3 Bundled contracts with construction and operation/maintenance: One special issue

These bundled contracts typically cover a 10-30 year period and this opens up at least one extra issue concerning the payment method. Should the client pay only a yearly fee – covering both capital costs and operating costs – or should the client pay a combination of an "up-front" payment when the premise is ready for use (which can be seen as covering the investment cost) and then a yearly fee for operation and maintenance? The last model was for example used in one of the first road projects of this type in Sweden (Norrortsleden). There seems to be at least two arguments for the second model. The first is that it fits better into the government budget system if the government has a classical investment budget. The second argument is that if the financing cost of the government is lower, then total cost would be reduced if a certain sum is paid by the government when construction is finished.

4.4 Bonuses and penalties in relation to time and quality

All contracts specify what the contractor should deliver and in all contracts it is possible to add bonuses and penalties if the contractor delivers something that is better or worse than what was agreed in the contract. The simplest version of this is bonuses and penalties in relation to project completion, but also other measurable qualities can be used as a base for quality bonuses and penalties. In some cases it may be more rational to make the contractor pay a penalty instead of having to redo some work to reach the agreed quality, but this will not be discussed further here. Bonuses and penalties can also be related to the guarantee period (for a construction contracts), and to contracted quality during the contract period and at the end of the contract period (for integrated contracts). How the contract handles this is a complex issue that needs a special study.

4.5 Relation to the selected literature

Going back to the literature review, the different payment methods presented there is covered in our framework. What is called *Fixed price* above covers what Gould & Jayce (2011) call S*ingle fixed price*, and what Winch (2010) calls *Fixed price* and what Ritz & Levy (2013) call *Lump sum*.
Gould & Jayce (2011) further mentions *Unit price* contract and *Cost plus a fee*, which also are included above. The *Fee based contract* in Winch (2010) are similar to the *Cost plus contract* and his category *Incentive contract* cover both what is called *Cost sharing* and various bonus systems mentioned above. Ritz & Levy (2013) further mentions *Cost-plus* and *Bonus* which are covered by the categories above.

5. Reflections on the Choice of Contract Types and Payment Mechanism

5.1 There are always problems…

From a theoretical perspective it is clear that there are potential problems in all models.

- Integrating construction and maintenance have potential advantages in terms of creating incentives for minimising life-cycle costs. On the other hand, integrating

construction and maintenance tend to reduce competition and it is always difficult to write long-term contracts, see for example Lind & Borg (2010).
- Leaving the detailed design to the contractor opens up for new solutions and makes it easier to adapt the design to the skills of the contractor. On the other hand, giving the contractor increased degrees of freedom also increases the risk for moral hazard and solutions that minimise the short-term cost of the contractor (see Nyström *et al*, 2014; Borg, 2011). A risk-averse contractor tends to choose traditional established solutions and that might reduce the rate of innovation (Borg, 2011).
- Using a general contractor reduces the transaction costs and the risk for the client. On the other hand this model also reduces competition, and transferring risk to another party always comes with a cost.

In the same way there are difficulties in all payment methods:

- Putting all the risk on the contractor can reduce competition and be costly if contractors are risk averse.
- If a price index is used there is always a problem of choosing the right index, and in some cases the indexing can create new uncertainties as the effect of the index is unsure, for example when different prices change in different directions.
- A cost-plus model that put all the risk on the client reduces incentives for the contractor.
- Unit-price contracts opens up for strategic bidding (see e.g Mandell & Nyström 2013, Skitmore & Cattell, 2013) when the contractor thinks that actual quantities will differ from the one in the procurement documents.
- Sharing divergences from an agreed price also makes it necessary to measure the actual cost which also is difficulties. The risk sharing contracts also reduces the incentives for the contractor.
- Bonuses related to certain specific parameters (e.g. completion on time) may lead to reduced quality in other dimensions as the contractor focus on the dimensions that can lead to a bonus (see Milgrom & Roberts 1992, Chap. 7).

5.2 How deterministic is the world?

Given the complexities discussed above a natural research strategy would be to find relation of the following type: "In situation X, contract type Y is the best" (see e.g. Eriksson & Hane 2014). Warsame et al (2013), however, questions whether this really is possible. How a certain model works in a specific situation will depend on the skill and earlier experience of the parties involved. If the actor believes in "model A" and know the potential problems in this model, it might be possible for the actor to take measures that control these problems and therefor get good results from "model A". Another smart actor that believes in "model B" might in the same way make that model work in the same situation. A client that has had problem with one model might choose to change to another just get a new start.

6. Conclusion

The main contribution of this paper is the proposed structures for classifying contract types and payment methods.

Concerning the procurement contract types the first important feature is the stepwise structure with three main steps in the contract design:

1. Should the contract only include construction or both construction and operation/maintenance
2. Who should do the detailed design of the premise (and decide the details of how operation/maintenance should be carried out)?
3. How many contractors should the client use?

An important new feature of the structure is also that in both step 2 and step 3 there is a continuum of alternatives and this is especially important in Step 2 where the client might want to regulate certain things in detail, while leaving other things to the contractor.

Concerning the payment methods the structure is primarily based on how the project specific risks are shared, where Fixed price put all risk on the contractor and Cost-plus puts all risk on the client. Unit price contracts puts the quantity risk on the client and the price risk on the contractor, while Cost sharing contracts implies that client and contractor share both price and quantity risks. In all contracts bonuses and penalties can be used for example in relation to completion date and measurable quality dimensions.

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