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Tiina Koppinen & Pertti Lahdenperä

Road sector experiences on project delivery methods

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Abstract

Globally, innovative delivery methods involving broader service packages are increasingly used in infrastructure projects. In addition to construction and technical design also; financing, operation and maintenance for a certain period of time may be integral parts of the contract. This change is driven by the clients' quest to focus on their core business – securing adequate infrastructure – and by the clients' and the contractors' aim to increase their benefits. At the same time, the number of alternative project delivery methods is increasing making it more difficult for the client to select an appropriate method. As a result, decisions to use any of the alternative project delivery methods are often subjective. There is an evident lack of consolidated knowledge about the specific merits of these alternative routes.

To assist strategic decisions on the best project delivery methods for future project delivery, the research concentrated on gathering data on the performance of different road project delivery methods and comparing their performance levels now and in the future. This first report summarises the data used as the basis for the actual performance analysis presented in the second report 'The Current and Future Performance of Road Project Delivery Methods'. The purpose of this part of the study was to gather data on the performance of the traditional Design-Bid-Build (DBB) and the Design-Build (DB), Construction Management (CM) and Design-Build-Maintain (DBM and its variants DBOM, DBFO, BOOT, etc.) project delivery systems in road construction in Finland, UK, Australia, New Zealand and USA. The main source of information were semi-structured interviews of the main market actors (clients, contractors, designers, consultants and researchers). Additionally an extensive literature review was done to supplement and verify the data provided by the interviewees.

It seems that the problems experienced with DBB have led to increased use of DB and DBM-type project delivery. These methods help deliver projects in time and to budget while also reducing other experienced problems (adversarial relationships, etc.). However, there seem to be some problems even with DB (reduced quality, etc.) and DBM (reduced client flexibility, etc.). Solutions to these problems are sought through largely similar means globally. Alliancing also seems to provide an interesting alternative for complex and large projects. Use of CM in road construction is marginal.

Preface

This report is a result of the research project carried out by VTT Building and Transport called 'The Performance and Development Potential of Project Delivery Methods for Infrastructure' or INKA. The research concentrated on gathering data on the performance of different road project delivery methods and comparing the performance levels of these methods now and in the future. The project is part of The National Technology Agency's (Tekes) INFRA National Technology Programme where development of appropriate project delivery and procurement methods for infrastructure construction is one of the focus areas.

This report (first in order) summarises the data used as the basis for the actual performance analysis presented in the second report 'The Current and Future Performance of Road Project Delivery Methods'. This report allows industry people to learn from project delivery experiences of the main industry actors in different markets (Finland, UK, Australia, New Zealand and USA) helping the infrastructure industry to concentrate on the main problem areas experienced with each project delivery method. However, the report does not attempt to make any conclusions yet concerning the performance level of different project delivery systems.

The project began at the outset of 2003 and was completed by the end of August 2004. The work was largely done by Mrs. Tiina Koppinen (M.Sc. Tech., MBA) with contributions and guidance by Dr. Pertti Lahdenperä.

The research was commissioned by The Finnish Road Administration (Finnra), The Finnish Road Enterprise, The Confederation of Finnish Construction Industries (RT), The Central Organisation of Earth Moving Contractors in Finland (SML), The Finnish Rail Administration (RHK) and The Finnish Association of Consulting Firms (SKOL). These parties also formed the steering group, which supervised the research. The steering group consisted of:

Markku Teppo	The Finnish Road Administration (*Chairman*)
Jussi Kauppi	The Association of Finnish Local and Regional Authorities
Matti Kiiskinen	The Finnish Association of Consulting Firms
Pekka Pakkala	The Finnish Road Administration
Ilkka Romo	The Confederation of Finnish Construction Industries
Harto Räty	INFRA Technology Programme
Timo Vikström	Lemcon Ltd; representing The Central Organisation of Earth Moving Contractors in Finland
Tom Warras	The National Technology Agency, Tekes
Lars Westermark	The Finnish Road Enterprise
Harri Yli-Villamo	The Finnish Rail Administration

I want to thank all the above parties, who made this research possible. I also express my gratitude especially to the interviewees, who were willing to devote their valuable time and share their experiences on road project delivery with me.

August 2004
Tampere, Finland

Tiina Koppinen

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Glossary

Alliance; Alliancing. Project Alliance is an agreement between two or more entities (the client and contractor(s) plus potentially other project participants or stakeholders) that undertake to work cooperatively, on the basis of sharing project risks and rewards, for the purpose of achieving agreed outcomes based on principles of good faith and trust and an open-book approach towards costs.

Alliancing. See Alliance.

Build-Own-Operate-Transfer (BOOT, BOT). A private company finances, designs, and builds the project and then operates it for a specified concession period. During this concession period, the company collects revenues (often user fees) from operating the project to recover its investment and to earn a profit. At the end of the concession period ownership of the project transfers to the client.

Client; Owner. The owner is the initiating party for whom the project is developed. This party is also in most cases the source of the financing. Owners may be public or private.

Consultant. The consultant is a construction expert hired by the client typically to administer the construction (and design) phase of the project on behalf of the owner in the absence of a construction manager.

Construction Management (CM). Construction Management is a project delivery method based on the owner's agreement with a qualified construction firm to provide leadership and perform administration and management for a defined scope of services.

Construction manager (CMr). The construction manager is the party responsible for the core duties in a project. The CMr may be a design firm, a contractor or a professional construction manager. Construction management services range from mere coordination of contractors during construction to broad responsibilities over project planning, design, construction scheduling, cost monitoring, and other management services.

Contractor. The general contractor is the entity charged with the responsibility of actually implementing the construction work. This party determines the means, methods, techniques, sequence, and procedures needed to direct the actual construction activities. In DB, the contractor (design-builder) is also in charge of finalising the design.

Design-Bid-Build (DBB). In this ‘traditional’ project delivery method a designer prepares complete construction documents for the owner. The owner then receives bids from contractors based on the design documents and awards a construction contract to the lowest responsive, responsible bidder. The contractor builds the project, and upon completion, the owner assumes responsibility for the operation and maintenance of the project. The owner provides all financing.

Design-Build (DB). In Design-Build the owner selects a single contractor to both design and build the project. Upon completion of construction, the owner assumes responsibility for its operation and maintenance. The owner provides all financing

Design-Build-Finance-Operate (DBFO). This project delivery method integrates operation and maintenance with the tasks of design and construction. The responsibility for financing the project is assumed completely by the contractor, typically at the contractor's risk. The client pays for the service provided according to a pre-determined payment mechanism. Control of the asset may return to the client at the end of the concession period (i.e. contract period).

Design-Build-Maintain (DBM). This project delivery method integrates maintenance with the tasks of design and construction. The term is used here as a general term that covers all procurement methods that extend the contractors’ responsibilities from pure design and construction to longer term maintenance liability, with or without other duties, such as operation and financing (DBFO, DBOM, BOOT, etc.).

Design-Build-Operate-Maintain (DBOM). This project delivery method integrates operation and maintenance with the tasks of design and construction. At completion of the contract, the owner assumes operation and maintenance responsibilities himself or through another procurement process. The owner provides all financing and may collect third party revenues.

Designer. Designer/engineer is the party that designs the work.

Key Performance Indicator (KPI). A Key Performance Indicator is a measure of the performance of an activity that is critical to the success of a project or organisation. Key Performance Indicators need to be quantifiable measures that are agreed to beforehand.

Output specification. Output specification describes the total service solution the client desires to procure. It defines the quantity and quality of the service, but does not describe how the service should be provided.

Owner. See Client.

Performance-based specification. A performance-based specification states the client's requirements in terms of the required results and provides criteria for verifying compliance, but it does not state the methods for achieving results. It defines the functional requirements for the product, the environment in which it must operate, and the interface and interchangeability requirements giving the service provider latitude to determine how to best meet the stated needs.

Private Finance Initiative (PFI). PFI is one of the alternatives of Public-Private Partnership (PPP) that involves private financing of schemes, where the investment is recouped through public sector service fees. Here a private sector entity takes the responsibility to design, build, finance and operate (DBFO) an asset used in the provision of public services for a contract period up to four decades. In addition, the private sector entity has ownership of the project asset for at least the contract period.

Procurement. Procurement means the acquisition of goods or services through a transparent, competitive, public process.

Procurement process. The procurement process is a series of activities in compliance with statutory and regulatory requirements by which owners acquire goods or services from the private sector.

Project delivery. Project delivery involves processes required to complete a good or service according to the contract.

Project delivery method; Project delivery system (PDS). A project delivery method is a system for organising and financing design, construction, operations and maintenance activities that facilitates the delivery of a good or service.

Project delivery system (PDS). See Project delivery method.

Project Company (ProjectCo). A project company is the company responsible as the first tier supplier for organising the delivery of the DBM project to the client.

Public-Private Partnership (PPP). In PPP the public and private sectors combine their special capabilities to deliver the project most efficiently. The content of the contract may vary significantly, but generally the public sector transfers a significant level of risk and responsibility to the private sector for the long-term arrangement.

Public sector comparator (PSC). A public sector comparator (PSC) is used in estimating the value of a proposed DBFO project. It is calculated by costing what the public sector would have to pay to procure the construction of the relevant schemes and

the operation and maintenance of the project road over the selected concession period by the best practice means (generally DBB or DB).

Request for proposal (RFP). The request for proposal is a legal document that specifies how the client wants to get the project delivered. It offers instructions to bidders and provides the scope of the work and other important information that govern the construction of the project.

Shadow toll. The shadow toll is the payment per vehicle per kilometre for using a privately funded project road in accordance with a preset tolling structure. They are referred to as 'shadow', as opposed to real, tolls because the payment for usage is made by the public agency rather than the road user. /58/

Target cost; Target cost estimate (TCE). Target cost represents the maximum allowable expenditure for material, labour, outsourcing, overhead, and all other expenses associated with a project. In target cost arrangements a contractor's *ex post* profit consists of a fixed payment plus some share of the cost underrun/overrun, that is, the difference between an *ex ante* agreed estimation of the project cost and the actual cost. A target cost is generally proposed by the contractor, then checked and agreed by the client becoming the principal instrument in budgetary control of the works.

Target cost estimate (TCE). See Target cost.

Tendering cost. Tendering cost is the cost a bidder spends on preparing the tender. It can be expressed as a real money value or as a percentage of the total project cost/contract value. The contract cost in DBB is the cost of construction, in DB the cost of design and construction, and in DBM the cost of design, construction and operation/maintenance.

Turnkey. In turnkey procurement, a single contractor acquires and sets up all necessary premises and equipment, and brings a project to a state of operational readiness. The contractor also finances the project, and is generally paid upon completion of the project, instead of the usual payments made in accordance with the progress of construction. Sometimes the contractor may continue to operate the facility for the client, but often the client assumes operational control.

Abbreviations

ATI	Alternative Tendering Initiative
BaFO	Best and Final Offer
BOO	Build-Own-Operate
BOOT, BOT	Build(-Own)-Operate-Transfer
CAT	Capability Assessment Toolkit
CM	Construction Management
CMr	Construction Manager
DB	Design-Build
DBB	Design-Bid-Build
DBFO	Design-Build-Finance-Operate
DBM	Design-Build-Maintain
DBOM	Design-Build-Operate-Maintain
ECI	Early Contractor Involvement
EOI	Expression of Interest
EU	European Union
I/D	Incentives and Disincentives
IT	Information Technology
KPI	Key Performance Indicator
OJEC	Official Journal of European Union
OM	Operate-Maintain
PC	Present Cost
PDS	Project Delivery System
PFI	Private Finance Initiative
PPP	Public-Private Partnership
PR	Public Relations
ProjectCo	Project Company
PSC	Public Sector Comparator
R&D	Research and Development
RFP	Request for Proposal
TCE	Target Cost Estimate
VE	Value Engineering

Introduction

1. Background

Globally, innovative delivery methods, where a contractor offers broader service packages, are increasingly used in infrastructure projects. Clients do not always wish to divide projects up and procure different kinds of services via separate contracts as has been the custom. In addition to construction and technical design, financing and maintenance for a certain period of time, may be integral parts of the contract. This change in project delivery is driven by the infra-sector clients' quest to focus on their core business – securing adequate infrastructure nationally – and by the clients' and the contractors' aim to increase their benefits.

The change has led to an increased number of alternative project delivery methods available to clients. At the same time, it has become more difficult for them to make an educated selection among the alternatives. It often appears that the decision to use any of the available alternatives is subjective, even though there seem to be direct linkages between procurement strategy and cost and time overruns and industry under-performance. There is an evident lack of consolidated knowledge about specific merits of these alternative project delivery routes. Thus, more information on the performance of the project delivery methods is needed. At the same time, there is an excellent opportunity to learn from different countries and differing applications used in these countries.

2. Objectives and scope

The purpose of this part of the study was to gather data on the performance of the traditional Design-Bid-Build (DBB) and the Design-Build (DB), Construction Management (CM) and Design-Build-Maintain (DBM and its variants DBOM, DBFO, BOOT, etc.) project delivery systems in road construction. The data collection phase had three distinct objectives:

1. To collect data on the different project delivery methods presented in international literature.
2. To develop data collection tools for the interviews including interview forms, reference process models, risk matrixes, etc.
3. To gather true, realised data from the main industry actors on the performance of the different project delivery methods.

The collected data formed the basis for the second phase of the research which produced a comparative analysis of the performance and development potential of the different road project delivery methods.

3. Reporting

The report summarises the information gathered during the data collection phase:

> This *Introduction* chapter shortly presents the background of the research and describes the process used in developing the interview form and selecting the project delivery methods of interest.
>
> Subsequent *Parts I through V* explore the experiences of the infrastructure market actors on project delivery in different countries (Finland, UK, Australia, USA and other countries). The data gathered through semi-structured interviews in different countries are summarised to provide a compact presentation of the market perceptions, while the main findings of the extensive country-specific literature reviews are presented merely as collections of quotations from the source material.

This report does not attempt to make any conclusions based on the data presented, but rather collects different views on the subject for further analysis. The actual analysis is presented in the report called:

> Koppinen, T. & Lahdenperä, P. The current and future performance of road project delivery methods. VTT Publications 549. Espoo, Finland, 2004. 115 p.[1]

In addition to the performance analysis, the later report sheds light on the overall research strategy and the approach chosen for the data collection phase. Thus, it may be of interest also for the reader of the country-specific summaries presented in this report.

4. Interviews

A large volume of information was generated through the semi-structured interviews. To facilitate the interview process, an interview form was developed that focused on project delivery performance issues (see Appendix A). An extensive literature review assisted in the formulation of the instrument. The criteria that have been used by others

[1] This report is also freely available in the Internet http://www.vtt.fi/inf/pdf/publications/2004/P549.pdf.

to assess the performance of project delivery methods or to select a project delivery method were listed and included in the instrument (see Table 1). Interview forms were piloted in Finland to ensure that they provided the required data on project delivery performance. The interviews were tape-recorded and transcripted after the fact for the analysis.

The interviews attempted to shed light on all aspects of project delivery from statutory requirements to periodic maintenance and warranties. The interview forms dealt with various project-specific and non-project-specific issues relevant to procurement practises in the selected countries. Thus, two types of interview forms were developed: case-specific (C) and general (G). The type of form used for each interview was selected based on whether a certain project was discussed or whether the interview dealt with project delivery experiences in general. The questions were grouped under the following headings:

- Interviewee
- Participant objectives (G)
  - Client/owner objectives
  - Designer/contractor objectives
- Project delivery in general (G)
  - General experiences on project delivery
  - Applicability
- Project information (C)
- Project delivery process
  - Service provider selection
  - Design
  - Construction
  - Periodic maintenance
- Project output
  - Risks and responsibilities
  - Project team
  - Administration
  - Schedule
  - Cost
  - Quality
  - Change orders
  - Claims and disputes
  - Innovation
  - Client satisfaction
  - Project success
- Lessons learned
- Market issues (G)

Table 1. Criteria used in literature to assess performance of the project delivery or to select a project delivery method.

Parameter	References																
	/29/	/5/	/18/	/26/	/8/	/27/	/33/	/36/	/38/	/39/	/40/	/41/	/47/	/50/	/51/	/22/	/32/
Schedule performance	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**		**X**
Project duration	x		x		x					x			x		x		x
Duration of different phases			x	x		x		x	x			x					x
Delivery speed		x	x						x					x			
Schedule growth		x		x			x		x			x	x				
Time certainty								x		x				x	x		
Cost performance	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**		**X**	
Project cost	x		x	x	x	x		x	x			x	x				
Cost of different phases			x			x			x			x					
Cost growth		x					x		x			x	x				
Life-cycle cost								x	x					x		x	
Cost certainty								x	x	x				x			
Quality performance	**X**	**X**	**X**	**X**				**X**	**X**	**X**		**X**		**X**	**X**		**X**
Quality	x	x	x					x									
Design quality				x					x	x				x			
Construction quality				x					x	x				x			
Rework			x									x			x		x
Conformance to specs.			x														x
The level of QC and QA														x			x
Owner satisfaction			**X**		**X**	**X**		**X**		**X**			**X**	**X**	**X**		**X**
Value for money						x				x				x			
User satisfaction	**X**			**X**	**X**								**X**				
Competition			**X**	**X**						**X**			**X**	**X**			
Contractor selection	**X**	**X**	**X**	**X**	**X**								**X**				
Best value procurement	x		x		x								x				
Pre-qualification		x			x												
Design completion		x	x	x	x								x				
Project team characteristics		**X**	**X**			**X**		**X**	**X**	**X**			**X**	**X**	**X**		**X**
Experience of team members		x	x			x							x				x
Communication		x				x		x						x	x		x
Relationships		x				x											x
Decision making		x						x						x			
Teamwork			x						x								x
Team performance									x								
Project management	**X**		**X**						**X**					**X**		**X**	**X**
Project safety			x						x					x			x
Administration			**X**		**X**	**X**				**X**			**X**	**X**			
Degree of agency burden			x		x	x				x			x	x			
Procurement process			x			x							x				
Risks & responsibilities			**X**	**X**		**X**			**X**	**X**				**X**		**X**	
Risk transfer			x			x				x				x		x	
Disturbance caused by delivery			**X**	**X**					**X**								**X**
Change orders	**X**		**X**	**X**			**X**										
Flexibility									**X**	**X**			**X**	**X**	**X**		
Claims	**X**		**X**				**X**										
Disputes and resolution						**X**		**X**		**X**	**X**						**X**
Innovation			**X**	**X**		**X**			**X**					**X**			
Performance of built asset				**X**		**X**			**X**					**X**		**X**	
Lessons learned	**X**	**X**	**X**			**X**											

Throughout the following chapters discussing the data collected through interviews, the data represent mostly evaluations of informed and expert respondents from the road industry, including both private and public sector representatives. These data are based on attempts at an 'objective' accounting of costs and benefits of different project delivery methods as the interview forms were designed to extract real and accurate numeric information from the interviewees. However, the text does not aim to provide the one and only coherent description of the models, but rather collects the potentially partially conflicting views presented by the interviewees.

Industry experiences and views were charted in Australia, England, Finland, New Zealand and the United States, where a total of 66 persons were interviewed as shown in Table 2. The interviewees (see Appendix B) and potential study cases were selected through expert referrals, industry journals and databases, local road administrators' Web pages, and referenced articles. The national road administration organisation was chosen as the client organisation in each country. The other interviewees were primarily hands-on project participants (designers or constructors) or people that were known to have extensive experience on performance of the different project delivery methods (researchers or consultants). The average interview lasted 1.5–2 hours.

In order to maximise the input of each interviewee, questionnaires were sent to them approximately two weeks prior to the meeting. To validate the data gathered in the general interviews, the 15 projects of Table 3 were reviewed in the subject countries. Concentrating on an actual project focused the conversation on real, experienced effects of the project delivery method used. Moreover, different parties to the contract (the client, contractor and sometimes designer or consultant) were generally interviewed to assess the potentially different experiences and views of the participants. However, detailed case studies were not done. The project delivery methods normally used by clients and explored during interviews in each country are listed in Table 4.

The summaries of country-specific interviews presented in Parts I through V were sent to the interviewees to verify that the information recorded appropriately presented their views and the situation in the market. Comments and corrections were incorporated into the text.

Table 2. Research interviews.

Country	Client	Contractor	Designer	Consultant
Finland	11	4	1	1
UK	5	2	0	1
Australia	12	4	1	4
New Zealand	1	1	1	2
USA	4	1	2	8
Total (66)	33	12	5	16

Table 3. Cases studied in each country.

Country	CM	DB	DBM	Alliance
Finland	1	3	1	
UK		1	1	
Australia		2	2	
New Zealand		1		1
USA		2		

Table 4. Road project delivery methods used in different countries.

Country	DBB	CM	DB	DBOM	DBFO	BOOT	Alliance
Finland	**O**	O	**O**	O	**O**		
UK	O		**O**	O	**O**		
Australia	**O**	O	**O**	**O**	O	**O**	**O**
New Zealand	**O**		**O**				**O**
USA	**O**	O	**O**	O		O	

O Project delivery method used/common.
O Project delivery method used in the past/will be used in the future/is rare.

5. Project delivery methods

Each interview aimed to compare on the performance of one alternative project delivery method at a time to traditional project delivery. The basis for comparison was selected based on extensive experiences with Design-Bid-Build (DBB) project delivery that is (or has been) applied in much the same form globally. In DBB the owner contracts separately with a designer and a contractor. This requires design completion prior to procuring construction. A contractor is typically selected based on the bid price and enters into an agreement with the owner to construct the road in accordance with the pre-made design. Periodic maintenance is commissioned separately or performed in-house by the client.

Alternative project delivery methods for the research were selected based on the interests of the Finnish road sector. Thus, the alternative project delivery methods included in the research are Design-Build (DB) and Design-Build-Maintain (DBM) with its variants. These methods have been globally found to provide benefits over traditional project delivery. Construction management (CM) was also considered worth looking into.

In DB one entity is contractually responsible for both design and construction, but periodic maintenance is commissioned separately. DBM contracts may vary extensively, but the common de-nominator for the contracts is the responsibility assigned through a single contract to the private sector to design, build and maintain the asset for the contract period. Thus, DBM replaces the purchase of an asset with the purchase of services. In both DB and DBM the client identifies the project's desired end result and service levels, and defines clearly the scope of work. Bidders prepare a technical and price proposal showing how they intend to deliver the project. Selection can be based on quality, price or on a price/quality combination. Combining design, construction and potentially maintenance and operation creates a single point of responsibility.

CM was included in the research, since it is used extensively by local authorities. In CM a construction manager (CMr) is hired by the owner to oversee and manage project delivery on his behalf. CMr can offer constructability reviews, value engineering studies, construction estimates and contract packaging usually into much smaller packages than would be the case in DBB. Design and construction can usually overlap. Periodic maintenance is commissioned separately or performed in-house by the client.

During the data collection phase alliancing was also found to be a potential future project delivery method that is so far used only in Australia and New Zealand. Project Alliance is an agreement between two or more entities (the client and contractor(s) plus potentially other project participants or stakeholders) that undertake to work cooperatively, on the basis of sharing project risk and reward, for the purpose of achieving agreed outcomes based on principles of good faith and trust and an openbook approach towards costs.

The research work was started by defining the content of different project delivery methods and the resulting allocation of responsibilities and risks. Process maps (see Appendix D) and risk allocation matrixes (see Appendix C) were drawn for each project delivery method. The interviews implied that highly similar procurement processes are used in different countries with only slight differences in the interaction between the project parties in the use of selection criteria and in the level of decision making. Thus, the process maps provide a generally acceptable reference for the procurement

processes. However, risk allocation tends to vary more extensively between the studied countries and even case-by-case. Thus, the risk matrixes presented are merely an indication of the common risk allocation between the parties in different project delivery methods.

PART I

FINLAND

1. Market

The Finnish Road Administration (Finnra) is a government agency responsible for the management of approximately 78 000 kilometres of public roads network. As a result, Finnra manages about 25% of the Finnish infrastructure sector volume /132/, which makes it a significant actor in the market able to affect the way infrastructure is being procured. Finnra is responsible for road policies and strategies, safety, traffic management, road programmes, and procurement of all related capital investment schemes, periodic maintenance and routine maintenance. Services are procured through pre-qualified or open competition, where a separate, state-owned enterprise that builds and maintains roads must also compete for work.

The market is competitive, even though there is a lack of experienced designers and consultants. This needs to be taken into consideration in timing tenders for large projects. Also, only a few large, national contractors account for most of the industry revenues, as 90% of market actors are small local companies. Thus, there are only four companies capable of bidding for projects worth €50 million or more. The client would like to entice more European competition. To increase competition the Scandinavian road authorities are working together to create a common Scandinavian market for infrastructure. All big contractors already operate in the different Scandinavian countries.

Due to the project delivery methods used and intensive price competition, there have been only a few innovations in the infrastructure market. In hard price competition suppliers do not earn margins that would allow them to invest in process or product development. Thus, until now equipment manufacturers have been largely responsible for the development of the market. Now the client is aiming to increase cooperation between suppliers and innovativeness through changes in its procurement strategy. As a response to these changes the industry is expected to change the way it operates.

2. Owner values

Finnra has a progressive procurement strategy /1/ to address the current problems in the infrastructure sector: lack of innovations, lack of customer focus, poor image and low value-added client services. Through its new strategy Finnra is aiming to improve the processes and productivity of the market. To motivate the market actors to seek changes Finnra allows service providers to have their share of the benefits in the beginning believing that in the long term the client and society will benefit from the results. Better productivity is seen as a prerequisite for price reductions and adequate industry margins. Productivity may be improved through many alternative routes. For example,

standardisation would allow certain structures (speed bumps, narrowings, bridges, etc.) to be prefabricated, speed up the delivery, improve quality and reduce prices.

Finnra aims to buy increasingly services instead of products. To ensure effective implementation of its new strategy Finnra will start measuring the performance of the regional offices and road managers based on how actively they promote usage of procurement methods that meet the client goals (see Table 5).

3. Project delivery methods used

Traditional procurement is used in 24% of road projects (by value) procured by the Finnish Road Administration and its regional offices. These projects are mainly small ones or projects located in cities, where construction is highly regulated and constrained. Construction management, both at-fee and at-risk, is used in 4% of projects. Design-build has become the most common road project delivery method used in 69% of projects. Life-cycle models (DBFO) have so far been used only in one pilot project, but their usage is expected to increase in the future. One DBOM project has already been awarded and a DBFO project is at the tender stage.

According to the client, traditional project delivery does not help achieving its goals. Knowledge is lost in the process due to separate contracts for small pieces of the project. Buildability of design may also be poor. Thus, Finnra is aiming for broader and longer-term contracts that encourage innovation, emphasise the life-cycle perspective and are more economical. The new procurement strategy is expected to result in savings of at least €50 million annually due to more efficient delivery that gives better value for money. As project delivery is changing and responsibilities are transferred from the owner to the industry, the industry needs to organise itself in order to be able to execute the research and development needed to manage the road life cycle better.

Table 5. The client's values and goals /123/.

• better life-cycle value • innovations • increased productivity in the industry • cost savings • increased industry profitability • teaming effort between design and construction professionals	• increasing market's competence and know-how • value-added client services • better services for users • reduced traffic congestion during project delivery • usage of best procurement practices

Until quite recently the decision about the project delivery method was largely based on personal opinions of project managers. However, now a more systematic approach is applied to compare the perceivably best practice (DB) with other alternatives and to choose the most beneficial method. Since the project delivery method affects budgeting of the project and its initial design needs, the decision should be made before the road scheme preparation.

4. Industry experiences based on interviews

4.1 Construction Management at-fee

4.1.1 General

Construction management (CM) is mainly used in high administrative burden projects with difficult negotiations with landowners/utilities/regulators and a lot of coordination between the parties. In such projects the client does not have adequate resources to manage the project, but rather uses a construction manager (CMr) as an extension of client resources. CM may also be used in projects that have complex programmes or tight schedules, or require significant flexibility in project delivery.

4.1.2 Project delivery process

Designer/contractor selection

In CM multiple projects may be packaged into one contract to reduce the client's administrative burden in procurement. Generally, the road scheme is prepared at the time of RFP. Competition for a CM-at-fee contract is somewhat limited as the CMr cannot supply other services (design or construction) for the project. Moreover, there are only about five experienced construction management companies in Finland. Usually pre-qualification is used. The tender period tends to be two months, and the contract is awarded based on both price (60% weighting) and quality (40%). However, according to interviewees, the selection should emphasise the references of the bidders more as the CMr's capabilities are crucial for the success of the project. As target cost arrangement with associated incentives is the primary commercial term used, target cost could also be used as an award criterion.

Design and construction are procured by the CMr. The CMr is responsible for dividing up the project into small work packages that encourage smaller contractors to tender and create more competition than in DB. The CMr tends to use the approved contractor listings of the client when selecting companies to receive RFPs. Tender costs are low.

While designers are selected based on the quality/price combination, construction contracts are awarded purely based on price. Tenders for different work packages may be requested in an optimal, economic situation which results in reduced prices. Additionally, the increased competition provides the client accurate and detailed price information that may be useful in other projects.

Design

Design is divided up into separate packages, and paid for based on hourly rates. The design process is similar to DBB with no contractor contributions. However, the CMr, generally a construction professional, brings his knowledge into the design phase. Design is done in phases according to the work packaging. Generally, deficiencies in the road scheme are easier to negotiate than in DB and the required design changes can be done flexibly. Also, negotiations with land owners are easier to handle.

Construction

Construction is also divided up into multiple small work packages coordinated by the CMr and paid for based on unit charges or fixed lump sums. Responsibilities between different packages need to be defined clearly to avoid unnecessary disputes. The contractors do not generally have ownership as they are responsible only for a small part of the project. Coordination and scheduling of parallel contracts are very demanding, although supervising the project progress and agreeing on changes are considered somewhat easier for the CMr than for the client, since the CMr is closer to the contractors. The contractors' profits tend to be the same as with DBB.

Periodic maintenance

Generally, the CM contract expires, when the road is approved, but occasionally CM contracts have been extended to the end of the warranty period of the construction contracts (2 years), which is considered beneficial for the client. The periodic maintenance does not differ from that of traditionally built roads. However, some suppliers have complained that the accepted quality may be slightly lower than with DBB causing potential inconveniences for the users or higher maintenance expenses in the future.

4.1.3 Risks and responsibilities

In CM-at-fee the client retains the final decision-making power and all contracts are between the client and suppliers. The client is also responsible for permits and environmental clearances and right-of-way acquisition. Responsibilities of the CMr include coordination, design and construction management, procurement of design and

construction (RFP preparation, tender evaluation, proposition for contractors), supervision, acting as a client representative, hand-over processes, check otherwise required bills sent by the contractors, reporting, and negotiations with landowners. Thus, the CMr works as an extension of the client organisation and balances periodic changes otherwise required in the client's personnel.

4.1.4 Project team

Professional project team management facilitates communication and cooperation between the project participants. According to the interviewees, cooperation between other service providers and the CMr is slightly better than cooperation between the client and service providers in DBB. Also, contractors and designers prefer having direct contracts with the client over being subcontracted, as they can expect timely payments. This improves working the atmosphere at the site.

Due to a greater number of project parties working partly simultaneously at the site, work coordination and project safety may be at risk. However, projects have generally had shorter durations mainly as a result of more efficient scheduling and planning. Also, in problem situations constructors prefer contacting the CMr instead of the client, which facilitates problem solving. Generally, the client cannot afford engaging as much resources as the CMr for the project. More efficient project management improves and accelerates decision making in issues where the client is not involved. At the same time, some critique was expressed due to too slow client decision-making in bigger issues, where client decisions should not delay the fast-tracked work at the site.

4.1.5 Administration

While procurement involves as much work as in DBB, markedly less client resources are tied up in the project during contract administration. However, multiple contracts and work orders translate into multiple bills for the client adding slightly to the administrative burden. The client's administrative burden could be decreased, if all stakeholders were better informed to contact the CMr directly when problems occur.

4.1.6 Schedule

Partially parallel design and construction are allowed resulting in markedly shorter project duration than with DBB. Also, CM projects have generally been delivered in time. Fewer constraints due to annual budgets would result in even more optimum project duration and increased savings.

4.1.7 Cost

Even though the final cost of the project (at the client's risk) is known only at the end of the project, it is often lower than with DBB. According to the CMr, there is generally potential to reduce contract prices by 5–20%. At the same time, without proper quality assurance, there may be the risk of increased life-cycle costs. The cost of the CMr is 8–12% of the total project cost. The CMr is reimbursed based on the target cost (TCE) with a potential incentive/sanction of approximately 5% on savings/overruns. This I/D motivates the CMr to keep the project on budget. However, generally the CMr wants to negotiate target cost increases whenever there are design changes. There are also multiple negotiations over the effects of extra work on TCE. As a result, according to the client, the process of setting up a target price and changes to the price during the project need clarification. To reduce time-consuming negotiations, a neutral zone, where no bonus or sanction is paid could be set around the target cost.

4.1.8 Quality

While design quality may be slightly higher than with DBB, construction quality and conformance to specifications may be affected negatively, if a proper quality assurance system is not used. According to the client, the cost of quality auditing should be apportioned between the client and the CMr. In some instances, the CMr has used an outside quality control consultant, which is considered redundant, as quality responsibility could be transferred to the contractors.

4.1.9 Change orders, disputes and claims

Generally, there are only minimal changes (2.2% of project value), and the related change orders can be handled flexibly. Disputes are also rare. In Finland, contractual relations in construction are considered to be less adversarial than in, for example, the UK and USA.

4.1.10 Innovations

While according to the CMrs there have been significant savings as a result of innovations, the clients argue that CM does not promote innovations or development of the infrastructure market. As a result, productivity remains lower than in many other industries.

4.1.11 Client satisfaction and project success

The clients have been relatively satisfied with their CM projects. However, CM is not considered Finnra's future project delivery strategy. Also, the CMrs and contractors

have some reservations concerning CM procurement. However, many of the industry representatives, who expect the use of either a CMr or a construction consultant to increase due to the lack of client resources, consider the CMr a better option than a construction consultant, who bears no risks. Advantages and disadvantages of CM are listed in Table 6.

Table 6. Main advantages and disadvantages of CM.

Advantages	Disadvantages
• less client resources required • the outcome should meet all client requirements • client control throughout project delivery • CMr's experience available during project delivery • cost-effective work packaging • reduced capital cost • reduced supervision cost • time savings • time certainty	• price emphasis • difficulties in assessing CM bids • price known only after completion • does not develop market • risk allocation may be ambiguous • multiple bills to handle

4.2 Design-Build

4.2.1 General

In a DB project the risks need to be clear and well understood. Projects are also larger than with DBB. Usually the minimum size of a DB project is perceived to be about €3.5 million. As the average road project in Finland is relatively small, packaging of these small projects into appropriate entities for DB is a demanding task. Bigger project size also raises some resource concerns, as there is only a limited number of experienced design and large construction companies. Multiple simultaneous DB projects may tie up their resources fully. Also, opportunities of small companies to work in DB projects are often perceived to be limited despite the normal subcontracting practise.

Even though it is often argued that DB can be applied only to large projects, quite opposite opinions have also been expressed. Generally, the cost and time required for design and approvals are relatively higher in small than in large projects. As a result, larger percentage savings are achievable through DB. For example, DB has been applied successfully to bridge projects. Small road improvement projects are also considered suitable for DB procurement. However, the Water Rights Legislation reduces the applicability of DB in bridge projects, as the obtained permit applies to only one specific bridge design leaving alternative designs redundant. Due to the time requirements, the bridge permit is acquired before the road scheme is complete.

4.2.2 Project delivery process

Designer/contractor selection

Generally, a Road Scheme is prepared by the time of RFP. Even though writing specifications is considered routine work, there have been some complaints about specifications being too technical and prescriptive. Also, the information provided may be perceived as inadequate or erroneous. In small projects, it is uneconomical for bidders to do site investigations. In larger projects, bidders have more resources for the tender work and lesser initial information may enhance innovative thinking, but even then it is uneconomical for bidders to do the same investigations. More extensive initial investigations included in the RFP would decrease project risks and reduce tender prices. Also, a standard documentation and more automated tendering process could facilitate procurement.

Generally, competition is limited due to the project size and high tendering costs. Moreover, it may be difficult for contractors to hire a designer due to scarce design resources. In some large DB projects there have been only two bidders, but lately competition has increased and this trend is expected to continue. Prequalification is common, and it is promoted by contractors as a way to reduce industry costs. Also, the client often pays a small tender fee (33–50% of the tender cost) to unsuccessful bidders who earn acceptable quality points. According to contractors, a doubled tender reward would increase competition especially among small and medium-sized companies. Some clients have already increased the tender reward to cover the full cost of design services.

The tender period is generally 2–3 months, which is considered adequate. According to the industry, the tender should ideally be prepared when there is no snow on the ground. Tender design includes preliminary technical design. The additional tender work is 3–4 weeks compared to DBB (i.e. 0.3–0.45 % of the project cost). While the tender cost of a single project is considered very high, with continuity in client procurement the incurred tender costs can be recouped in won other projects. The biggest problem is perceived to be the need for external design services during tendering which could be reduced by leaving more of the design to be done after the contract award. According to the contractors, this would save money and increase innovativeness due to longer design time.

The award criteria combine price (70–80% weighting) and quality (20–30%). Even though this 2-envelope system is considered clear and relatively objective, in reality, quality may have less than 10% effect. Since it is difficult to evaluate different technical solutions, quality assessment does not generally alter the ranking based on bid prices. Also, price differences tend to be quite significant. Thus, some critics promote

qualification-based pre-qualification followed by pure price award /131/. In the future, the life-cycle cost of a road might also be a basis for the award. It could be measured after a long warranty period or calculated after a certain, preset time period. If the cost differs from the contractor's estimate, he would either get a bonus or a reduction in the price. However, today DB contracts are still purely fixed, lump sum contracts.

Design

The state-owned construction enterprise has in-house design capabilities, while others subcontract design. Due to their inexperience, contractors have not yet been able to fully exploit their possibilities. In some projects, technical solutions have been suboptimal and constructability has been deficient. Generally, the designer and contractor work in separate locations, which leads to inadequate communication between the parties. However, the existing dialogue between design and construction has already enabled elimination of unnecessary design and adjustment of technical solutions to the needs of construction. As experience has increased, tender work and collaboration between the parties have improved. According to contractors, physical vicinity and integration of the contractor's views into the design are prerequisites for a successful project, but the value of the designer's capability and innovations should not be underestimated. Also, moving from technical specifications to more performance-based specifications should improve design.

It is estimated that contractors pay less for design than the client would pay, and designers have suffered significant economic failures. Contractors would often prefer the designer doing the tender work at risk, and they seek to reduce design cost by pressuring the designer to reduce his fee. No incentives for design cost savings are paid. As a result designers would prefer working directly for the owner. A step-wise change is needed with the owner having a significant role in transferring his knowledge to contractors. The situation could also be improved through joint ventures, where the designer is an equal partner earning an appropriate margin.

Construction

As design is developed in parts, the work at the site can be started earlier than with DBB. However, occasionally there have been problems due to too early start-up based on a preliminary design and inefficient knowledge transfer. Traffic management and requirements for minimising public inconvenience also often set strict constraints on the construction work.

Generally, contractors can earn higher margins for bearing more risks (1–6% higher profit than in DBB). However, in some projects contractors have experienced also

losses due to materialised risks. Subcontractors' margins do not differ from DBB due to the conventional price bidding that may inhibit the conveyance of the client's goals into actual project implementation.

Periodic maintenance

DB delivery does not affect the whole-life costs of a road. While clients expect a 5-year warranty to provide an incentive for good quality, contractors argue that only a 10-year warranty would improve delivery of large projects. In small projects, long warranties should not be used, as companies executing these projects have inadequate resources for long-term responsibilities.

4.2.3 Risks and responsibilities

The client is responsible for acquiring permits, and the contractor is responsible for implementing the project and informing stakeholders about the works. While the extensive risk transfer is generally considered appropriate, it is not worthwhile to the client to transfer all risks to the contractor due to the high risk premiums associated. Negotiations on risk allocations are beneficial in achieving optimal allocation and an appropriate risk pricing. At the same time, the project parties gain a better understanding of the risks. Best and Final Offers could be solicited to reflect the negotiated changes in risk allocation.

Risk-analysis is paramount. While in some cases clients have been worried about the contractors' ability to price risks right, according to the contractors, generally the cost of risks is so high that it cannot be fully included in the bid price. Especially risks associated with excavation volumes may be excessive and might be better managed by apportioning them between the contractor and the client. Currently, a general risk matrix is being developed by the client in order to facilitate risk assessment. Additionally, the client makes a risk analysis for every large project in order to assess whether transfer of certain risks provides value for money. Very risky works can also be separated from the project and delivered under a separate, traditional contract (i.e. early works contract).

4.2.4 Project team

While partnering may be used in some projects, use of it largely depends on the contractors' willingness to co-operate. The lack of systematic partnering is based on the inherent Finnish culture that tends to lead to co-operative project delivery with minimal conflicts between projects parties. Thus, DB does not generally affect the contractor-client teamwork, but it may improve the contractor's internal teamwork. However, designers may find it difficult to adapt to their new role. To encourage better cooperation, in the future the contractor will be required to submit a list of designers and

subcontractors in the bid and to specify the project team's working model. This is expected to secure the position of the designers and subcontractors and to reduce pure price competition.

As information is transferred through the contractor instead of the client, knowledge is better preserved in the process. At the same time, more accurate and timely information transfer is required. A common system should be developed to eliminate problems in the information transfer. The client can also ensure the availability of tacit knowledge by having the same person take the project through from the road scheme to the road opening.

Decision making improves slightly, when the contractor makes decisions and is motivated to do it quickly. While the client does not see differences in win-win solutions compared to DBB, contractors find it more difficult to attain win-win solutions, since there are no clear rules for benefit/saving apportionment. However, DB encourages process improvements and offers potential to reduce public inconvenience, if quality criteria include traffic arrangement issues.

4.2.5 Administration

While the client's administrative burden during the procurement phase is slightly higher than with DBB, it is lower in contract administration. Especially during the design phase the work load is only 33–50% of that with DBB. Thus, according to the client, big projects (> €500 000) should not be procured through DBB, because administration of the design phase is too burdensome. Generally, it is not considered the client's role to manage works as the clients' resources are insufficient for that. Due to resource limitations, consultants are often also used. While some clients think that DB is the easiest way to deliver roads, there are also clients who want to keep control of projects. However, less burdensome procurement methods should translate into more economical methods for the society.

Each contract involves a certain amount of administrative work independent of project size. In the future, administrative work is expected to be reduced as the number of contracts diminishes. Development towards more automated information transfer will also reduce the work load. However, at the same time the use of consultants is expected to increase to maintain the clients' staff requirements and to complement experience.

4.2.6 Schedule

Schedules tend to be prepared as they were prepared for the in-house construction staff resulting in some slack. Thus, projects are generally completed slightly ahead of time. Timely project delivery is also encouraged by the absolute schedule requirements and

extensive sanctions resulting from delays. However, for private companies and in a competitive environment, schedules could be tighter to allow additional savings and user benefits. Due to parallel design and construction, projects can be delivered up to 44% faster than with DBB. According to the contractors, even faster execution would be encouraged, if the warranty started on the day the road is taken into use instead of the day when the road is accepted.

4.2.7 Cost

Even though competition generally reduces prices below the client's cost estimates, the final cost is often higher than the bid price due to client additions. Still the project's capital cost is lower (15%) than it would be with DBB as processes tend to be more cost effective. Cost certainty is also improved markedly due to fixed lump sum contracts. However, there has been some negative feedback from contractors, who contend that the current profit levels will not hold their interest for very long.

4.2.8 Quality

The contractor's quality responsibility is becoming a norm. As the contractor controls quality and the client only audits the quality systems, overlapping controls that may account for 2% of the normal 7–8% in administrative costs can be partly eliminated. According to the clients, the design quality is expected to be at the same level with DBB and to improve in the long run, as designer capability improves due to the instant feedback provided by the contractors. While current specifications tend to lead to over-quality with DBB, according to the contractors, quality can be optimised with DB where only the necessary design is done leading to savings. However, the interviewees agreed on the deficiencies of the current performance-based specifications. While Finnra is increasingly using performance-based specifications, the actual specification-type used depends on the client region. Some clients use more prescriptive specifications than others. In the future, quality standards will be increasingly subject to end product specifications, and will include more outcome criteria /123/. At the same time, better tools are needed to measure road performance.

Generally, there are no problems with construction quality. However, in some special cases feedback on ground water protection has been negative indicating improper work. As quality and price have a direct relationship, the contractor attempts to optimise quality. If the warranty is 5–10 years, the contractor does not take risks on structural issues, but he may achieve savings by eliminating aesthetic elements of the road. As quality responsibility has been transferred to the contractor, problems associated with inadequate quality systems have also become a challenge. There are multiple information sources for quality and many measures are taken routinely, but this

information is not easily accessible to quality auditors. More system development and automation is required, as old systems do not serve new project delivery methods.

4.2.9 Change orders, disputes and claims

Generally changes have been small (0–5% of the total cost) and less than with DBB (5–8%). With DBB more changes are also contractor driven. However, with DB all changes after the tender require difficult negotiations, as contracts do not provide unit price lists as a basis of pricing. In such circumstances, it is also difficult to negotiate about saving/benefit apportionment. Basic change rules should be included in the contract to facilitate the process. According to the contractors, contracts should allow more freedom for them to make changes to the design as long as the performance-based specifications are met.

4.2.10 Innovations

Innovativeness depends on performance-based specifications that compel the contractor to consider what needs to be done and whether the design really benefits project delivery. Projects have experienced some improvements through better buildability and elimination of non-value adding steps. However, road alignment usually restricts innovations. In most cases, balancing masses would be the most cost effictive solution. Also, according to the contractors, risky structures and ground conditions lead the contractor to include the safest option in the bid which also tends to be the most expensive one. These special structures (like structures in loose soil) would benefit from more design freedom after the contract award due to the expensive and time-consuming site investigations required. However, some concerns were expressed over most innovations aiming to save money, not to improve quality, or to benefit the client. As the construction and warranty periods are relatively short compared to the life cycle of the road, the client needs to ensure that the solutions implemented are reliable. This, and often also the schedule, limit the opportunities to innovate.

To motivate the contractor to value-engineer and the client to accept the suggested changes, savings should be shared. Earlier contractor involvement (in preparing the road scheme) will also be piloted to give more flexibility to contractor innovations. However, the difficulty is in finding the right balance between freedom and limitations. Too much freedom makes tendering more expensive, too little freedom results in standard solutions being adopted. The contractors generally hope that the client would indicate issues that mostly benefit from innovations giving the contractor a clear direction on which issues to concentrate in the bid and implementation.

4.2.11 Client satisfaction and project success

The clients are satisfied with DB, and it is considered the only logical procurement method in the future. Contractor satisfaction, on the other hand, is similar to that with DBB due to some experienced economical failures. While big construction companies consider DB the future project delivery method and start hiring designers, medium-sized companies would not depart from traditional project delivery. However, generally the industry feels that the client's change strategy is appropriate, but the pace of change may be too fast. The advantages and disadvantages of DB are listed in Table 7.

Table 7. Main advantages and disadvantages of DB.

Advantages	Disadvantages
• potential for innovation • contractor contributions in design • alternative designs • outcome should meet client requirements • buildability • minimal or no change orders • risk transfer • qualitative component in contract award • improved participant relationships • less interfaces between different parties • price certainty • reduced capital costs • reduced supervision costs • time savings • time certainty	• potential for reduced quality • difficulty in setting outcome requirements • more work in road scheme and RFP preparation • designer's position and margin degraded • high tender costs • old roles are hard to change

4.3 Design-Build-Maintain

4.3.1 General

DBM-type procurement is considered a variant of DB with an extended service package. While some clients argue that green sites with more freedom to innovate are more appropriate projects to be procured this way, according to the ProjectCos, project type does not really matter. However, there must be economies of scale, and the project has to be clear and relatively independent of the surrounding road network. The project may involve a demanding service package, interests of many stakeholders, a large investment, high OM costs and alternative service levels /21/. Some interviewees argued that the project size should be €100 million or more to entice international financiers. However, national contractors consider this the maximum project size. In a small market, projects of €40 million or more may be more appropriate. There cannot be

too many DBFO roads as this would tie up annual budgets, but continuity requires about one DBFO project annually. To assess applicability of the project delivery method, a public sector comparator methodology is being developed.

4.3.2 Project delivery process

Designer/contractor selection

The road scheme which, accounts for approximately 50% of design, is generally prepased by the time of RFP. The Road Scheme constrains geometrical design leaving the contractor responsible only for technical design. Even though specifications were highly technical in the pilot project, more performance-based specifications will be used in the future. However, some technical elements will remain as, for example, right-of-way acquisition can be done only based on adequate design. Both contract parties emphasised the importance of timely and accurate information in the RFP.

Based on EOIs, 2–5 bidders are selected to tender. The tenderers are consortia formed by a number of companies (a contractor, a designer, an OM company, financiers, etc.) potentially including international parties. The importance of international competition is emphasised, as the interviewees questioned the national market's interest in these large and risky projects due to a lack of experience from large projects. Financing issues are also generally considered difficult, since the contractors have no experience from them and may fear losing their independence /131/.

The tender period is expected to be 3–4 months due to additional detailed negotiations with the bidders. Yet, a tender period of six months is generally considered adequate. While the client estimates that the cost of tender design is about 0.1–0.2% of the total project cost (and 50% of the tender cost), according to the ProjectCos, the tender cost is amazingly high (€0.25–1 million or 0.1–0.4% of the total cost). A large portion of the cost desires from external advice and financing arrangements. Part of the cost is also independent of project size. To reduce relatively high company-specific tender costs the client compensates the bidders and aims to standardise the contracts. However, if the total industry cost is considered, the total tendering cost may be actually somewhat lower than it would be with DBB, where multiple contractors bid for multiple contracts over the life of one DBFO contract.

The concession period is 15–25 years, with longer concession periods considered more appropriate. Contracts are awarded based on the weighted criteria (quality 10% and price 90%). However, in the pilot project quality assessment did not affect the selection as price differences were significant. While all the interviewees agreed on the necessity of using partly qualitative award criteria, they also noted that often technical solutions tend to be very similar giving no basis for differentiation between the tenders. Thus,

according to the ProjectCos, the client might consider using a stepwise selection process, where the preferred bidder is selected purely based on qualifications. According to the client, it is also redundant to ask every bidder to prepare full technical designs. Instead it might be advantageous to ask bidders to design only the critical parts of the project, where differences may appear or where alternatives are sought. Also, the client would like to increase transparency of the tenders in order to be able to assess the price of different service packages.

Design

The private service provider can select capable suppliers without compulsory competition. Generally, design and construction are packaged into a single contract and awarded to the construction company participating in the consortium. In the pilot project even long-term maintenance was included in the contract. The contractor then selects capable designers for the work. As adequate design resources are considered critical for fast-tracking of construction, 3–4 design companies may be employed.

The designers have more responsibilities than with DBB. They deliver the designs directly to the contractor without seeking an owner acceptance that would release them from liability. The design needs to be accurate and correct, and corrections have to be done immediately. As a result, schedule pressure on the designers is significantly higher than with DBB. The design work may also be phased differently from DBB and more demands are set on the information transfer between the project parties. According to the client, the designers' profits may be somewhat lower than with DBB as the designed savings generally only benefit the contractor.

Construction

Due to the shadow toll payment mechanism used, fast project delivery allows the ProjectCo to start collecting service fees earlier. This is why the contractor is offered a bonus for fast completion. Thus, the construction phase tends to be organised very effectively. Some resources may be used 24 hours a day with no expensive downtimes. The contractor is also inclined to choose cost-effective technical solutions based on whether a faster implementation schedule or better long-term quality can be achieved. Overall, incentives were considered critical for success of the project. As the risks of the contractor are high, risk premiums are also included in the prices. If risks do not materialise, there is an opportunity for the contractors to earn higher profits than with DBB.

Periodic maintenance

Truly life-cycle optimised implementation is achieved if the design, construction and OM for the concession period are awarded to the same company. Then the contractor is motivated to take into consideration the long-term usability and maintainability of the road. Generally, it is also in the ProjectCo's interest to have the road continually in good condition to ensure higher traffic volumes, if its payment is based on them. Then, the road is maintained well and timely and reporting is done better than traditionally /125/. Based on the highly positive user feedback, it can be estimated that the road is in somewhat better condition than other roads. Also, no unexpected periodic maintenance interventions have been required. However, to emphasise the importance of the road´s condition (especially in northern climate), payments could be partly based on them.

In the pilot project the handout requirements were set relatively ambiguously (i.e. 'the road has to be in similar condition as other motorways of the same age') leaving room for differing interpretations. In future contracts, more specific requirements should be made. Also, there should be a system for ensuring that the price of OM remains competitive throughout the concession period. Additionally, there are some reservations in the industry concerning the packaging of operation and maintenance in the same contract with design and construction. To provide the ProjectCo adequate incentives to innovate during the operation phase, the area to be operated and maintained should be large enough. Otherwise the operation of the road may suffer and the life-cycle emphasis may be lost /131/.

4.3.3 Risks and responsibilities

The client acquires permits for the project and prepares the Road Scheme before the RFP. As risk allocation should be economically optimal, according to the ProjectCo, it is important for the client to consider the price of risk transfer. Risks that cannot be described accurately may lead to extensive risk premiums. For example, risks associated with existing structures may be considered large by the tenderers. As a result, in the pilot project the client retained these risks as they were known to be limited. Also risks from increased traffic volumes (ground water spoilage, noise and gasoline tax with resulting traffic reductions) were borne by the client. To ensure optimum risk allocation, it is best to negotiate about risk transfer with the bidders during the tender period.

The ProjectCo needs to bear adequate risks to be motivated to optimise the project delivery processes. Often the longer concessions allow more responsibilities to be transferred to the ProjectCo leading to better optimised structures. Generally, the ProjectCo is bears risks associated with design, construction, operation, maintenance, financing, technical issues, weather and traffic volumes. However, this is a big change for the industry that needs to learn to bear greater responsibilities. The selection of the

implementers and associated risk transfer are important parts of the ProjectCo's risk management. Thus, the ProjectCo must select organisations that are most capable of doing the work and can produce the required quality.

4.3.4 Project team

The ProjectCo is challenged by the broader project management and cooperation with other project participants /130/. Even though specific partnering procedures are not used, it is in the interests of the ProjectCo to have good relationships with all stakeholders. Team work tends to be better than with DBB as a result of shared goals and there is no need to discuss money issues during implementation. Better teamwork enables also better information transfer. No disputes have been experienced. However, having international parties in the consortium brings additional challenges for the teamwork due to cultural differences. Also, there is still some lack of continuity in client representation, even though availability of tacit knowledge has improved.

Decision making has also improved, as it is delegated to lower levels and a separate client project organisation. According to the client, however, the ProjectCo does not take an adequately hands-on role in the pilot project due to inadequate resources. Instead, the implementation of the contract is left largely to the contractor. In future projects, a stronger presence of the ProjectCo would be beneficial. Continuity in DBFO-type procurement and a DBFO programme would allow ProjectCos to manage a number of projects simultaneously and to retain larger resources/personnel.

Project safety is good. Win-win solutions are sought actively and processes are improved. Public inconvenience is the major driver of project delivery, and it is reduced very effectively. Also, as the positive image of the road is important, environmental issues are taken very seriously and aesthetics of the road are improved in cooperation with adjacent communities.

4.3.5 Administration

Procurement takes significantly more time and effort and is more demanding than with DBB. Also, the international participants complicate the procurement process as the tender documentation needs to be prepared in multiple languages, and the contract negotiations become more complicated. However, contract administration takes less effort than with DBB: during design the client's administration is reduced significantly; during construction the number of the client's supervisors can be reduced from the normal 5–10 persons to only two. During periodic maintenance there is no difference in administration, though. Moreover, the additional cost of the external advice used in drafting the contract documentation is significant (less than €1 million), especially in the pilot project. However, continuity in procurement would allow further use of the

developed documentation and knowledge and result in less administration in the future projects.

4.3.6 Schedule

While RFP development took six months in the pilot project, it is expected to take less time in the future. From the RFP to the award it took approximately nine months due to the longer than expected negotiations with the preferred bidder. Design was done throughout the project with the initial 2-month design period that was done at risk before the contract was signed in order to enable fast project progress after the award. Due to the incentives and effective work organisation, the project was completed almost a year earlier than scheduled and in half the time it would have taken through DBB. The contractors' incentives are considered critical in achieving fast project delivery. Also, private financing enabled the project to be delivered significantly earlier (5–6 years) than through public financing. While earlier opening of the road causes additional costs to the owner, these extra expenses are well offset by the user and safety benefits.

4.3.7 Cost

The capital cost of the road is about 50% of the contract value and the maintenance cost 20%. While the design cost is lower than what the client would pay in DBB, faster project delivery costs the contractor some extra. However, savings are sought throughout the design process and no redundant design is done. Savings can also result from the optimal timing of the project to coincide with the industry´s recession, more effective use of resources, economies of scale in subcontracts and shorter project duration. Overall, it can be estimated that 10–14% construction cost savings are achieved compared to DBB. Also, periodic maintenance is expected to be less expensive than with DBB due to the high quality of the road. Moreover, cost certainty is very good.

The payment method reflects the risk allocation. In the pilot project, payments are based on shadow tolls which are clear and technically easy to implement. However, according to the interviewees, the payment should be tied to road availability. Also, a performance related payment share could be used to encourage the service provider to improve service quality. To society the residual value of the road might be a worthy payment basis and safety of the road could be ensured through bonuses and sanctions. However, as more complex payment methods result in higher tender prices, the change towards performance-based payment should be gradual.

4.3.8 Quality

Even though, according to the client finishing of the design has occasionally been inferior to what it is with DBB due to the tight time frames and the aim to minimise unnecessary expenses, generally more than normally is invested into the design to ensure development of the most optimal structures in life-cycle terms. The quality of construction is also high. Only bridge design is controlled by the client /125/. In the pilot project, quality control and auditing during construction were done in cooperation between the client and the ProjectCo's quality auditors, which may not be the optimal solution. As DBFO produces over-quality in order to minimise the life-cycle costs, the client needs to consider what quality level he needs, in order not to pay for over-quality. The client audits quality also during OM.

4.3.9 Change orders, disputes and claims

During construction changes are minimal (1% of the project cost) and mainly result from deficient contract documentation. While the owner has the option to procure additional work through open competition, it is generally easiest to get the work done by the ProjectCo. The changes are paid through increased service payments in 1–2 years. This is a difficult payment mechanism adopted only for taxation purposes and a better system should be developed.

The current contract does not encourage the ProjectCo to improve the road or to keep up with technological improvements. All changes and improvements are negotiated as contract changes. Benefits resulting from refinancing and increased productivity go solely to the ProjectCo. Thus, the contract documentations should be made more flexible and should include better mechanisms for changes and benefit sharing. As there is a lot of bureaucracy involved in small changes due to other infrastructure works and permits required for added features of the road corridor, these responsibilities could be transferred to the ProjectCo to facilitate the operation of the road and to decrease the client's administrative burden.

4.3.10 Innovations

Theoretically DBFO offers a lot of freedom for the ProjectCo. Changes to the design can be made flexibly as long as performance specifications and standards are met. However, according to the ProjectCo, too many norms restrict implementation. So far innovativeness has been at a normal level. The biggest innovations have occurred in the project management and work organisation, as the private sector has a stronger motivation to optimise the economies of the project. Most efficient project delivery is achieved, when the service provider is given freedom to select the most efficient

delivery schedule, resourcing and procurement packaging. Effectiveness, productivity, and cost management differ significantly from those of a public organisation.

Generally, the public client is not very receptive to new technological solutions as it does not want to carry additional risks. DBFO facilitates acceptance of innovations as the risks involved with the new technology remain with the private organisation. As a result, some technical solutions differ from what would have been built with DBB. The innovations done in DBFO projects may also help develop the whole industry and its productivity.

4.3.11 Client satisfaction and project success

Both client and contractor satisfaction are higher than traditionally. DBFO has brought the client 5–6 year time savings and approximately €16.8 million savings in accident and user time costs compared to traditional delivery. Also, users are content with the DBFO road. The road is considered well delivered, fast, safe, efficient, and very well maintained, and the users are kept well informed. As a result, the project has gained immensely positive publicity. Generally, it is perceived that a public organisation with a non-profit emphasis will never be able to achieve the efficiencies a private organisation has in managing and operating a road. The advantages and disadvantages of DBFO are listed in Table 8.

Table 8. Main advantages and disadvantages of DBFO.

Advantages	Disadvantages
• potential for innovation • good quality product and service • improved participant relationships • price certainty • reduced life-cycle cost • increased road availability + other user benefits • time savings • time certainty	• complex and expensive tendering phase • lack of competition in big projects • changes during contract period

5. Literature review on project delivery systems

5.1 General

The client needs to be able to compare the value for money achievable through different project delivery alternatives. The comparison should involve assessment of risk transfer,

differences in quality of the service and product, and consequences of the delivery schedule. The client should generally use procurement methods that promote innovation and higher industry productivity and profitability. Thus, quality should be emphasised in contract award, service providers should be paid based on performance and outcome, and the open-book practise should be followed /126/. However, as it is often difficult to select the service provider based on the quality of the technical proposals, importance of pre-qualification is emphasised. While all parties agree on the benefits of these changes in road procurement, the industry considers the speed of changes too fast, as the market is not perceived to work properly yet /128/.

In small countries like Finland, it is often difficult to entice adequate competition for large projects. This problem may be overcome by developing the Scandinavian Common Market as is currently being done. However, even though there are many potential benefits (larger market, more service providers, need for service providers to develop their operations and knowledge base, and initiation of international competition in the infrastructure industry) there are also hindrances that will pose significant challenges to client organisations. These include the lack of common terminology and concepts, language problems, contractors' unwillingness to enter new markets, cultural differences in work and contractual issues, and markedly differing client procurement strategies. /133/

One deficiency of project delivery methods is that they do not penetrate the whole supply chain, but rather concentrate on the relationship between the client and the main contractor. Subcontracting methods have remained largely the same as before. Generally, quality, continuous relationships or delivery certainty are not a competitive advantage for a subcontractor who cannot offer the lowest bid price. However, subcontractors tend to have a significant role in project delivery, as they do much of the work. /128/

5.2 Innovation

There is a large gap between current industry innovativeness and the innovativeness sought by the client (see Figure 1). Reasons for this are evident. Procurement tends to be price driven. Projects are divided up into small, strictly defined work packages, and interfaces are managed by the client. Profitability of the industry is poor, differentiation is not encouraged and public clients are reluctant to award contracts to alternative bids. Long-term and broad cooperation and networking in the industry are missing. /129/

As more responsibilities are transferred to the industry it is becoming responsible also for research and development. However, so far private sector development has concentrated mainly on equipment development. As the companies should invest part of

their turnover into R&D, there is a risk that R&D will stop (see Table 9). R&D is further hindered by the infrastructure sector characteristics: there are only a few clients and products have long life cycles. /128/

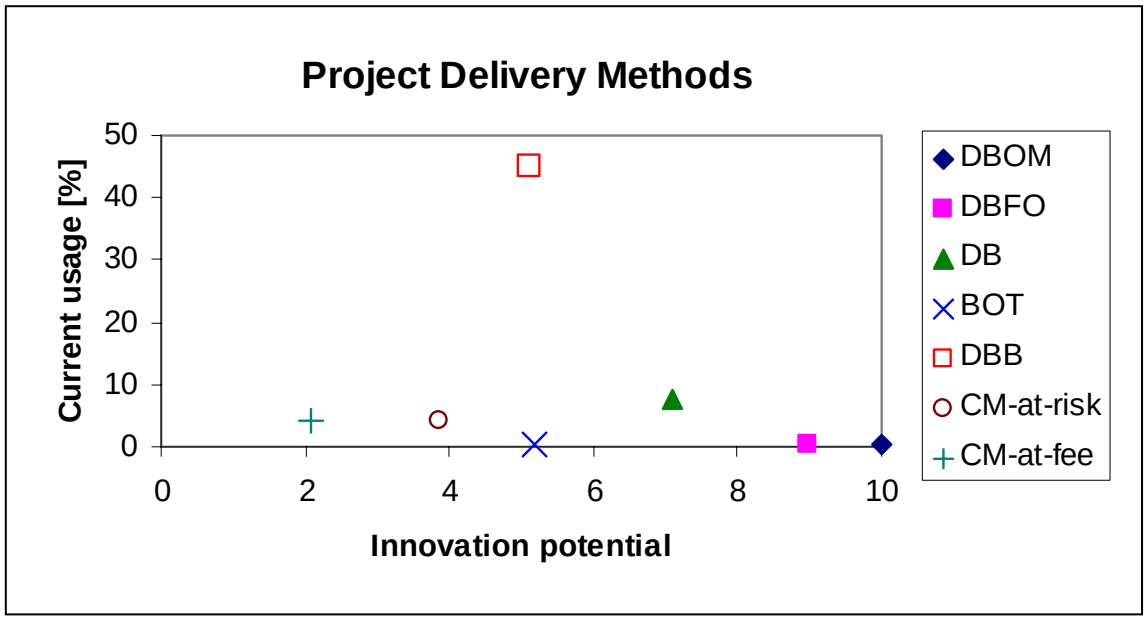

Figure 1. Innovation potential and use of the different project delivery methods /129/.

Table 9. Motives for and hindrances to innovations. /135/

Motives for innovation	Hindrance to innovation
• competitive advantage • entry into new markets • client needs and regulations • cost pressure • competing products/services • management of the road life cycle • international competition/markets • verification of product characteristics • change in company ownership	• lack of financial resources • no internal project managers/workers for R&D-projects • no management commitment to R&D • reluctance to change • no time/capability to outsource R&D • results are not believed to improve business • no R&D partners

As many innovations are derived from organisational interfaces, partnering and networking increase company and industry innovativeness. Generally, if the client has more time to prepare the RFP, more innovative methods are applied. Also, if bidders can concentrate on preparing their bids without other bids under work simultaneously, there is more competition, lower prices and more innovative solutions. Additionally, if

the bidders know better the infrastructure sector´s future demand they can better select the projects, where they have more experience. The better the client masters procurement and the use of innovation incentives, the more he can encourage industry innovations that improve productivity and cost effectiveness. /129/

5.3 Maintenance

Finland, with many other countries, has moved from in-house maintenance to outsourcing these services. Overall, the OM industry has not developed well, as the project delivery methods have not supported life-cycle costing, emphasis on environmental impacts or overall economical consideration. The lowest price has often been the only contractor selection criterion. As a result, competition has significantly reduced prices, industry margins have been driven down and the number of subcontractors has decreased /14/.

To eliminate the experienced problems, maintenance is currently being changed towards performance-based project delivery. This involves increasing the size and duration of contracts, broadening of contractors' responsibilities, and increasing the operational freedom of the contractors /14/. Also, incentives are implemented to emphasise the importance of user satisfaction. To facilitate changes the contract documents need to be standardised, and quality weighting in contractor selection needs to be increased. While big contractors see opportunities in these changes, smaller contractors would prefer the current size and length of contracts /15/. Thus, the changes are implemented gradually to allow the industry time to adjust to the new environment and to allow the client adequate time to develop appropriate performance-based specifications, performance measurement methods and associated documentation.

Performance-based maintenance is used also in Sweden, Norway, Denmark, England, Netherlands, USA and New Zealand, where experiences have generally been positive. For example, Sweden has reported annual savings of 30% as a result of performance-based contracting. However, in Denmark improved quality has resulted in increased prices. Generally, performance is measured at certain phases of the work: at completion and after the warranty period. Warranties vary between 2–15 years. /6/

5.4 Construction Management

To overcome the lack of cost certainty experienced in CM, the CMr can be motivated to look for more economical solutions through target cost arrangements with a bonus/sanction related to a cost underrun/overrun. If the target cost is also used as a criterion for selecting the CMr, a competitive and more accurate price can be ensured.

However, it must be recognised that a CMr who takes on the risks of the target cost arrangement will also ask for a higher fee than a CMr who bears no cost risks. /139/

There is currently a research project in its initial steps, aimed at combining CM and DBM models. In this so-called life-cycle CM, the CMr would procure and manage design, construction and long-term maintenance for the client. This would allow small and medium-sized companies to compete for the work resulting in more competition than large DBFO contracts can entice. At the same time the life-cycle perspective would be emphasised. /127/

5.5 Design-Build

5.5.1 Project team

In many projects cooperation between the contractor and client, and the contractor and designer has been problematic /138/. Problems in the latter case are due to the design companies facing a transfer further down in the value chain, as the contractors place themselves in between the client and the designer. As a result, the designers' culture shock has been significant requiring a cultural change in order for them to be able to work effectively with the contractors in their new role /128/.

5.5.2 Schedule

DB allows time savings /138/. However, the client should ensure that there is adequate design time included in the schedule, as often the schedules are too tight and leave too little time for careful design of structures that requires almost as much time as constructing those structures /137/. In addition to the delivery process, timing of the project, market situation and available contractor capacity also have an effect on the schedule and costs. A large project should start in the spring, as later start-up and lengthening of the schedule will increase costs. Generally, an optimum duration is possible only, if all whole financing is in place when the contract is awarded. This may result in construction cost savings of 10–15% compared to a project scheduled based on annual budgets /136/.

5.5.3 Cost

Generally, the cost certainty of road projects is relatively poor, as projects tend to change (enlarge) during long planning periods leading to increased project costs /136/. However, DB results in fewer change orders than DBB leading to improved cost certainty. Also, the general perception is that DB projects have been very economical

for the clients resulting in savings of up to 24% compared to the initial cost estimates /138/.

The problem associated with DB is the high tendering cost (0.6% of the contract value) made mote pronounced by the relatively low contractor profitability, especially in the early DB projects. The contractors have not been able to assess risks properly, and they have not included adequate risk premiums into their bids. However, this is expected to change as a result of more experience, short-listing of bidders, and tender fees. /138/

5.5.4 Quality

Often quality requirements are inappropriately set both on the end product and intermediate phases. As a result of the potentially conflicting requirements, there are some reservations concerning whether DB actually leads to the quality level sought by the client. This issue is faced especially in projects awarded based on a very low bid price, where the contractor may take short-cuts to save money. Also, the contractors' quality control has occasionally been somewhat insufficient emphasising the importance of adequate site supervision /138/. Thus, it is generally considered important that the designer participates in the construction phase which allows him to develop his skills and to ensure adequate construction quality. However, as the designer is often a subcontractor and the design cost is minimised, no money is left for the designer to be involved in the construction. This makes quality a secondary factor /137/.

5.5.4 Innovations

Often the RFP does not leave adequate room for innovations /138/, and the time reserved for technical alternative design is also inadequate /137/. Moreover, a 5-year warranty still restricts innovations the client is willing to accept due to risks involved with the road's long-term performance. The client's risk reluctance could be reduced, if the warranty would cover one pavement life cycle (10–25 years) /130/.

5.6 Design-Build-Maintain

5.6.1 General

DBM models have potential to deliver better value for money for the client than traditional models /140/ through risk transfer, long-term contracts, outcome emphasis, performance measurement and incentives, and private sector management skills /126/. At the same time, DBM leads to increased international competition /124/ and involves more complicated procurement and tendering processes than other models. DBM requires that the road scheme is prepared further to allow setting appropriate quality

requirements, as often the biggest problems are associated with inadequately specified environmental issues. Also, the design directives have been too loose and allowed differing interpretations /142/. As operation of roads requires highly specialised equipment and is generally delivered by specialist contractors, according to some sources, there may not be adequate synergies in including this into the DBM contract. Instead there are clear benefits in including periodic maintenance into the contract /130/.

5.6.2 Risks and responsibilities

The viability of the project is dependent on risk identification and allocation. Delay and market risks are identified as the main risks affecting the success of a DBFO project. Cost and legal risk are also considered significant /140/. As these risks are transferred to the party best able to manage them, the price of risk management should be lower than traditionally /126/. The client is typically in the best position to carry risks when /140/:

- there are no risk management systems that would allow safe-guarding against the risk or spreading it
- the risk is so large that the authority is the only realistic risk manager
- determining risk probability and pricing of risk is very difficult.

5.6.3 Schedule

DBFO enables fast project delivery /124/ as a result of parallel design and construction and the lack of financial limitations. Also, the start of service payments, when the road is taken into use, encourages faster project delivery /140/. While short project duration decreases overhead costs and the capital tied in the incomplete road, it may in some cases actually increase construction costs /142/.

5.6.4 Cost

Adequate and flexible private financing enables efficient schedules accompanied with efficient use of resources. This reduces project costs /124/. The construction cost does not significantly differ from the traditional as most savings are made in maintenance and overhead costs. Some savings result also from reduced subcontract prices as the subcontracts tend to be larger than with DBB and entice more competition /142/. In total, the construction cost savings may amount to 10–25%, while operation and maintenance cost savings may be 10–40% /140/. Also, cost certainty is improved, even though the final contract cost is not fully known. To improve cost certainty further a maximum cost can be determined for the project /126/.

5.6.5 Quality

Minimal use of the client's quality auditing resources reduces the client's supervision costs to only 10% of those with DBB. However, there have been some inadequacies in the quality monitoring done by the ProjectCo due to the very tight schedule. This may have occasionally led to decreased quality. Thus, construction quality has been at an average level, but operation and maintenance quality has been very good. In the future, quality responsibilities of the ProjectCo will be set more clearly in the contract. Also, shadow tolling has raised some criticism as it does not encourage the service provider to improve the service level. /142/

5.6.6 Change order, disputes and claims

A better methodology to deal with changes should be developed to allow more flexibility in the contract. Especially the current payment system adopted for changes (changed service fees) is considered too complicated /124/. Due to the complicated negotiations on the changes, it has been suggested that a contingency fund be set up in the contract to allow reasonable changes to be made without lengthy negotiations /142/.

5.6.7 Innovations

New procurement methods activate the technologically stagnant infrastructure market. As a result, both parties to the contract have been satisfied with the DBFO project delivery /124/, and it has proved beneficial for both the client and the ProjectCo /142/. However, the concession period should be long enough, as the final outcome of a new technical solution may only appear after 20 years /130/ affecting the client's risk perception and the ProjectCo's payback on the investments made.

6. Summary on Finnish project delivery

The Finnish infrastructure sector is experiencing significant changes in the way roads are procured and delivered. The client is actively tracking experiences in the foreign markets to ensure that the project delivery methods adopted are the best ones. The client aims to reduce his project management and project cycle times and to achieve value for money delivery through effective procurement. Project size is growing and responsibilities of contractors are broadening. Thus, a cultural change in the industry is required to adopt these new ways of operation. Even though the changes are considered beneficial some resistance exists.

DBB is still used in 24% of road projects (by value), and it is considered an appropriate project delivery method in highly constrained projects (see Table 10). Also local

authorities also use DBB as the major project delivery method. Construction management has been used in 4% of projects, but it is not considered a future project delivery method. Pure construction consultancies will be used increasingly, though. Generally, DBB and CM are not perceived to encourage industry development.

Table 10. Future applicability of the project delivery methods in Finland.

Factor	DBB	CM	DB	DBFO
Client satisfaction		Medium to high	Medium to high	High to excellent
Contractor satisf.		Low to medium	High	High
Willingness to tender	Yes	Yes	Yes	Yes
Main advantages	Simple, small and medium-sized companies competitive, well known	Simple, small and medium-sized companies competitive, well known, faster than DBB	Market and contractor development, single point of responsibility, capital cost savings, time savings, optimised design, buildability, innovations	Whole-life cost considered & lower, earlier project delivery, market and contractor development, innovations
Main disadvantages	Slow, does not develop market	Does not develop market	Barriers between designer and contractor	Inflexibility over long term, lack of capable service providers
Applicability	Highly constrained projects < €500 000	When client's own resources inadequate	Projects with room for innovations, > €3.4 million	Projects > €40 million

As market development has been sought, DB has become the most common road project delivery method used in 69% of projects. Experiences gained have shown benefits to well surpass initial difficulties. Thus, DB is considered superior to DBB. Also large contractors prefer project delivery methods that allocate them more responsibilities. As an extension of DB, DBM-type procurement has been piloted. As the benefits of DBFO have significantly surpassed any disadvantages, it is considered the future project delivery method for large projects and is already applied in new projects.

While the high tender costs and large project sizes of DB and DBM contracts reduce competition, DBB and CM encourage small and medium-sized companies to tender (see Table 11). To encourage tendering for DB and DBM contracts, performance-based specifications, automated tendering and standard contract documentation are under development. Also, the client generally does a more extensive initial site investigation and pays a tender fee for acceptable, unsuccessful bids. While price award is used with

DBB, the best value criteria are used with DB and DBM contract award with price often having the dominant status. In the future, the importance of the quality criteria and pre-qualification will be increased.

Table 11. Summary on Finnish procurement processes.

Factor	DBB	CM	DB	DBFO
Design completion				
in RFP	100%	50%	50%	50%
in tender	None	None	Preliminary technical design	Not much
at start of work	100%	Partial	Partial	Partial
Specifications	Input based	Input based	Technical	Technical, towards output specification
Award basis	Pre-qualified bidding or open competition	Pre-qualified bidding	Pre-qualified bidding	EOI, Pre-qualified bidding
Award criteria	Price	CMr: price & quality. Contractor: price. Designer: quality & price	Weighted (70–80% price, 20–30% quality)	Weighted (technical 10%, price 90%)
Pricing	Unit prices or fixed price	Increasingly target cost contracts	Fixed price	Payment based on traffic, availability and performance
Risk transfer	Client carries most risks	Client carries most risks	Contractor carries most risks	Maximum risk transfer
Innovations		In project management	Price focused	Less than expected
Warranty/concession	2 years	2 years	5 years	15–25 years

Both project duration and client administration are effectively reduced through the alternative delivery methods (CM, DB, DBM) (see Table 12). Time certainty is also improved. Time savings result in savings in overhead and other time-related costs. As DB and DBM lead to more effective project management, they tend to reduce project costs compared to DBB (see Table 13). Moreover, cost certainty is significantly improved due to the payment methods applied and reductions in change orders.

At the same time as the quality responsibility is largely being transferred to the contractor, there is some debate over the quality achieved through CM and DB. However, DBFO has provided indisputably good quality and value for money (see

Figure 2). Teamwork is improved through DB and DBM, even though some problems exist in cooperation between the participants due to old, well-established roles. Improved communication and information transfer between participants are prerequisites for innovations that are necessary for industry development. While CM and DBB offer little opportunities to innovate, DB and DBM have more potential. However, the statutory processes and inadequately developed specifications tend to reduce the number of innovations. One possibility to encourage innovations could be earlier contractor involvement.

Table 12. Summary on Finnish schedule issues.

Factor	DBB	CM	DB	DBFO
Schedule	Longer than DB	Shorter than DBB	44% shorter than DBB	50% shorter than DBB
RFP preparation	less than DB		1 week	6 months
tendering period	3–6 weeks	2 months	2–3 months	3–6 months
tender to award	A lot shorter than DB	A lot shorter than DB	Contractor selection 1.5–2.5 weeks	6 months (procurement 20 months)
design	Longer than DB		Initial design 6 weeks, continues during construction	Initial design 2 months, continues to the end
pre-construction	Mobilisation period longer		Started as design started	
construction			Longer than DBB	Faster than expected
Time overrun	Generally none	0	6.5% early	29% early
Agency burden				
procurement		Same as DBB	More than DBB	High, more demanding
contract admin.	7–8%	Less than DBB	Less than DBB	Low
design		Less than DBB	30–50% of that with DBB	A lot less than DBB
construction		Less than DBB	About the same as DBB	2 supervisors instead of normal 5–10
maintenance		Same as DBB	Same as DBB	No difference

Based on the interviews in Finland the following value networks were produced for the CM, DB and DBFO project delivery methods (see Figures 3–5). In the value networks the yellow, coloured circles in the middle depict client values, while the white circles depict factors affecting project delivery in meeting the client values. The green, solid arrows illustrate the facilitation or improvement of the subsequent factor, while the red, dashed arrows illustrate the hindrance caused to the subsequent factor. Blue shadings depict a trend or a change adopted or suggested to decrease the detrimental effect of the factor. In the Finnish market the hindrances to the project delivery methods have been largely recognised (see Table 14), but the industry is still very much in the learning

phase, and the true results of the changes remain to be seen. However, the change towards broader service packages and increased transfer of risks to the industry is irreversible.

Table 13. Summary on Finnish cost issues.

Factor	DBB	CM	DB	DBFO
Tender cost (contractor)	0.1–0.3% of total cost	Same as DBB	0.6% of the contract cost	0.1–0.5% of contract cost
Costs of the client		5–20% lower than DBB	Up to 24% lower than DBB	10–14% savings
procurement			Higher than DBB	Higher than DBB, DB
contract adm.	7–8%		Up to 2% lower than DBB	Less than DBB
design	Road Scheme 3–7%, technical design 3–10%	4.1% of project cost	Road scheme 3–7%, technical design less than DBB	Savings
supervision		For CM: 1.5% of the total CM cost	Overlapping controls eliminated	Savings
construction	83–94%	91%	93% (design 5%, investig. 3–4%, constr. 92%)	50% of the contract cost. 10–20% savings.
maintenance			Same as DBB	5–20% of the contract cost. 10–40% savings.
dispute resol.	Some		0	
external adv.		CM 8–12% of the project cost	Same as DBB	More than with DBB. < 0.1% of the project cost.
Cost overrun	Some		Less than DBB	None
Profit			Margins very tight	
designer		Same as DBB	Less than DBB	Less than DBB
contractor		Same as DBB	1–6% over DBB profit	Higher than DBB
Value of redesign	More than DB, more technical	Less than with DBB	Small	
Value of change orders (of total cost)	5–8%	2%	0–5%	Minor during construction (1%), some during operation
Disputes	Some, not often	0	0	0
Claims	Some	0	0	0
Enhancing performance			Yes	Yes

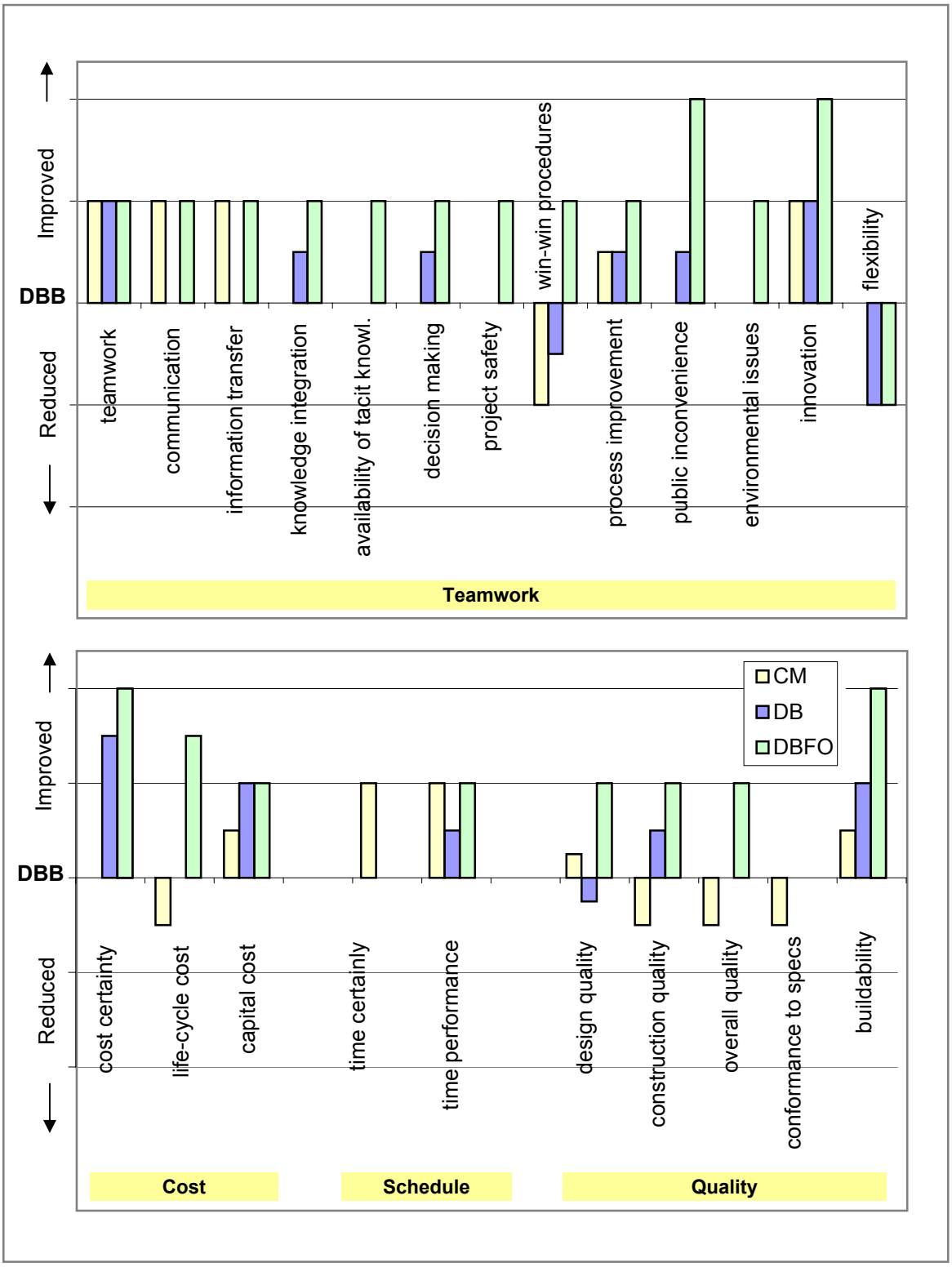

Figure 2. Summary on cost, schedule, quality and teamwork in Finland

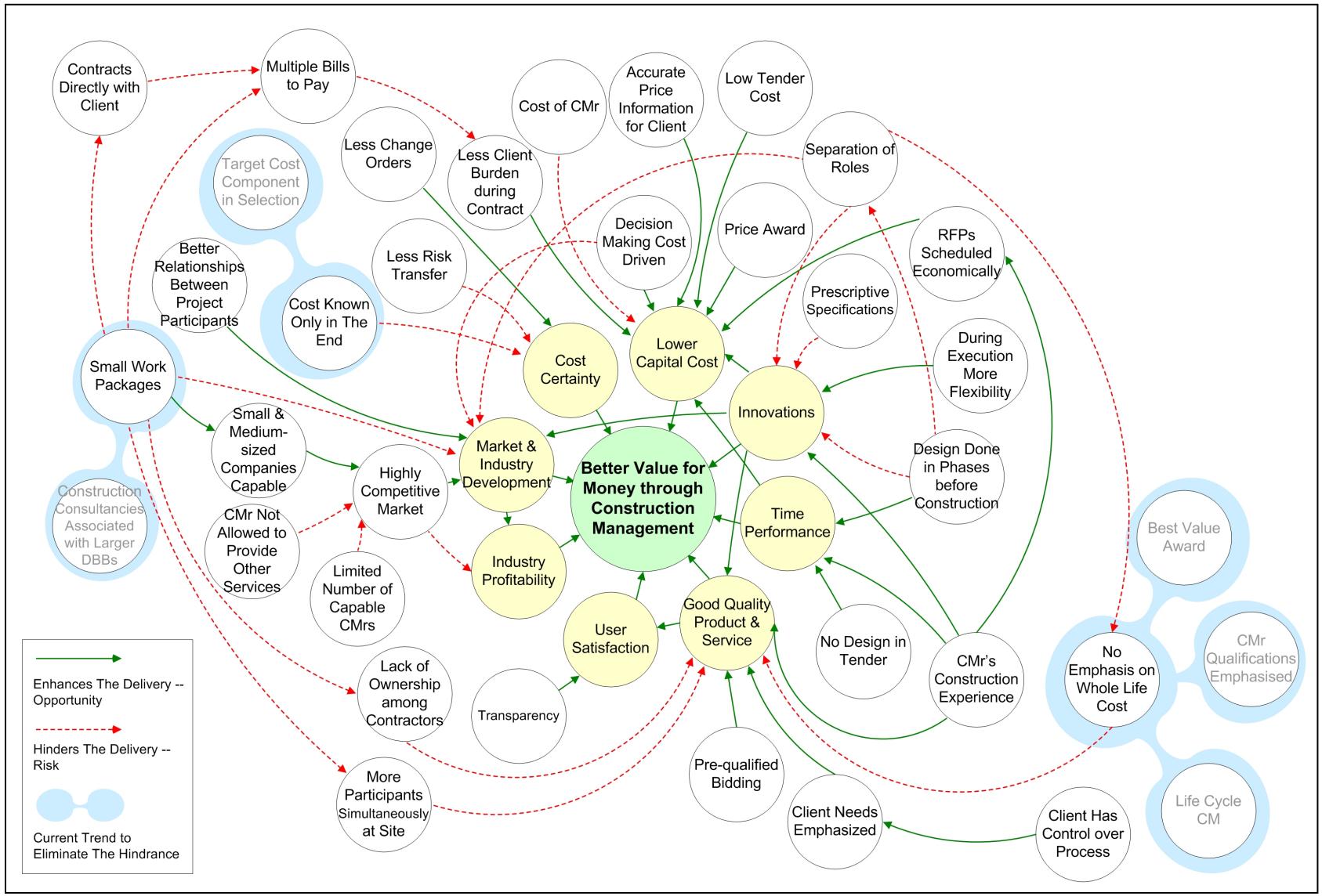

Figure 3. Value network of CM-at-fee (Finland).

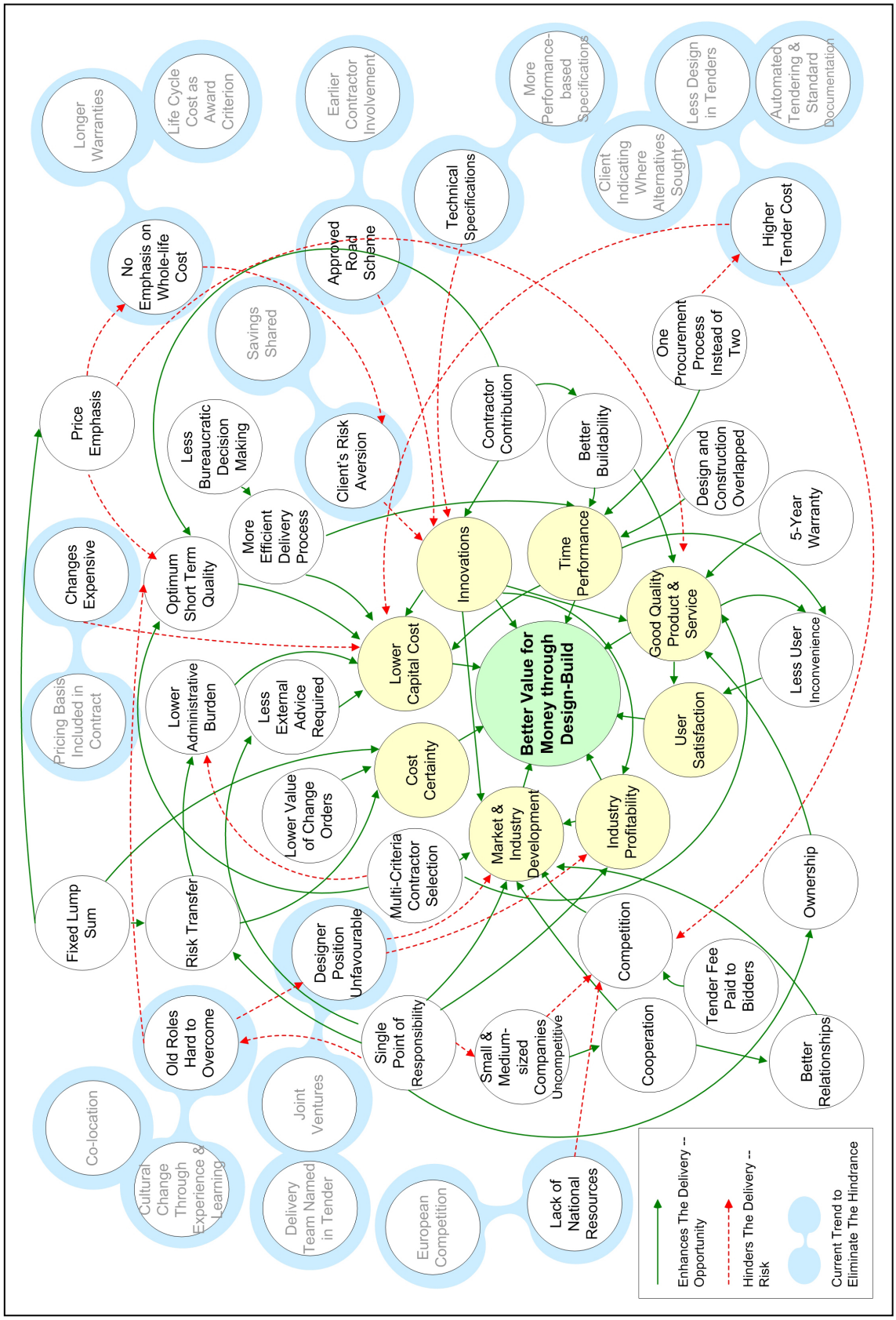

Figure 4. Value network of DB (Finland).

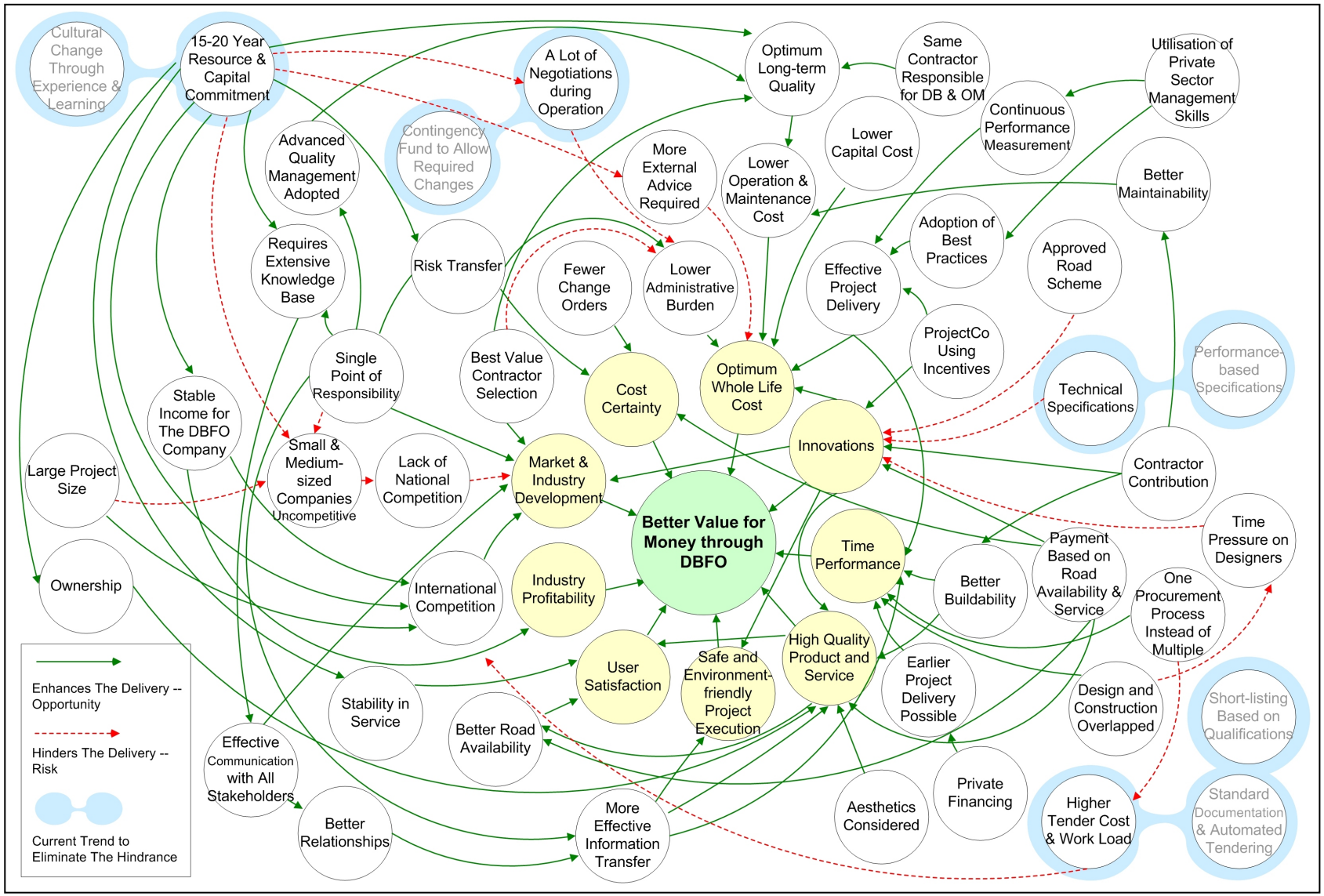

Figure 5. Value network of DBFO (Finland).

Table 14. Future improvements in Finnish road procurement.

	Problems in procurement	Improvements
DBB[1]	Price emphasis	Best value award, pre-qualification, fixed lump-sum contracts
CM[1]	Poor cost certainty	Target cost arrangements
	No emphasis on road life cycle	Best value award, CMr references emphasised in selection, life-cycle CM
DB	High tender cost	Automated tendering, standardised documentation, pre-qualification, less design in tender
	Inefficiencies due to professional division	Cultural change, experience, joint ventures, co-location
	Client goals not reflected in subcontracting	Naming suppliers in the bid, longer term cooperation between parties, less price pressure
	Lack of innovations	Earlier contractor involvement, better performance-based specifications
	No emphasis on road life cycle	Longer warranties, life-cycle cost as an award criterion
	Changes expensive	Pricing basis included in contract
DBM	High tender cost	Automated tendering, standardised documentation, more emphasis on tenderers' qualifications
	Shadow tolls do not encourage service improvements	Payment methods linked to road availability and other performance criteria
	Changes to contract expensive, inflexibility	1) Benchmarking and market testing mechanisms, 2) Periodic reviews and adjustment to payments or 3) Contingency fund
	Lack of innovations	Longer concession period, better performance-based specifications
	No incentives for ProjectCos to make changes/keep up to date	Market testing, benchmarking, residual life requirements and technology change provisions

[1] The reason for the minimal problems listed and improvement suggestions is that the current emphasis is on the other project delivery methods.

PART II

UNITED

KINGDOM

1. Market

In the UK road sector, the main client is the Highways Agency, an Executive Agency of the Department for Transport, which manages, maintains and improves the network of trunk roads and motorways in England. Other clients in the UK are the Welsh and Scottish office and Local Authorities. Ninety-five per cent of the Agency's works are purchased from external suppliers /60/.

Based on the Agency's 10-year plan, 75% of the road construction will be conventionally financed, while private financing will cover 25%. As the size of the privately financed road projects is increasing, the influence of the financiers is also increasing. At the same time it may become more difficult to entice them into the market due to the larger risks involved. Currently the Highways Agency is unsure of whether there is enough interest in the market for very big projects and sufficient benefits to recoup the accompanied big risks.

The UK road construction market is a competitive market, but the government client is thought to increase risks due to its volatile demand. While some interviewees expressed their concerns over a shortage of talented and experienced engineers, there is a stable supply base of big national and smaller regional contractors. As projects have become larger, the competitiveness of regional contractors has decreased. The larger companies have greater resources to invest in quality work and adjust themselves to new delivery trends. At the same time, the construction companies are turning into full service providers by acquiring facilities management companies as this is believed to enable safer and steadier business with higher profit margins.

Currently the Highways Agency is aiming to be a network operator which requires purchasing both asset management and management of traffic services from its suppliers /58/. Single-point accountability will remain the Agency's key policy driving consultants and contractors together to forge new partnerships. The closer these parties work together, the greater the chance of a well-designed and constructed product.

2. Owner values

The Highways Agency is radically and rapidly changing the way it works and procures roads. It is currently looking for reductions in its project management and in project times from inception to completion. The Agency is also aiming to increase contractors' involvement (see Table 15).

Table 15. The client's values and goals.

• best value – value for money • cost certainty (no claims or litigation) • time certainty • shorter cycle times (less than ten years) – faster infrastructure creation • innovations • safe project execution	• minimum adverse impacts on the environment • employee development • development of the market • client satisfaction • maximum road availability, minimum user inconvenience

3. Project delivery methods used

The government requires the principles of Rethinking Construction to guide all public clients' procurement practices. These guidelines are listed in /73/:

- Traditional processes of selection should be changed to ensure Best Value.
- An integrated team should be formed before design starts and maintained throughout the project delivery.
- Contracts should lead to mutual benefit for all parties and be based on a target and whole-life cost approach.
- Suppliers should be selected based on Best Value and not on lowest price.
- Performance measurement should be used to underpin continuous improvement.
- Culture and processes should be changed to facilitate collaborative working.

The Highways Agency has fully adopted these guidelines. In Design-Bid-Build (DBB) the number of conflicts between the parties grew leading to increased use of Design-Build (DB). Today DB has become the established project delivery method with the vast majority of projects being procured this way. At the same time, about 22.5% of transport projects are procured through Design-Build-Maintain-type arrangements, more specifically through DBFO /121/. DBFO is used almost as a synonym for Private Finance Initiative (PFI) that was originally adopted by a political decision.

4. Industry experiences based on interviews

4.1 Design-Build

4.1.1 Project delivery process

Designer/contractor selection

The Request for proposal (RFP) may include 0–80% of design, while the most common share is 20–25%. This level of design is required to make use of the compulsory purchase power needed to acquire the land. The tender period varies depending on the size of the project, but according to the interviewees it has generally been adequate (approximately 20 weeks). Tender design accounts for about 15% of the total contractor's design cost, and 40% of it is done at risk by the designer. While most of the detailed design is done after the contract is let, most of the critical issues are solved at the tender stage which settles about 75% of the design. Once the contract is let there is not much room for changes.

To limit the cost of tendering and to improve the quality of tenders, the Agency uses pre-qualified bidding. Companies are classified based on their resources to keep tendering costs proportionate to the companies' resources. Three to six companies are chosen to tender. To facilitate assembly of the tender list, the Agency uses the capability assessment toolkit (CAT) that evaluates the contractor's capability to deliver the project (see Figure 6) /84/. In essence, the CAT plus Performance Reports determine the future vendor ratings. The client does not compensate the bidders' tender costs.

To speed up the tender stage and to decrease tender costs, the Agency is looking into reducing the required tender design. The contractors may be asked to price an illustrative, fixed design and to answer specific questions to demonstrate their problem solving capabilities. However, when an illustrative design is used bridges, etc. already have their outline planning approvals. Changes to these approvals would require statutory processes to be gone through again. Also, the contractors claim that there is a tendency to believe that the contractor's 'better design' is perceived to mean cheaper quality. This discourages them from developing alternative designs and suggestions to improve the illustrative designs.

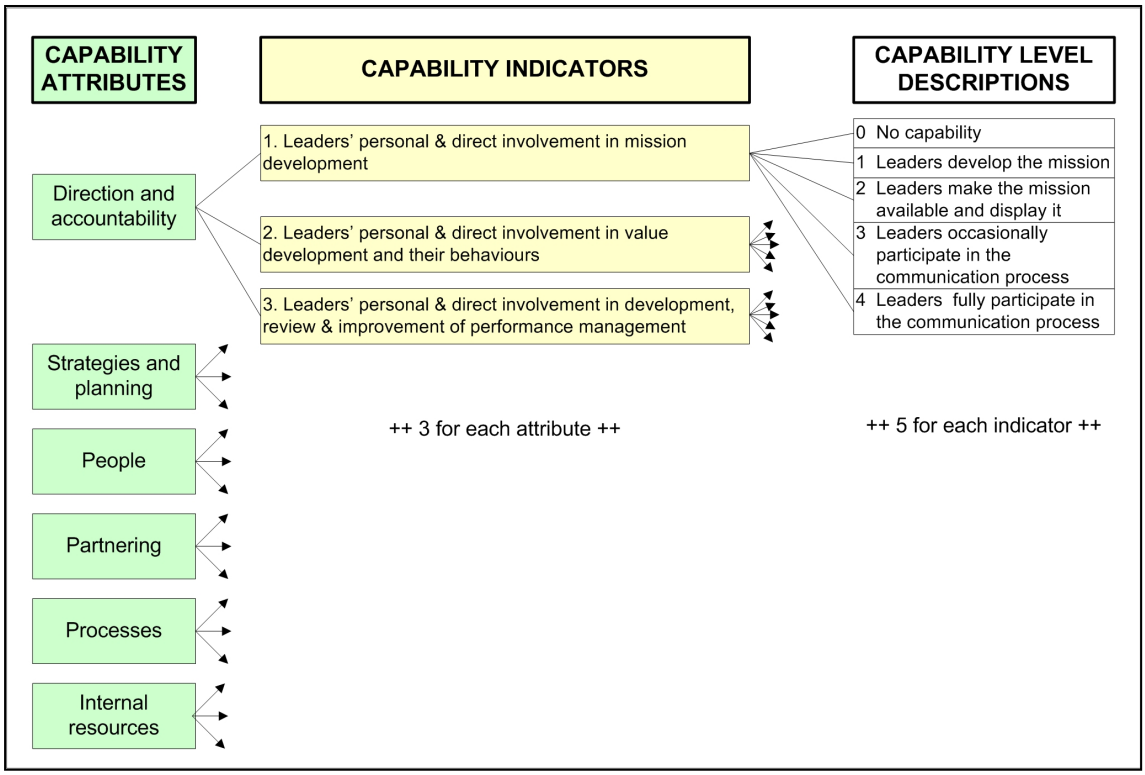

Figure 6. Principles of CAT evaluation.

In most cases, the best value award combines both quality and price factors (for example, price 60%, quality 40%). Despite this, the contractors feel that contracts have generally been awarded solely based on price. This indicates that either the bids are qualitatively very similar or qualitative parameters are not given enough emphasis. According to both the contractors and clients, concentrating too much on price leads to difficulties and disputes during project delivery, as quality is equally important in achieving best value. To emphasise quality, the Agency is starting to use 100% quality award criteria. The objective is to identify the best team, who are most likely to identify the optimal solution and to deliver it efficiently to the required standards. The bidders are required to express how they would deliver best value to the client within the project budget and how the target cost can be determined, when the design is finalised (indicative unit prices, profit margin, etc.). As the target cost is affected by the fact that pricing is not open to competition, the contractor is given incentives for continual improvement throughout the project. Currently the principal contracting method in conventionally financed projects is a target cost DB contract. Fixed pricing is used only in small projects.

According to the client, in the future it will be more important to actively manage the supply chain and the market share of suppliers. As 4–6 big projects are aggregated into one there will be only 5–7 capable bidders. To maintain healthy competition one supplier should not dominate the market. While the clients are looking for bigger

European companies to enter the market, the threat of global competition does not please national companies.

Design

There are two different DB approaches. In simple design-build a contractor is engaged in the project at the final design stage, after the road scheme is approved and much of the specifications and requirements are set. In early contractor involvement (ECI) a contractor is engaged in the process as soon as possible after identification of the preferred route. At the moment, ECI is at its piloting stage with the first four projects let in 2000–01. These projects have progressed satisfactorily.

The interviewees agreed on the need of a better working relationship between the designer and the contractor and on the contributions made by the contractors during the design process. However, sometimes the client and the contractor had differing opinions on the value of these contributions. Disagreements were mainly related to the effects these contributions had on the road life cycle. Generally, DB project delivery reduces design costs, because design scope and designers' margins are reduced.

Construction

In the competitive market, the contractor is forced to start construction as soon as possible after the contract award. Parallel construction and design shortens the schedule, but it may occasionally leave too little time for initial detailed design. Both the client and contractors agreed on the benefits of the initial design period set in the contract. Generally, the contractors' average profits do not differ much from DBB, but due to materialised risks the profits may be even lower than with DBB.

To enhance co-operation and to align participant objectives the Agency tends to enter into project partnering arrangements with its suppliers. These partnerships have been successful and beneficial in delivering mutually agreed common objectives. Partnering and co-operation is facilitated by the fact that the partners share an office during project execution. Also, partnering workshops are arranged in the beginning of a project to enhance cooperation.

Periodic maintenance

Generally, the project delivery method (DB or DBB) does not affect periodic maintenance. Only the slightly longer warranty period (five years instead of two) may affect periodic maintenance. Also, according to the client, in some cases innovations

have not delivered what they were expected to deliver causing increased periodic maintenance need in the future.

Maintenance and local improvements are procured through separate, innovative Managing Agent Contractor (MAC) arrangements that are 4-year contracts with an option for a further three years. As an alternative, Framework contracts cover work between £250 000–5 million, and provide single-point responsibility, self certification, a strong partnership approach, use of performance-based specifications and annual targets. Payments are based on the target cost approach with bonuses related to the performance level measured against performance requirements. These contracts allow the Agency to employ directly specialist firms which then work for the construction manager, who is responsible for planning and coordination, and acts as the Agency's cost advisor and project manager.

4.1.2 Risks and responsibilities

In the simple DB, the client acquires permits and environmental clearances to the extent required for the contractor to go ahead with the project after the award. However, the contractor is generally required to liaison with regulatory and environmental agencies, as well as with the public, to get the required permits for the contractor's design changes.

In DB projects, the client transfers extensive risks to the contractor. However, currently the contractors are trying to transfer risks back to the client. Generally, the client thinks that the contractor should bear the risk of unforeseen ground conditions, while contractors feel that this is an unreasonably high risk with their tight margins and does not really bring best value to the client. According to the contractors, the client should also retain risks on issues arising due to his prescriptive specifications. On the other hand, some risks, like weather, should be apportioned between the parties.

When most risks are borne by the contractor, the client can omit extensive risk assessments. However, sometimes improved price certainty has been sought by transferring risks, without giving full recognition to the contractor's ability to assess and manage these risks. Also, the client is concerned about the private sector's inability to price risks properly, because the companies often worry about pricing themselves out of competition. To minimise these problems, a risk register is prepared today with the bidder in a risk workshop. In the workshop, potential risks are listed, priced and the parties negotiate about risk sharing based on their capabilities to handle these risks. The Agency is even trying to set up a generic risk register.

4.1.3 Project team

All interviewees thought that partnering improves the relationship between the contractor and client, and facilitates project delivery through mutual objectives. Partnering also improves communication and information transfer and quickens decision making. The only complaint the interviewees had on partnering was that after the project ends the collaborative spirit also ends. Procurement of major projects on an individual scheme basis means that the partnerships and the invested knowledge and experience of the team members are lost. Lack of continuity makes it difficult for suppliers to plan their resources and impedes training and development of the workforce. Also, it was noted that, despite partnering, when problems start to build up in projects, attitudes often revert back to where they would be with DBB.

The Agency's new procurement strategy will lead to a market with fewer, better quality suppliers appointed on a long-term basis. Longer term partnerships are sought to retain successful teams and to allow maximum use of the developed skills and invested knowledge /60/. These integrated delivery teams will be responsible for delivering the whole programme of smaller works for a 10-year period, not just single projects. The use of integrated teams will speed up project delivery, encourage the development of a community of small and large contractors, foster best practices, improve quality and ensure best price and more efficient project delivery.

4.1.4 Administration

The procurement phase is more burdensome for the client than with DBB. It is estimated that it takes nine times more time and effort. However, contract administration is considered more pleasurable, even though the amount of time spent is about the same. During the design phase the administrative burden is smaller, but there is no difference in the client's burden during construction. This is due to the fact that in traditional procurement most administration is performed by the client's consultant. In DB the need for external advice is reduced to only 1/9 of that with DBB.

Changes in procurement have laid new demands on the client staff, as well. The Agency staff have attained procurement qualifications to widen their experience and vision and to give them a better business perspective. They tend to consider their work more demanding, but at the same time more interesting. While the process has involved some hidden costs, the client expects that the changes will encourage the supply chain to drive down the actual costs as a result of reduced tendering costs and long-term commitments and contracts.

4.1.5 Schedule

DB allows time savings. In addition to the overlapping of design and construction, time is saved also due to no need for multiple separate procurement processes. Also, time certainty of DB projects seems to be better than with DBB projects. This is essential, since one of the key issues in road project delivery is time. However, to reduce time pressure and to improve design, the client occasionally requires use of an initial design period.

The Agency aims to shorten its current 10-year project duration from the identification of the need to the completion of a road. One way to achieve this is through early contractor involvement (ECI), where the contractor's value engineering is expected to lead to time savings and value increases. While a 7–10 year commitment is a long time for the contractor, who initially has to rely solely on the designer, it will allow safer and steadier work. The contractor will be able to plan future works better and to estimate the amount of required resources. Flexibility can be increased further by bundling 4–6 ECI projects into one, which allows the contractor to proceed with the easier projects while the difficult ones are still at the public inquiry stage.

4.1.6 Cost

As a result of savings in costs associated with time extensions, dramatically lower uplifting costs, better buildability and more optimised design, the capital cost of the project is lower than with DBB. Also, the contractor generally pays less for the design than what the client would pay for it, and the client needs less external advice. In some cases the total saving has been 15% compared to the cost estimate made based on DBB.

Even though there should be no price increases in fixed price DB projects, price increases have been quite common. Increases are not as high as they would be with DBB (10–20% instead of 30%), but DB has not always offered the cost certainty expected. Even with a very good risk register, the cost is generally underestimated. Post-analysis of major government infrastructure projects has shown that costs between the conception and outturn are underestimated by an average of 27%. Typical areas for underestimation are dealings with Statutory Undertakes (electricity, gas, water company diversions), ground conditions, land acquisition and structures, that together account for 75% of project costs.

4.1.7 Quality

The clients and consultants generally think that the quality level achieved is lower than what would be achieved with DBB. The contractor encourages the designer to produce a `lean´ design that can be constructed at minimum cost and just meets minimum

specifications. In DBB the designer, employed directly by the client and independent of the contractor, tends to produce a design at the upper end of the specification range. Also, there are more negotiations about the acceptability of the design and resulting work in DB, since there is always room for different interpretations.

Thus, a client who generally uses DBB may not get exactly what he expects through DB. While everything works satisfactorily, the finishing quality and aesthetics may be lower than the client expects. According to the client, the quality problem is partly caused by a lack of supervision. Contractors are not yet ready to pay for supervision as much as would be required under self-certification. Generally, the number of designers at the site supervising the works is only 13–15% of the number the client would have at the site in DBB. Even the contractors' internal supervisory work is reduced (2% less) as DB provides an incentive to eliminate excess workforce. It can be estimated that the total supervision cost is 60% of what it would be with DBB.

There are also projects, where use of effective quality systems has eliminated quality-related problems. Performance assessment based on key performance indicators (KPIs) may also be used to improve quality (see Table 16). KPIs make it possible to define who the best suppliers are, and to benchmark the performance encouraging the companies to work together and to adopt each others best practices. KPIs are currently piloted in a project that aggregates six projects into one. The contractor has to do well in one project and demonstrate continuous improvement in order to get the next one. The contractor's profit margin is set at 2.5% with an opportunity to maximise it through efficient work, while inefficiency reduces it.

From a contractor's point of view, fixed price contracts and price-based award drive concentration on the least cost. In a target cost environment the contractor is looking for the best value for the client and focuses on the whole-life cost. The whole-life perspective can be emphasised also through a longer warranty period. A 30-year liability would encourage the contractor to take greater interest in the completion of the finished product.

Table 16. Key Performance Indicators (KPIs). /61/

Client Product Satisfaction	Predictability of Construction Time
Client Service Satisfaction	Profitability
Defects	Productivity
Predictability of Design Cost	Safety
Predictability of Construction Cost	Cost
Predictability of Design Time	Time

4.1.8 Change orders, disputes and claims

The project delivery process is more flexible for the contractor, but client changes often become very expensive, even though the value of change orders tends to be smaller than with DBB. The contractor understands the effects of design changes better than the client in traditional projects, which improves programme delivery. Also, disputes are significantly reduced from DBB, even though some claims and disputes have arisen due to different interpretations of specifications. Occasionally issues that have arisen have not been handled quickly enough, since co-operative working relationship may be hindered, when commercial pressures come to the fore.

4.1.9 Innovations

The interviewees agreed on the limited scope of innovations achieved due to too prescriptive specifications and client reluctance in accepting suggested, untested improvements. Performance-based specifications are currently being improved, as innovations are considered easier to implement, when the whole life of the road is truly considered through well thought performance-based specifications or a longer defect correction period. However, DB in its simplest form will never allow the innovativeness achieved in vertical construction due to the statutory processes. The road scheme eliminates much of the design freedom as about 80% of the design is constrained leaving little scope for innovation and consideration of buildability /60/. Cost savings can be found solely in detailed design and value engineering. As the clients use value management and engineering when setting their design criteria, the savings in design, deliverable by the private sector, are reduced and innovations become the only key for future success /58/.

One option to increase innovativeness is involving a contractor already when the road scheme is being prepared. As innovations in simple DB are done during a short tender period, ECI offers more time to innovate. It also gives the contractor new expertise and the designer a better understanding of the contractor. The client also expects improvements in risk management, forward planning of resource requirements, recruitment and retention of staff, consideration of buildability and health & safety. The construction period should become shorter and construction impacts decrease /60/.

Traditionally, the supply chain is appointed only after the award of the main contract. This has led to the undesirable practice of getting the lowest prices from the supply chain without considering the consequences for the quality, performance or sustainability of the supply chain. In ECI, the supply chain is built early which decreases price competition /60/. At the same time, the contractor gets to know the suppliers´ technologies and capabilities better and earlier. It is often these specialist subcontractors and suppliers, who possess detailed knowledge of the products and

solutions. In order to provide maximum scope for innovation and identification of the optimal solutions this detailed knowledge is needed as early as possible. The whole supply chain needs to be integrated in a seamless manner and incentivised to contribute innovative ideas which lead to better value /60/. However, according to the client, ECI is not worth applying in very small projects (less than £15–20 million).

4.1.10 Client satisfaction

The client is generally content with DB project delivery, and benefits are perceived to well surpass disadvantages (see Table 17). Most problems have been recognised and solutions have been found. According to the interviewees, the whole road construction sector feels that early contractor involvement, target cost contracts with incentives and 100% quality award with lowered tender costs are the best way to develop the market further and to deliver better quality. Partnering is also considered essential.

Table 17. Main advantages and disadvantages of DB.

Advantages	Disadvantages
• simplifies the procurement process • outcome should meet client requirements • should offer contractor no way to make claims unless client adds something new • appropriate risk analysis should eliminate the risk of underpricing • qualitative award makes competition fairer • improves participant relationships • price certainty • reduced capital cost • reduced supervision cost • time savings • time certainty	• reduced quality in some cases • contractors not ready to take full responsibility for quality control • designers' position and margins degraded • has not produced expected level of innovations

4.2 Design-Build-Maintain

4.2.1 General

DBFO roads are mainly on strategically important lengths of the network with the greatest need for investment. By the end of April 2003, 14 DBFO roads have been brought to financial close. Two further projects are in procurement and a joint project between the Scottish Office and the Agency is progressing. Their total capital value is £1.3 billion, the capital cost of a single project being £9.4–214 million. However, now the UK Government has ruled out backing any future PFI projects smaller than £20 million, as the cost of the bidding process makes them uneconomical.

4.2.2 Project delivery process

Designer/contractor selection

The Agency's objectives, when launching the use of PFI in 1994, were /56/:

- to minimise adverse impacts on the environment and maximise benefits of road users
- to transfer the appropriate level of risk to the private sector
- to promote innovation, not only in technical and operational matters, but also in financial and commercial arrangements
- to foster the development of the private sector road-operating industry
- to minimise the financial contribution required from the public sector.

To offer value for money, the present cost (PC) of projected payments with DBFO should be lower than the PC of the public sector comparator (PSC) that includes the cost of design, construction, operation and maintenance of the project road over 30 years incorporated with a risk assessment under best practice procurement. If value for money is achieved with DBFO, the negotiated selection process includes the following steps:

1. Consultation phase.
2. Advertisement in the Official Journal of European Communities.
3. Expression of interest – generally there have been 8 interested bidders.
4. Pre-qualification of bidders – generally 3–4 bidders are selected.
5. Tender period – approximately 13 months. The RFP may include up to 80% of design (depending on the design level required for outline planning permission). After the tender 85–90 % of the design is done. Variant bids are invited if the tenderers are perceived to offer a better value through different risk allocations.
6. Tender evaluation to select a short-list – generally 1–2 bidders are selected.
7. Negotiation with short-listed bidders.
8. Receipt of best and final offers (BaFOs).
9. Analysis of BaFOs and selection of the preferred bidder – selection criteria include PC, quality assessments of technical merits and environmental soundness of solutions. ProjectCos think that selection criteria still weight low PC, too heavily.
10. Completion with the preferred bidder.
11. Finalising of technical requirements and contract terms.
12. Contract award.

According to the ProjectCos, the tender period tends to be too long, since the longer the period the more money both sides use. It is also a long time to keep the companies interested. Tender cost (2.7% of the PC) is about 11 times higher than with DBB (0.25% of the capital cost) and about 3 times higher than with DB (1% of the capital

cost). However, the tender work load is reduced as the company gains more experience. To improve tendering, the cost from initial submission to preferred bidder phase could be reduced to make more money available from the preferred bidder phase to contract award, but this would decrease the competitive pressure on the bidders.

The client aims to improve the tender stage by reducing the tender cost and the time taken to carry out the selection process. This can be achieved by reducing the scope of the technical submission at the tender stage leaving full design, departures processing, etc. for at the short-listing stage. The Agency also considers reducing the scope of the financial and commercial submission at tender stage, as well as providing better data for the bidders (e.g. improved asset data quality, quantity and format, comprehensive site investigations). /57/

The consortia formed at the start of the DBFO road programme have stayed mostly intact and sought to pre-qualify for new DBFO road projects. There has been competition from a wide range of companies and the contractors have faced competition from property companies, support service organisations, equity investment institutions, etc. All this has led to a less manageable market and to a need to improve the contractors' marketing, bidding and risk assessment skills /62/. However, the ProjectCos think that both the financiers and contractors will remain interested in the road projects due to the available risk/reward ratios and spin-off opportunities these projects provide to other parts of the organisations, since significant elements of the projects are subcontracted to specialist companies. Key subcontracts are typically for DB and long-term OM.

In the future, the Agency will pursue to maintain a competitive and sustainable market by packaging small DBFO schemes into discrete contracts, with each contract likely to include a number of different schemes at different stages of development. This is expected to bring savings in finance set-up costs and risk management. Thus, there will be a few large DBFO contracts /57/.

Design

In the early DBFO projects, design tended to act as a constraint during project delivery, which led to a consortium of designers being involved today. Generally, these contractor-led joint ventures tend to enable better buildability, quality and design savings. The contractor motivates the designers to exploit all chances (allowed by the statutory requirements and often too prescriptive specifications) to innovate through incentives tied to the cost savings design in. However, if the potential bonuses are not considered, the interviewees assume that the designers' margins are lower than what they would be with DBB. This is due to the different basis of payment: time-based charge in DBB versus fixed packages in DB/DBFO.

Construction

The interviewees agreed on the fact that the contractors' margins may be somewhat higher as a compensation for higher risk bearing, achieved more easily and paid in a more timely fashion than what they would be in the other project delivery methods. Additionally, the contractor may earn a bonus for completing ahead of time. However, according to the principles of pain and gain sharing, penalties are also applied with more emphasis on liquidated damages today. While the contractors have been able to generate very efficient processes and programmes, some third party slow downs have still occurred due to inadequately organised supply chains. Thus, today advanced software is used increasingly to facilitate coordination and auditing of the documents.

Generally, a 10-year warranty is used to emphasise the importance of long life and good quality of the road, as the parent company bears the 30-year responsibility. This has led to a longer initial design period. At the same, the ProjectCos have been able to eliminate most of their non-value-adding auditing. To further improve the whole-life focus of the implementation, ProjectCos are looking into including a periodic maintenance period (of ten years or so) in DB contracts.

Periodic maintenance

Generally, the value of operation is about four times that of construction. The ProjectCo subcontracts operation and maintenance to an operation company. Periodic maintenance is acquired through separate DBB- or DB-type contracts. Small periodic maintenance works due to changing standards, etc. are procured by the client through DBB or DB contracts. However, the Agency is currently looking into the possibility of including these maintenance works in the responsibilities of the ProjectCos in future DBFOs.

The DBFO contract specifies a required residual life for each element of the project road immediately after the end of the concession period. This influences the ProjectCo's record-keeping and decision-making during the OM phase and brings advantages that are very difficult to replicate with DB. This is not so much a feature of DBFO, but of the 30-year contract. Every decision that the ProjectCo makes reflects its 30-year responsibility for the road. As the ProjectCo does not have similar budgetary constraints as the authorities, maintenance activities can be scheduled optimally leading to more economical maintenance of the road. However, DBFO does not affect the level of maintenance or the maintenance methods used.

4.2.3 Risks and responsibilities

The contract determines the outline design of the road scheme, requirements with which the construction works must comply, the date of completion, and the operational service

requirements for all existing and new road stretches. Generally, the client acquires the permits required for the construction. The ProjectCo is responsible for designing, constructing, financing and operating the road. The ProjectCo generally acquires construction through a fixed-fee DB contract and transfers all associated risks to the construction company. This transfer of responsibility is thought to increase the scope of innovation in construction. Generally, the interviewees considered this risk allocation appropriate. However, the ProjectCos complained about the traffic risk borne by them due to shadow tolling.

Due to the length of the concession period, the circumstances covered by the contract may change (see Figure 7). Some specified changes represent risks which the ProjectCo is asked to assume, and where the contract is silent, the ProjectCo bears the risk of change. However, the client reserves a right to change the technical or commercial requirements of the contract. When such changes alter the ProjectCo's costs or traffic flows on the project road, service payments are revised /58/.

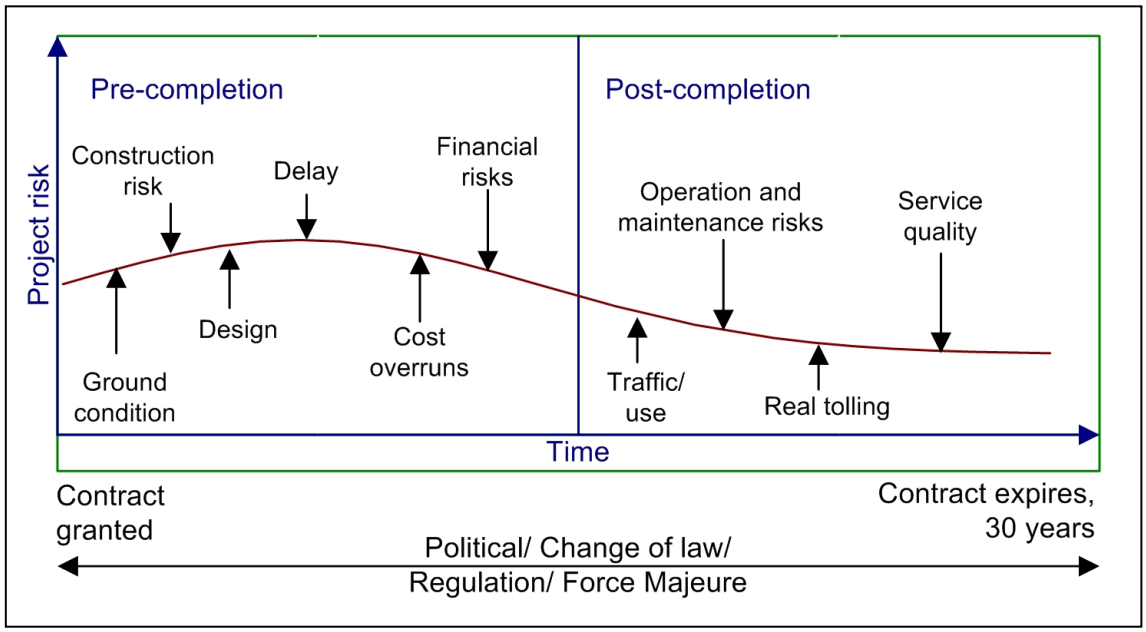

Figure 7. The typical risk profile of a DBFO contract /43/.

4.2.4 Project team

Generally, everybody is working for the common good, even though there are still cultural barriers due to old roles. This is where partnering can level the road. All interviewees acknowledged that partnering has improved relationships, communication, availability of tacit knowledge, information transfer and decision making between the client, ProjectCo and contractor. The high employee retention level in the private sector

facilitates partnering. However, the interviewees complained about lack of continuity in the client's representation, as 18 months is the average time one person stays with the project. This is due to the client's aim to broaden the experience of its staff.

Generally, the ProjectCos have taken the opportunity to improve processes and cost-effectiveness of project delivery. Safety issues are taken very seriously and there have been improvements in environmental issues and public inconvenience. The project participants have acquired genuine ownership of the project, and the ProjectCos have achieved acceptance of the communities due to their openness.

4.2.5 Administration

Originally all DBFO projects were managed by a special team. Now project management is transferred to area teams to allow better consideration of overall road network benefits. Regional management staff attend regular contract coordination group meetings, where common issues are debated and policies are determined. The Agency encourages the managers to discuss individual contract problems in order to learn from each other /27/. Generally, the Agency staff consider their work more interesting and rewarding due to long-term relationships.

Due to resource limitations, the Agency uses external advisers in all procurement. However, in DBFO projects the required amount of legal and financial advice is significantly higher than in other procurement methods. After the contract is signed and the project commences, the amount of external advice needed drops, but remains still at a higher level than in DBB. The cost of external advice is partly recouped through savings in the client's own administration costs and other DBFO benefits that may be even more important than savings in works contracts. During the operation stage the client's administrative burden tends to be somewhat higher due to the payment mechanism and close auditing required to ensure that value for money and contract terms are fully met.

4.2.6 Schedule

The main advantage of and the main reason for using DBFO-type project delivery is that it makes it possible to deliver road schemes earlier than through political resource allocation. Also, the time performance and time certainty of DBFO projects are excellent, as most projects have been finished ahead of time or at least on time. This can be credited to the payment mechanism and resulting innovative measures taken by the ProjectCos to motivate contractors.

4.2.7 Cost

DBFO may increase the capital cost of the project due to the better quality product produced in order to minimise the whole-life cost. As a result, the first eight DBFO road projects have been able to generate savings of about 15% in PC terms compared to their PSCs. (However, some concerns were presented about the validity of the PSCs.) Generally, savings of can be expected mainly as a result of bundling 4–6 small DB projects into one big DBFO project which brings efficiencies through the contractor being able to plan works better, omitted start-up and rundown costs and omitted procurement processes. Competition for materials and labour is also omitted.

The Agency reimburses the private sector through shadow tolls linked directly to the number and type of vehicles using the project road up to an agreed cap. Even though there is little the ProjectCos can do to increase traffic, except for introducing a reduced payment per vehicle in the higher traffic range and extra maintenance costs for the ProjectCo for increased traffic, some of the interviewees believed that the current shadow toll system encourages the ProjectCos to increase traffic. The payment method should better reflect the benefits and values of the stakeholders by determining the ultimate service objectives and linking the payment to meeting these objectives. Lane closure charges and safety performance payments are two areas of operational importance to which payments may also be linked. Lane availability (together with the volume of traffic) is a key factor in journey time reliability, which is one of the main criteria by which road users judge the performance of the road. The payment issue is highlighted on urban roads, where traffic is consistently heavy and traffic risk low. In these urban projects, the Agency intends to refine the payment mechanism to improve the incentives of the ProjectCo to optimise road space, improve safety performance and take steps to improve road performance to the benefit of the road user /58/.

4.2.8 Quality

It is generally agreed that there are less defects with DBFO than with DBB/DB roads. The 30-year concession period and the 10-year warranty period imposed on the contractor drive better design, supervision and quality work. According to the ProjectCos, DBFO also provides better value for money in terms of quality achieved for supervision input. This does not necessarily mean better quality work, but it takes into account the inherent overdesign. Incentives could be used to further promote better quality implementation. The ProjectCos could also provide variant quality proposals for the client.

While the client knows what he is getting with DBB, there is always some uncertainty with DBFO. This is why some interviewees had concerns over the end quality of DBFO roads. To eliminate this risk there are strict procedures for the handback. During the last

five years the client deposits 40% of the agreed remedial works costs into the ring-fenced accounts upon which only the client can draw until contract termination. This money will be used to carry out any work the ProjectCo fails to complete. Once the contract ends and all such repairs are made, any money remaining in the accounts is paid to the ProjectCo /56/.

4.2.9 Change orders, disputes and claims

There have been only a few minor disputes, but multiple changes in standards have resulted in negotiations and changes to contracts. Generally, the ProjectCos are informed about the standard changes and asked whether they will adopt these changes. ProjectCos tend to adopt cost-saving best practises and changes affecting safety or insurance risks. Other changes become the responsibility of the client to adopt. As changes tend to be quite inexpensive, the Agency is currently aiming to include these changes in the ProjectCos' contractual obligations. This complicates pricing of risks, but streamlines service delivery. However, reasonability should be followed.

As the Agency is to become a Network Operator, it will need to manage actively the trunk road network. This is more difficult with private companies operating parts of the network and long-term contracts decreasing the flexibility of the client. Even though introducing a change under an existing contract is relatively straightforward, agreeing a price for the consequential operation and maintenance over the remaining contract period is difficult, and prices may go high. This problem could be resolved through benchmarking and market testing mechanisms that compare the cost of services with the prevailing market and realign the price charged by the ProjectCo with the market price. The other alternative could be periodic reviews at fixed intervals to consider the requirements of the project and resetting them as necessary. Also, payments would be adjusted to reflect changes in requirements /57/. Future contracts may be drafted to allow also the client to have some control over traffic management.

4.2.10 Innovations

The clients have expected more innovations, but due to the statutory processes and risk-averse financiers innovativeness has been relatively low. Generally, the contractors are not willing to force innovations on projects unless there are incentives to take the risk. To increase freedom in design, contractors' early involvement is currently considered in two large DBFO projects. The alternative methods to implement ECI are the following /57/:

- The supplier develops the design while steering the scheme through the statutory process. At the end of the development stage, the supplier agrees a price for constructing the works with the client. The Agency then invites ProjectCos to bid

for the DBFO contract under which the construction works are carried out by the ECI supplier as the appointed subcontractor.

- An integrated team is formed by appointing a ProjectCo to work with the client. The integrated team steers the scheme through the statutory processes, completes the design, and develops a price for construction, maintenance and operation.

ECI leads to longer contract periods allowing further cost savings as a result of greater freedom to take a strategic view on the methods and prioritisation of road maintenance. Also, it allows more time for full cost recovery, though somewhat delayed. However, some contractors have expressed unwillingness to be involved early in the process due to the risk of being committed to providing an asset which may never obtain approval or may have to be delivered in a substantially different form, or much later than anticipated /58/. These projects would also be 4–5 times bigger than any DBFO project so far (more than £1 billion).

Some interviewees claimed that early contractor involvement and performance-based specifications will not increase innovativeness to the level the client expects due to the client's risk reluctance. The only way to increase innovativeness is a toll road with a 50-year concession. The contractor would then have flexibility to use the materials and methods he prefers without the client having any risks due to the innovations. The first toll road has just been opened with a concession agreement of 53 years.

4.2.11 Client satisfaction and project success

The Agency is very pleased with DBFO projects as it has achieved better value for money with advantages well surpassing any disadvantages (see Table 18). The DBFO has also created new opportunities for the industry to develop stable, long-term business.

Table 18. Main advantages and disadvantages of DBFO project delivery.

Advantages	Disadvantages
• provides clear identification of service requirements • single point of responsibility • better value for money (whole-life focus) • outcome meets all client requirements • allows ProjectCo no way to make claims unless client adds something new • private sector participants have a long-term business opportunity • long-term price certainty • reduced operation cost, better maintainability • earlier project delivery • certainty of funding (less interferences) • time certainty	• commissioning authorities do not have the same influence over the project outcome as they do in traditional procurement • it is wasteful of resources and expensive for three or more bidders to work up scheme designs for projects

5. Literature review on project delivery systems

5.1 General

There have been serious problems with traditional projects due to the underestimating of project costs and duration, or overestimating of project benefits /66/. The full cost of the projects has not been calculated accurately beforehand, risk management procedures have not been implemented, and there have been insufficient incentives to ensure that projects are driven forward successfully /121/. Traditional contracts have also been extremely hierarchical and widely regarded as promoting a confrontational and contractual supply approach together with high associated transaction costs /78/. The main inhibitors of innovations have been lack of incentives, organisational ways of doing things and technical codes/norms /79/. In such an environment, increased usage of DB and DBFO procurement and the ensuing shift from input to output specifications, in addition to the introduction of partnering, have reduced significantly cost and time overruns and benefit shortfalls /66/. However, price is still the predominant contractor selection factor, even though 83% of the contractors believe that all parties would benefit from multi-criteria selection /77/.

5.2 Design-Bid-Build

The Scottish Office reviewed a number of different procurement options, but decided to continue with the traditional approach with some modifications towards a ‘refine and build’ system. The principal objective of the Alternative Tendering Initiative (ATI) launched in 1991 is to eliminate confrontation and to optimise the contractors’ skills.

ATI provides incentives for the contractor and increases the client's cost certainty. There are mechanisms that allow alternative designs and their assessment to encourage construction innovation. When bidding for a project, the contractor can produce at least five alternatives to the traditional bid, or the contractor can adopt the client's design and offer a fixed lump sum price. /42/

5.3 Design-Build

The clients most frequently select DB to shorten project duration through a single point of responsibility and the ability to fast-track design and construction. The other selection factors are cost establishment, cost reduction, schedule establishment, claim reduction, construction innovation and large project size /72/. DB facilitates procurement, improves the team relationship and produces a more efficiently delivered product. DB facilitates also implementation of continuous performance improvements and changes in management and culture. However, there is evidence that traditional, professional divisions between team members have led to discontinuities and somewhat ineffective processes during the construction phase /10/.

5.4 Design-Build-Maintain

5.4.1 General

DBFO has been used in very different, medium-sized to large road schemes, but in smaller than £10 million projects (by capital value) it has proved to be an overly complex procurement method /67/. Despite this, small schemes (< £20 million) make up 60% of all PFI projects, but account only for 7% of their value. Most of the small-scale projects are let by local authorities /70/ and have been considered successful /55/. Bundling of these small projects into bigger entities would offer economies of scale, but would, at the same time, leave the market largely to big, national companies creating barriers to entry and potentially a less competitive market and less innovation /67/. However, PFI is generally considered appropriate, when /121/:

- there is a major capital investment programme requiring effective management of risks associated with construction and delivery
- the private sector has the expertise to deliver and is at the cutting edge of service innovation
- the project allows the client to define his needs as service outputs, and risk allocation can be made clearly and enforced
- the assets and services can be costed on a whole-life basis

- the value of the project is sufficiently high to ensure that procurement costs are not disproportionate and there are benefits to be obtained from economies of scale
- the technology and other aspects are stable and not susceptible to fast-paced change.

5.4.2 Risks and responsibilities

Appropriate risk allocation is critical as all benefits of PFI flow from it /121/. The long-term value for money depends on how well the private sector manages risks and on the client's success in managing the contract. Projected savings against the PSC are sensitive to risk transfer valuation that accounts for 60% of the savings /22/. Generally the construction risk has been relatively low as projects have been low tech, tried and tested building techniques, design and materials have been used, and contractors have been experienced with similar projects /65/. Despite this, the construction cost overrun risk often considered the highest risk accounting for more than 50% of the total risk is valuation. Thus, while PFI is predominantly service-led, the construction element (the average capital expenditure after discounting 35%) seems to offer the greatest scope for innovations /22/. Consequently some PFI projects have shown little evidence of actual contract whole-life cost minimisation /120/.

Generally, financiers are the most risk-averse participants, while clients come next. Operators, general contractors and ProjectCos are more willing to bear risks /79/. The ProjectCos seek to transfer risks to their parent companies that act as subcontractors. Thus, construction risks are normally borne by the construction companies, while operational risks are allocated to the OM companies /80/. Although most clients are satisfied with the risk allocation, only 67% of the ProjectCos consider it appropriate. Transfer of risks (legislative and traffic) that are not best managed by the private sector increases the length and expense of tendering and reduces value for money as the private sector charges a premium for accepting such risks /27/. Especially shadow tolling is expected to increase the cost of roads, offsetting to some extent the benefits of placing other substantial risks appropriately /54/. As the public sector client likely has the most sophisticated traffic forecast models available, it is in a better position to bear the risk of demand /120/. However, shadow tolls acclimatise the private sector to the concept of payment per vehicle as a stepping stone to the potential introduction of real toll roads /122/.

Some of the difference between the estimated time and cost and the final outturn (optimism bias) is caused by a failure to identify and effectively manage project risks (see Table 19). Road projects tend to be susceptible to environmental impacts giving rise to high works duration optimism bias. As a result of risk transfer to the private sector, and the associated early effort spent on managing risks, the overall optimism

bias level of DBFO projects is lower than that of traditional projects. Also, the gestation periods for PFI projects tend to be twice as long as for traditional ones leading to better defined projects, and cost and time targets set later in the process /66/.

Table 19. Average optimism bias. /66/

All public projects

Project type	Time overrun	Capital expenditure	Operating expenditure	Benefits shortfall
Traditional	17%	47%	41%	2%
PFI	-1%	1%	5%	2%

Civil engineering projects

Project type		Time overrun	Capital expenditure	Operating expenditure	Benefits shortfall
Traditional	Non-standard	15%	66%	no info	5%
	Standard	34%	44%	no info	no info
PFI	Standard	no info	0	N/A	0

5.4.3 Project team

Participants are focused on how to best align themselves to achieve efficient project delivery. Having the same key team involved throughout the process ensures realistic targets and more certain margins /78/. Long-term returns and involvement provide a basis for further bidding and allow establishment of the knowledge and skill base required. They also provide a basis for long-term partnering and better relationships between the parties, and allow recovery of the initial investment, development of alternative approaches to service delivery and focusing on whole-life costs /22/. Seventy-two per cent of authorities and 80% of companies involved with DBFO projects consider their relationship as good or very good /27/. Due to the importance of the key team, suppliers should be chosen on general eligibility and suitability criteria which convey better ability to work in partnership with the client to supply value for money services /78/.

5.4.4 Schedule

The tender phase is time consuming. For the first DBFO roads it took 18 months from OJEC to financial close /121/, which was 2–5 months longer than expected due to the unforeseen amount of negotiations required on the contract terms, and in some cases the bidders' difficulty in bringing financing arrangements to a close. The lengthy and complex negotiations may involve a great number of parties, which the private sector

considers inefficient use of resources /80/. By shortening the initial, competitive bidding phase to reduce industry costs, the preferred bidder would be allowed greater opportunity to offer value-engineering supply solutions /78/.

DBFO allows implementation of projects earlier than possible with conventional methods. The ProjectCos are motivated to deliver projects and associated benefits faster and often ahead of schedule /22/. No PFI road project has been late, while 70% of non-PFI projects have /121/. If PFI projects are late, the client can defer payments, make payment deductions or seek damages. The clients need to ensure, though, that any additional payments resulting from early opening do not exceed the benefits achieved.

5.4.5 Cost

Civil engineering PFI projects are achieving higher savings than building projects, as complete service packages and centralised clients enhance delivery /79/. The first eight DBFO road projects outperformed their PSCs with savings averaging 14% /122/. The median reported total design, build and operate cost saving in transport projects is 10–20%, and 84% of transport projects reported a total saving of 5% or more. Construction cost saving may be over 20%, while the average operating cost saving is 5–10% /79/. Seventy-nine per cent of PFI road projects have been delivered with no changes to the annual unitary charge, while only 27% of non-PFI projects are delivered within budget. As potential construction cost increases are borne by the ProjetcCo, price increases are due to changes desired by the client or third parties /121/. Cost overruns have been 3–18% of the original capital expenditure /22/.

The tendering cost varies between 0.25–7% of total project cost /22/. Most often a cost of 3% /78/ – 5% /76/ is reported which is much higher than in traditional or DB projects. Also, more senior staff time is required /119/. The most expensive phase occurs after a company is named a preferred bidder, as about 80% of the total tender cost is spent during this phase /74/. While this expenditure does not pose similar risks to the company as the earlier costs, it may amount to 1–1.25% of the project's costs putting pressure on the companies, if they are selected as a preferred bidder in multiple schemes simultaneously /119/. The cost of staying in the competition as a reserve bidder has also raised some concerns, but the clients consider this critical to maintaining competition /54/.

Also, the client's pre-contract costs (such as advisers' fees) may be significant (0.25–7% of the project value) /22/. In the first four DBFO road contract awards the Agency incurred £2.08 million in costs per contract for external advice. A lot of this was due to the legal and financial advice needed, while traditionally only technical advisors are used /54/. In small projects, this may materially affect the value for money. However,

some fees incurred upfront will lead to savings in adviser costs later on, as reprocurement of the services becomes the responsibility of the ProjectCo /22/.

The ProjectCos are relatively inflexible entities with limited, although often stable, cash flows that cannot withstand big changes or interruptions to be able to service their debts timely /65/. The companies involved derive their profits as shareholders (expected return on equity 13–20%) and as contractors /71/. Where construction companies are able to manage risks they may earn greater profits on construction work (2.5 /26/ – 4.1% /71/) than traditionally (1%) /26/. However, as margins in the market are plunging, the rewards available for the companies may not justify high bidding risks. The contractors are forced to be more selective with the projects they bid for leading to fewer bids per scheme and specialisation by the major players. An additional factor is the new accounting rule that forces the contractors to write off bid costs as soon as they are incurred, placing more pressure on their balance sheets /76/. While a portion of the current bid costs is attributable to the development costs that may be excluded in the future /54/, a range of possibilities for reducing bid costs in the future are available /67/:

- Reducing tender stages
- Reducing time up to the Best and Final Offer
- Eliminating the Best and Final Offer
- Reducing number of bidders to 2–3
- Developing the brief as fully as possible before it is issued to the bidders
- Reducing the scope for detailed design upfront
- Moving design to the Best and Final Offer stage
- Reducing prescription of the design
- Increasing public sector knowledge
- Standardising contracts
- Not asking for full due diligence before the preferred bidder stage
- Using a binding bid timetable
- Making public sector advisers work at risk to financial close on par with the private sector bidders
- Fast tracking invitation to negotiation process
- Reimbursing part of bid costs.

Operating cost overruns in conventional public sector projects have been less visible, often because of a lack of reliable management information. Also, some elements of operating costs, such as maintenance expenditure, have in the past been kept below the economic levels as a means of managing public sector budgets. However, in PFI, the ProjectCos face financial penalties through payment reductions, if operating performance declines during the contract life. At the same time, maintenance costs are recorded accurately and managed effectively. The benefit of the incentive to perform is not captured by the PSC approach to evaluating value for money. The operational

benefits of PFI will take more time to establish even though early signs of the benefits have been promising. /22/

5.4.6 Quality

By designing and building the road to a standard that reduces maintenance costs, the ProjectCo can reduce its long-term costs, while still meeting the client's service requirements. As a result, in over half of the projects, the clients and project managers consider design and construction quality good or very good /26/. However, it is often difficult to specify the quality of the service which allows different interpretations and potential post-contract disputes /80/. Thus, a DBFO contract requires sophisticated quality management skills. All contracts include also arrangements for assessing quality of the service /27/ to secure delivery of value for money (see Table 20). Generally it is expected that experience from constructing an asset and maintaining and servicing it for 30 years will improve the quality of non-PFI projects, too /119/.

The client appoints a Department's Agent to oversee the project delivery. These Agents rely primarily on the operators' Quality Assurance Systems to assist in their monitoring /54/. However, quality monitoring undertaken both by the ProjectCo and the Department's Agent is seen as excessive /78/. As DBFO aims to limit the client's role and to encourage 'entrepreneurial flair', the client should concentrate upon assessing the suppliers' competencies at the tender stage rather than spending heavily on monitoring during the construction phase.

Table 20. Drivers of value for money in DBFO projects. /22/

	Drivers of value for money	**Average score**
PRIMARY (Max 18)	Risk transfer	15.36
	Output specification	12.14
	Long-term nature of contracts	11.64
	Performance measurement and incentives	11.36
	Competition	10.55
	Private sector management skills	10.00
SECONDARY (10)	Innovation	8.64
	Alignment of interests of the authority and contractor	8.41
	Public sector project development skills	8.36
	Public sector comparator	7.59
	Quality of advice to public sector and bidders	5.45
	Transparency of process	4.86
	Cost of capital	4.82
	Deal flow	4.36
	Public sector implementation	3.14
	Release of hidden asset value	3.05
	Project bundling	2.91
	Involvement of third party financiers	1.64

5.4.7 Change orders, disputes and claims

The length of the contract may create problems with managing changes in demand. Although most projects are still at their early stages, dealing with change is already a significant issue. Change procedures have been used in 55% of the contracts which contain such procedures. This allows quicker responses to the changes that generally relate to alterations in services covered by the original specification, introduction of new services, additional building works or design changes and amendments to the performance measurement arrangements /27/. Thus, appropriate contractual procedures for dealing with change should be built into the contract, since after the preferred bidder has been appointed, any price variation will occur without competitive pressure. Value for money can be maintained through agreed prices for defined options of additional work, agreed profit margins for unspecified further work, rights to benchmark and open-book accounting /26/. Moreover, it needs to be taken into consideration that the incentives of ProjectCos to improve the road may be weak and directed towards cost-cutting rather than service-enhancing activities. Thus, arrangements like market testing, benchmarking, residual life requirements and technology change provisions are appropriate /22/.

The actors in PFI contracts are subject to cultural change /79/. In conventional project delivery, when problems occur that are not attributable to the contractor, the contractor tends to inflate them in order to gain cost advantage. However, in DBFO collaborative problem solving takes priority over negotiation of claims positions and problem avoidance /78/.

5.4.8 Innovations

Often the preliminary design is done by the client, even though 55% of the public sector, and 82% of the private sector, consider that this does not make the process shorter, easier, clearer, cheaper or more accountable. By the time of the financial close approximately 20% of the design is generally carried out at risk. As DBFO encourages early start-up (with about 45% design done) to enable early toll collection, the potential time for value engineering and innovations is minimised. However, due to risk transfer the private sector has a strong motivation to optimise structures and construction techniques. /79/

Key innovations are typically developed in the early and competitive stages of the project. Most scope for innovation exists in buildability, quality management, excessive risk protection, operation staff, procurement, new technologies and construction speed. However, the transport sector shows the least scope for cost saving innovations compared to other industries, as transformation of the brief into an outline design, sufficient to obtain a planning permission, has remained the function of the client /79/.

Thus, the first four DBFO roads are considered over-specified /54/. Often clients consider output specification more performance-based, while ProjectCos consider it more technical and less functional. As a result, the scope of innovations is restricted from ‘rethinking what’ to ‘rethinking how’ encouraging incremental innovations and adoption of construction techniques from abroad, while hindering ‘unique’ solutions. Technological innovations may create cost savings by incrementally improving existing practices /79/. Innovations concentrate mainly on the design and iterative approach to service delivery, both of which depend upon the integration of the design, construction and provision of services /22/.

Innovations and efficiency improvements are required to offset the higher cost of private finance /54/. They may be promoted by allowing bidders maximum scope to propose new ways to meet service requirements. The earlier in the process the private sector is allowed to participate, the greater the scope of innovation /22/. Also, the core technical requirements need to be minimised, and necessary changes to these requirements should be made when the cost of the change is still subject to competitive pressure /54/. Since society is increasingly demanding more environmentally acceptable solutions, and economically and environmentally effective savings, DBFO represents a promising, long-term approach. There is also potential to influence a wider marketplace and to win wider acceptance for environmentally sensitive design. /75/

5.4.9 Client satisfaction

Eighty-one per cent of the authorities believe that the value for money of their PFI projects is satisfactory or better /27/, and 76% of public sector managers consider their initial expectations to be met /121/. PFI is expected to counter some negative aspects of public project delivery: over-design, poor project management, time and cost overruns, over-degradation of assets, higher maintenance and operation costs and lower asset residual values /81/. While many PFI projects in other sectors are getting negative publicity, PFI road projects have offered indisputably good value /66/. Even though achievement of the best value continues to be challenged by the clients’ inability to manage consultants /81/ and difficulties in dealing with advisers employed by the private sector /80/, benefits are considered to outweigh problems by far /81/. Factors contributing to the success of DBFO road projects are /79/:

- gains from technologically-based innovations by integrating responsibility for operations with responsibility for design and construction
- a highly centralised and increasingly experienced client with competent public sector project teams
- a small but sufficient number of increasingly experienced private sector consortia focused on this sector with substantial pre-PFI experience in highway design, construction and maintenance

- preliminary designs and output specifications which, although they contain a technical element, have allowed the private sector to focus on the economies of integrating operation into design and construction.

Participants have gained experience from PFI and there is a more standardised approach to bidding, contracts, and documentation. Ninety per cent of the ProjectCos are interested in bidding for future DBFO road projects indicating that there are potential efficiencies in building up a portfolio of DBFO projects /54/. As a result, the large national companies are aiming to increase their stake in the PFI market and are broadening their business models to become service providers /119/. PFI contracts are seen less exposed to the economic cycles, and to offer consistent demand, higher profit margins and long-term income /71/. However, at the same time, the suppliers are under increasing pressure to reduce costs to provide the public sector better value for money. This trend is exacerbated by greater risk transfer to the private sector and financing structures that are becoming more aggressive and complex /65/. This may reduce bidding capacity in the market. However, since the gap between the cost of private sector capital and public borrowing is narrowing, steady, although slower, growth in the market is expected /119/.

6. Summary on UK project delivery

The UK infrastructure sector is very pro-active and advanced, and it tends to be a global leader in the adoption of new procurement methods. The project size is growing and the responsibilities of the contractors are broadening, as the client aims to be a network operator. Through effective procurement the client aims to reduce his project management and project cycle times in addition to achieving value for money delivery. Also, the industry has learned to deliver with the more sophisticated procurement systems. As larger organisations are more competitive, consolidation of the market can be expected, which makes it increasingly important for the client to manage the supply chain and market share of the contractors.

While local authorities still use DBB, the Highways Agency has completely abandoned it. DB has become the established project delivery method with the vast majority of projects being procured this way. At the same time 22.5% of transport projects are procured through DBFO. Benefits of both DB and DBFO well surpass their disadvantages and they are considered superior to DBB (see Table 21). Also, contractors prefer project delivery methods that allocate them more responsibilities.

Table 21. Future applicability of the project delivery methods in the UK.

Factor	DBB	DB	DBFO
Client satisfaction		Medium to high	High to excellent
Contractor satisf.		High	High
Market interest		Yes	90% of ProjectCos
Main advantages	Simple, small and medium-sized companies competitive	Single point of responsibility, ownership, optimised design, capital cost savings, better relationships, accountability	Whole-life cost considered & lower, earlier project delivery, supplier development, better relationships
Main disadvantages	Adversarial, slow	Barriers between designer & contractor, reduced quality	Inflexibility in the future, changes expensive
Applicability		ECI: >£15–20 million projects	Projects > £20 million

While pre-qualification limits tendering cost in DB, the possibility to reduce the amount of tender design is also looked into to eliminate unnecessary industry costs. In DBFO, reduced tender submissions, improved RFP data and shortening of the tender period are looked at as opportunities to decrease high tender costs. In most cases the best value award takes into account both the quality of the proposal and the price, even though price tends to dominate the selection (see Table 22). However, qualitative contract award will be increasingly used, especially when early contractor involvement is sought to provide benefits in time and cost savings, innovations, buildability and programme delivery. The qualitative contract award is associated with target cost arrangements which are the most widely used DB contracting method today. The shadow tolls used in DBFO contracts have aroused some criticism and are not perceived to offer best value to the users or to the client.

Both DB and DBFO allow time savings and improve time certainty (see Table 23). Many of the DBFO projects have been delivered early. DB also reduces the capital cost of a project by saving costs associated with time extensions and by providing, dramatically lower uplifting costs, better buildability and optimised design (see Table 24). DBFO has reduced costs by delivering roads extremely effectively with the emphasis on minimising the life-cycle costs of the road. Cost certainty is also improved with both project delivery methods.

Table 22. Summary on UK procurement processes.

Factor	DBB	DB	DBFO
Design completion			
in RFP	100%	20–25% (up to 80%)	80% and less
in tender	0%	75%	20–90% at financial close
at start of work			45–90% of design
Specifications	Input based	Mixed	Output
Award basis	Pre-qualified bidding or open competition	Pre-qualified bidding	Pre-qualified bidding, negotiated contract
Award criteria	Price	Weighted (price emphasis), in the future quality	Weighted (PC emphasis), in the future quality
Pricing		Fixed price. Increasingly target cost contracts.	Unitary payment based on traffic, availability and performance
Risk transfer	Client carries most risks	Contractor carries most risks. Pursuing to transfer risks back to client.	Maximum risk transfer. Satisfactory: 79% of clients, 53% of contractors.
Innovations		Price focused	Less than expected
Warranty/ Concession period	2 years	3–5 years	30 years

Table 23. Summary on UK schedule issues.

Factor	DBB	DB	DBFO
Project duration	Longer than DB	4% longer than DBFO	
RFP devel.			3 months, selection of tenderers 3.5 months
tendering	A lot shorter than DB	16–20 weeks	4–5.5 months
tender to award	A lot shorter than DB	3 months	7.5–9 months
design	Longer than DB		Longer than DB
pre-constr.	Mobilisation period longer, more expensive		
construction	Same as DB	10% longer than DBFO	
Time overrun	15–34%. 70% of projects late.	11–14%	25% early. 24% of projects marginally late.
Agency burden			
procurement		9 times DBB	High
contract admin.	Mostly done by consultant	Same as DBB, more pleasant	Low
design		Less than DBB	A lot less than DBB
construction		Same as DBB	A lot less than DBB
maintenance		Same as DBB	More than DBB

Table 24. Summary on UK cost issues.

Factor	DBB	DB	DBFO
Tender cost	0.04–0.25% of contract value	0.18–1 % of contract value	0.25–5% of project value
Cost of the client in		Savings up to 15%	Savings 8–15%
procurement		Higher than DBB	Higher than DBB, DB
contract admin.	1%	1%	
design	12% of project cost	16% savings	10% savings
supervision	3% of project cost	1% of project cost (60% of DBB)	<1% of project cost
construction	85% of project cost	93% of contract cost (construction 94%, design+supervision 6%)	Capital cost 35% of PSC (design 20%). Savings > 20%.
maintenance		Higher than DBB	Operating cost 65% of PSC. Savings 0–10%.
dispute resol.	Higher than DB	Some	
external advice	7–9 times more than in DB	Some	More than DBB even during operation. 0.25–7% of project value.
Cost overrun	18–66% of project cost. 73% of projects.	1–28% of project cost	No construction related increases. Scope changes: 6% of project value, 22% of projects
Benefit shortfall	5%		0
Risk transfer valuation	Not done		Accounts for 60% of savings, 50% of this construction related
Profit		Margins very tight	
designer	6–8%, hourly rates	Less than DBB. 15%, lump sum.	Less than DBB. 10% + bonus for savings, fixed packages.
contractor	Aim 3 %, achieved 1–2%	Aim 3 %, achieved 1–2%	2.5–4%, achieved more easily
operator			3.5-6%
Cost of redesign (of total cost)	More than DB, all priced	8–10%, mostly minor	
Cost of change orders (of total cost)	Almost 100%	45%	Minor during construction, many during operation
Number of disputes	10–15 per project	Much less than DBB	1 (0.03 % of NPV)
Cost of claims (of total cost)	A lot, cost of resolving issues enormous	15%	None
Value for money			17–20% more than DBB

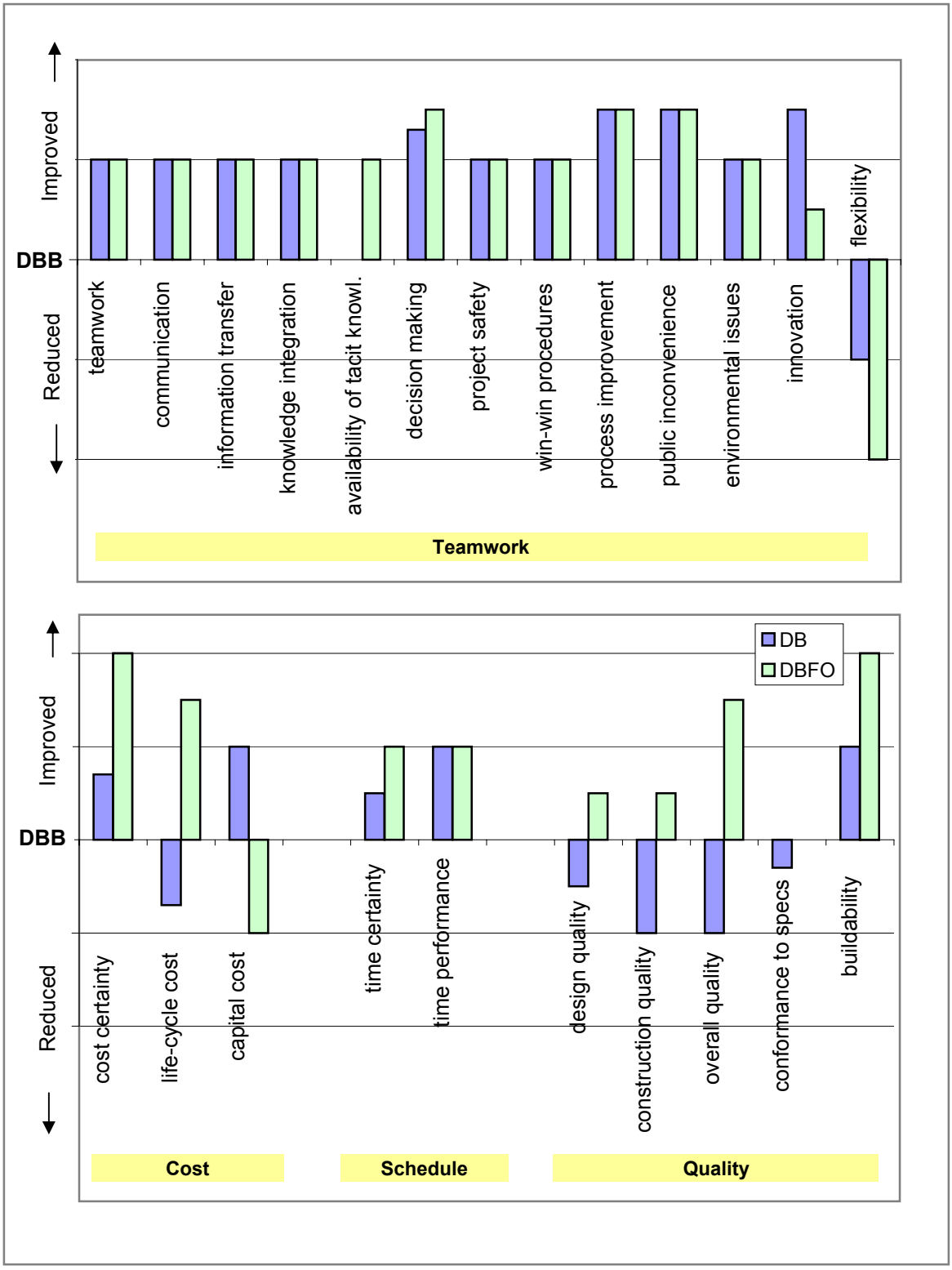

Figure 8. Summary on cost, schedule, quality and teamwork in the UK.

Performance-based specifications tend to lead to more negotiations over the acceptability of the end product, which results in a continuous need to improve specifications. A cultural change is also required in order to get the contractors to allocate adequate resources for supervision under the self-certification used in DB. In the future, KPI measurement and associated incentives will encourage contractors to improve quality in DB. In DBFO the ProjectCo already has a strong incentive to ensure adequate supervision, as it will be responsible for the road in the long term. While DB is not considered to improve the road life cycle, DBFO produces more economically maintained roads (see Figure 8). Every decision the ProjectCo makes reflects its 30-year responsibility.

Even though DB and DBFO, in principle, offer potential for innovation, the statutory processes and inadequately developed specifications tend to reduce the number of innovations effectively. Moreover, in DB the motivator for innovations tends to be price reductions, which do not necessarily benefit the client. On the other hand, in DBFO the financiers tend to be very risk averse reducing the number of innovations. As innovations are necessary to develop the industry, they are sought through early contractor involvement. Innovations can also be increased through better teamwork. Thus, project partnering is used widely to facilitate project delivery. Since partnerships have been very successful, the Agency seeks to retain successful teams through long-term partnerships and framework contracts.

Based on the interviews in England, the following value networks have been produced for the DB and DBFO project delivery methods (see Figures 9 and 10). In the value networks the yellow, coloured circles in the middle depict client values, while the white circles depict factors affecting project delivery in meeting the client values. The green, solid arrows illustrate the facilitation or improvement of the subsequent factor, while the red, dashed arrows illustrate the hindrance caused to the subsequent factor. Blue shadings depict a trend or change adopted to decrease the detrimental effect of the factor. It seems that in the UK market all the hindrances have been recognised and changes have been made to road procurement to enable more efficient project delivery in the future (see Table 25.). The change has become an integral part of road procurement as improvements are continuously sought.

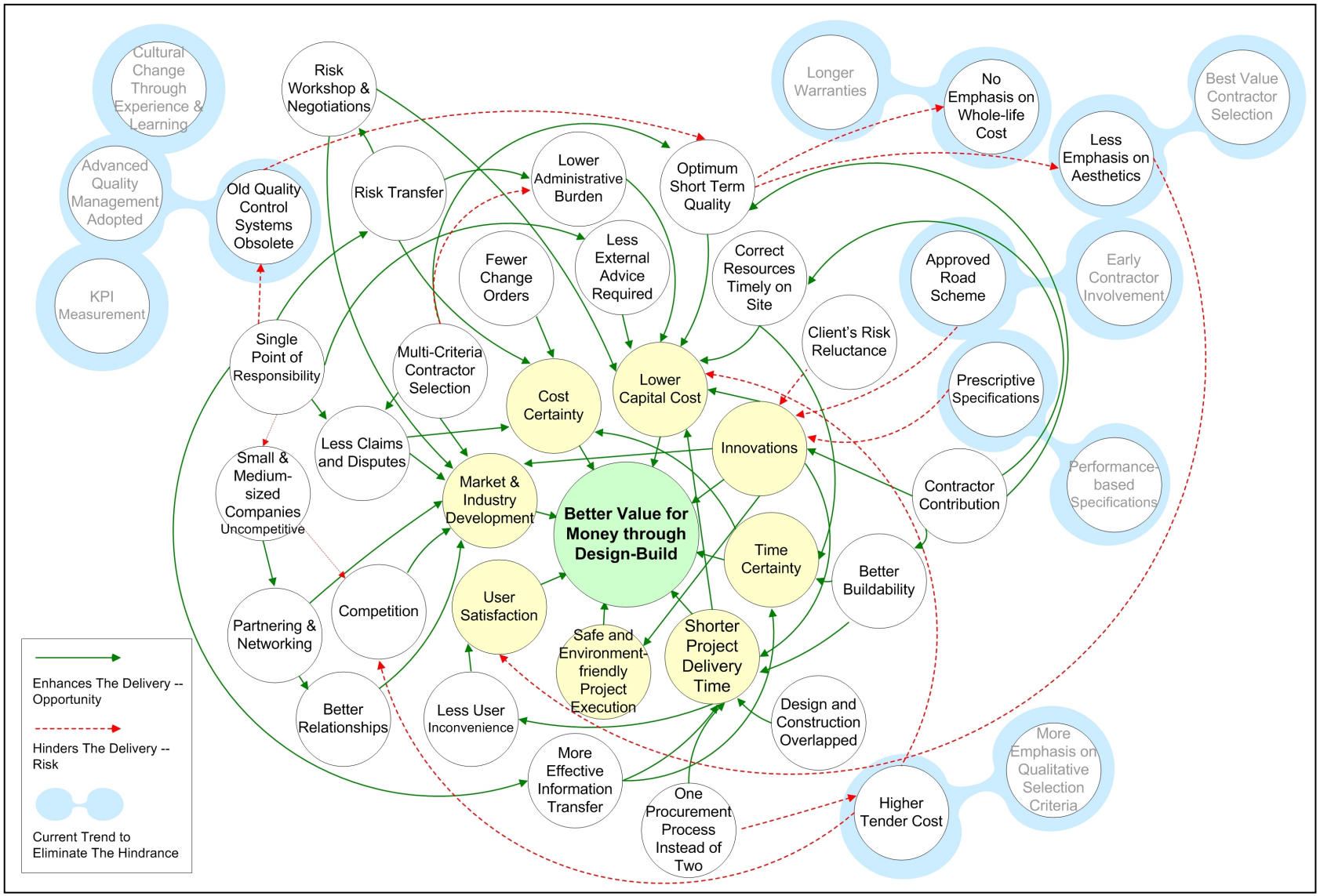

Figure 9. Value network of DB (UK).

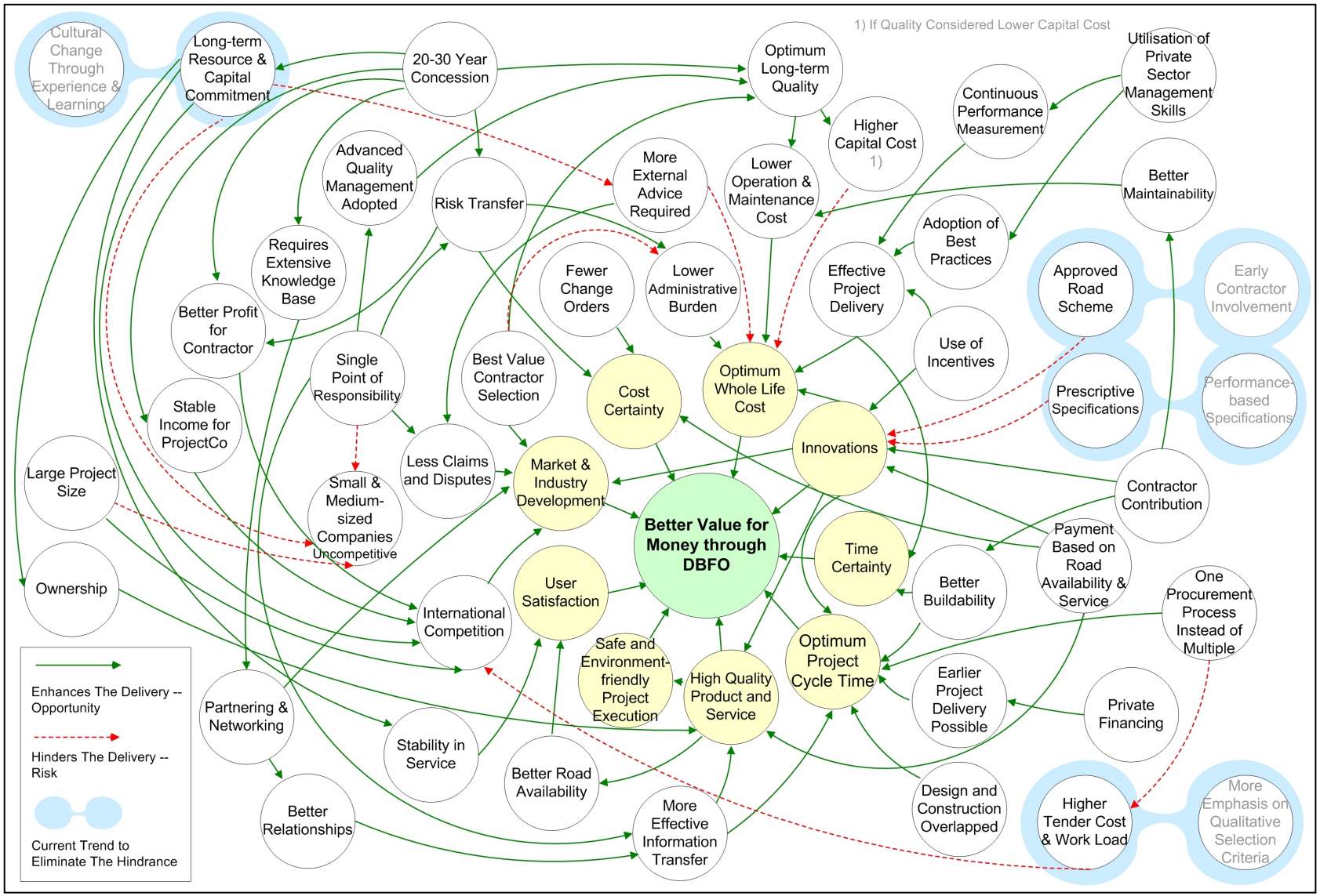

Figure 10. Value network of DBFO (UK).

Table 25. Future improvements in the UK road procurement.

	Problems in procurement	Improvements
DB	Inadequate emphasis on qualitative parameters	Best Value Selection, 100% quality selection
	High tender cost	Reduction of required design in tenders
	No global competition	4–6 big projects aggregated into one
	No continuous improvement	KPI measurement, bonus arrangements
	Inefficiencies due to professional division	Cultural change, experience
	Lack of continuity, loss of gained knowledge	Integrated teams responsible for delivering the whole programme of works
	Lack of innovations	Early Contractor Involvement
DBFO	High tender cost	Reduced technical submission in tenders, industry gains more experience, more standardised approach
	Shadow tolls result in higher risk premiums	Payment methods linked to road availability and performance
	Changes to contract expensive	1) Benchmarking and market testing mechanisms, 2) Periodic reviews and adjustment to payments, 3) Some control over traffic management to Network Operator or 4) Agreed prices for additional work, agreed margins, and open book accounting
	Lack of innovations	Earlier Contractor Involvement
	Excessive quality monitoring	More emphasis on qualitative selection, less on client quality monitoring
	No incentives for ProjectCos to make changes/keep up to date	Market testing, benchmarking, residual life requirements and technology change provisions

PART III

AUSTRALIA

1. Market

In Australia, the compulsory competitive policy was adopted in all major civil engineering construction in 1993. The market grew with enough capable and experienced large and small contractors and designers; there were relatively few medium-sized companies. In locations of higher population density competition in the road the sector is fierce, while in more remote locations there is inadequate competition encouraging use of in-house work force. Since the mid-90's private financing of larger road projects has increased. Project delivery is increasingly affected by external factors, changing legislature and the increasing importance of environmental and inheritance issues that tend to increase project costs by 2–3%.

There is no uniform approach to road procurement as the Australian states and territories are relatively autonomous. Often design and construction are packaged together leading to larger projects and increased efficiencies. However, economies of scale level out, when the control aspect of a very large project introduces inefficiencies and leads to reduced competition. Even though there is healthy competition, some concerns were expressed over the Australian market not being large enough to sustain extended service packages. The cyclical nature and shallowness of the industry reduce willingness of the contractors to invest in personnel and training which may lead to reduced competency of the industry /88/. Today there also seems to be a tendency to litigate which increases the industry's risk management awareness.

Currently the mature road market is restructuring as the emphasis is being transferred from new road construction to road maintenance /100/. The companies are consolidating which leads to a market with fewer competitors. The lack of work is reflected in contractors' low bid prices and reduced margins. The companies are also diversifying into maintenance that is perceived to offer a steadier and safer revenue stream. It is expected that the road network will shrink leading possibly to increased construction needs within 20–30 years.

2. Owner values

Delivering the project to the satisfaction of all stakeholders is the main goal (see Table 26). The best value for the community is achieved, when the road provides the desired level of performance and quality at the lowest whole-life cost, with the least possible adverse impacts on the environment, abutting landowners and road users. The delivery process must also ensure probity, transparency and accountability /110/.

Table 26. The clients' values and goals.

• cost certainty • time certainty and shorter project times • innovations for mutual benefits • minimum adverse impacts on the environment • best practice environmental management • value for money • competitive tendering	• high quality product • resolving issues in a timely manner • safe project execution • no claims and litigation • good relationships with all stakeholders • employee and market development • maximum road availability, minimum user disruption

3. Project delivery methods used

3.1 Victoria

VicRoads is the Victorian statutory authority responsible for maintaining and improving the condition and performance of Victoria's arterial roads. Until 1990 design was generally done in-house, while construction was acquired through multiple, small and separate contracts. Today VicRoads is increasingly using contracting. DBB is used in only 10–30% of the projects, mostly in rural areas. Construction management is not used without a few exceptions. DB has become the major procurement method used in 70–90% of projects, and work has been packaged into larger projects. BOOT procurement is also considered a potential future procurement method with one major project acquired this way.

3.2 Queensland

The Department of Main Roads is the State Government Agency responsible for road design, construction, maintenance and management of the state controlled road network. In Queensland the following procurement methods are used /89/:

- DBB is the primary contract type with 80–95% of projects delivered this way. Most DBB projects are less than AU$5 million.
- DB and its variants, Document & Construct (Design Novation) and DBOM, are used in only 5% of works.
- Construction management is not used.
- Alliance Contracting is used increasingly.
- Public Private Partnerships (PPP) are just emerging. All projects greater than AU$30 million or with a Net Present Cost greater than AU$50 million are candidates for PPP procurement.

3.3 New South Wales

Management of the construction and maintenance of state roads and national highways in New South Wales is undertaken by the Roads and Traffic Authority. Traditional procurement is used in projects smaller than AU$100 million. Projects greater than this are procured through DBOM or BOOT. DB and CM are not used.

4. Industry experiences based on interviews

4.1 Design-Build

4.1.1 General

If the scope of the work is less well defined, the client wants to transfer risks to the contractor, there are economies of scale in putting up one big project instead of multiple small ones and/or the project involves a green site, DB is an appropriate procurement method. However, DB reduces the opportunities of small and medium-sized contractors. Some of the small contractors may also avoid sub-contracting, because of the cost pressure applied by the principal contractor in these arrangements. As a result, a number of small contractors have gone out of business, leading sometimes to difficulties in attracting suitable bids for small projects /83/. Also, some training opportunities in the industry have been lost.

4.1.2 Project delivery process

Designer/contractor selection

The RFP may include 10–80% of design. Because the client in Victoria tends to be exposed to latent conditions, comprehensive site investigation data is provided to contractors, who have to interpret the data and determine whether additional testing is needed. In New South Wales contractors generally have to do more targeted investigations. Road alignment is fixed in the RFP, and land acquisition is done based on this. If a bidder wants to change the alignment he has to go through time-consuming planning approval processes. Thus, alignment tends to be accepted as a horizontal design constraint. More freedom is allowed vertically.

The more extensive design in RFP leads to Document and construct-type delivery that allows the owner greater control over the end product, reduces the risk of design shortcomings, and facilitates tender evaluation, but still enables better constructability than in DBB. However, at the same time the procurement period is extended, time saving opportunities are reduced, the contractor’s value engineering opportunities and

innovations are reduced, and the contractors may be unwilling to accept the risk posed by the client's initial design /89/. Document and construct is often used in Victoria and Queensland to ensure the long-term viability of the design and aesthetics of the scheme.

The most important task for the client is to prepare clear performance, technical and quality criteria for the project. These performance-based specifications include objectives for durability, design life, operational criteria, finishes, aesthetics, and community and environmental issues. Specifications give the contractor freedom and responsibility to decide, how to deliver a project that meets the client's requirements. If the client does not have well developed performance-based specifications, his standard specification may be used as the minimum performance requirements.

Both open and pre-qualified bidding may be used, but due to the high level of effort required from tenderers, open tendering is seen as inefficient. In pre-qualified bidding 3–6 tenderers are invited to bid. Generally, the higher the tender cost, the lower the number of tenderers /83/. In very large projects the client goes through a registration process. Even though there are generally only a limited number of companies capable of providing DB services, the industry margins tend to be very tight. Often in big contracts early works like bridge construction are awarded to give work to the small contractors and reduce risks of the contracts.

The tender period is 6–12 weeks which is considered adequate, as the longer the period the more costs tenderers will incur. In Victoria and Queensland there are generally pre-tender meetings to give contractors clarifications before they prepare their final bids. This saves money for the industry. Tenders include another 10–15% of the design. Architectural forms and pavement solutions are locked at the tender. Due to the time limitations the client may get a very traditional design with minimum time and effort put into it. The tender cost (2–3% of the total cost) is more than double the cost with DBB. This cost is divided between the designer and the contractor. The designer is generally engaged as a subcontractor, and gets paid by the contractor for making the tender design. He may put at risk 30% of the design cost. If the contract is won, the designer is paid the remaining tender cost, a success fee (20–30%) and a margin.

Tender evaluation with minimised tender submissions takes only two weeks, while the clients who require detailed technical designs spend four months in assessing tenders. Different design solutions cause considerable difficulty in tender evaluation, but performance-based specifications allow clients to use price award, while still ensuring good quality of the product. Thus, low price determines the contract award in 90% of the cases, which is fully accepted by the industry. However, there have been occasions, where the client requirements have not been taken into consideration adequately, which has led to insufficient contingencies and problems during project execution. As clients have recognised the problems associated with low bid price, Queensland and some local

councils have adopted multi-criteria selection with non-price factors often having a 30% weighting. Even then the client generally retains the right to adopt the lowest price. One of the final challenges during the tender period is the conversion of the preferred offer into a contract that marries the original requirements with the solutions offered by the contractor to meet the client requirements /89/.

Design

The delivery process is contractor-led, and the designer works under a fixed price contract. It is difficult to make money as a designer, since, due to the price emphasis, the designer is required to work on a minimum fee: Thus, DB offers a less secure profit than DBB. However, the designer knows better the project when being engaged already at the tender stage which enables a more accurate work load estimate and tender.

Generally, the contractor aims to start design 2–3 months ahead of construction, but the period may be compressed due to the pressure to start turning over work as soon as possible. As most design is done concurrently with construction, there is a higher risk of errors and coordination of activities becomes crucial. There are greater opportunities for the contractor to contribute, as savings in materials and construction time are sought. However, the designers often feel that changes after the tender do not necessarily benefit the client. This is why the clients allow more freedom only with issues that are not critical to the quality of the road or susceptible to the contractor's cost minimisation. Thus freedom is allowed in drainage, structures, etc.

The designers are under more pressure than when they work directly for the client. The total design period is about half shorter than with DBB due to quicker decision making and shorter contract period. This may also reduce the quality of the documentation and lead to deficiencies in design and design auditing. This is why clients require that the contractor gets the design verified by a design verification group employed by the contractor. The contractor is also required to employ an independent proof engineer to approve all structural drawings. There are also design coordination meetings involving the client, contractor and designer, and the contractor submits the design for the client's Superintendent's review prior to construction /83/. Additionally, the design needs to be warranted through Professional Indemnity Insurance for fit-for-purpose.

Construction

All contracts are quality-assured contracts with a defect correction period of two years. Contractors generally aim for a slightly better profit than with DBB (1–2% more). However, this is highly dependent on design development as contractors have a tendency to minimise their profits in the tender to win the project. As won contracts need to cover the cost of the lost tenders, there is a lot of pressure on pricing.

Periodic maintenance

The clients feel that even though DB forces the contractor to minimise quality to the minimum acceptable level, the high-quality prescriptive standards applied to the most important project aspects ensure that the road life cycle is not affected significantly. Optimisation affects mainly secondary structures, as the contractors have learned, where they can push the envelope and still meet the standards and produce an acceptable structure cheaper. The other option to ensure quality is to include an extended maintenance period in the contract (DBOM).

4.1.3 Risks and responsibilities

Risks should be allocated to the party best able to handle them. This is generally achieved by allocating massive risks on the contractor. However, according to some consultants, authorities can often only transfer 50–60% of the risks as they hold the base-line risk. The client is always responsible for risks associated with minimum design and construction standards, community and political acceptance, environmental impact remediation (except construction impact), and right of way matters.

The contractor is best able to manage risks associated with design, construction, design changes, changes in quantities, community relations, traffic management and environmental issues. Performance-based specifications place also the risk of non-performance on the contractor /110/. In New South Wales and Queensland the contractor carries the risk of latent conditions, while in Victoria the client bears this risk. The contractors feel that sometimes the poor quality of the client project team can also be a big risk that is pushed on them. As the contractors perceive that much of their risk is due to design, they tend to transfer a portion of the risks to designers through fixed price contracts. Some interviewees saw potential in more risk and benefit sharing between the client and contractor to encourage better co-operation and more innovation through working towards a common goal.

4.1.4 Project team

Relationships between clients and contractors are slowly improving as partnering has become a common practice. Mutually set project objectives are used as criteria by which project delivery is assessed monthly. This leads to improved teamwork, communication and information transfer in projects. However, availability of tacit knowledge has not improved to the expected level as client representation tends to lack continuity. Also, coordination of cooperation, managing people and keeping communication lines open in big projects with multiple participants may be difficult. Problems are experienced especially when schedules become tighter.

Decision making is also perceived to be more difficult than in DBB as there are more options available and more parties involved. Decisions tend to be price driven, in the same way as implemented process improvements and win-win procedures. Generally, more trust and co-operation is required to facilitate project delivery. Also, designers, who are currently often excluded from partnering, should be included in partnering arrangements, as designers have a key role in project success.

4.1.5 Administration

Project administration is still done mainly in-house, while use of consultants is increasing due to reduced in-house resources. The client's administrative cost and burden is the same as with DBB, but the emphasis is different. In DBB the focus is on claim solving, while in DB it is more on team building.

4.1.6 Schedule

The project time frame is shortened which saves time-related expenses and enables road users to access the road sooner. Despite the shorter project duration, both the tender and contract period are longer than with DBB. The longer construction time is due to the time required to enable enough design to be completed to allow commencement of construction /83/. Design, on the other hand, is done significantly faster than with DBB, as the private organisation aims to reduce overheads and allow more time for other revenue generating projects. Lead times between design and the construction are shortened through step-wise design.

Time certainty is better than with DBB, as the contractor has control over project delivery and can resource better. The contractor understands where problems may arise, and can take better informed preventive actions. However, at the same time the inexperience of the contractors affects project delivery negatively. Also, the clients' project programming has introduced some inefficiency, as there tend to be too many big projects simultaneously draining the work force of both the client and the engineering community which affects negatively the quality of available resources. There should be more stability and continuity in the market.

4.1.7 Cost

DB has delivered significant reductions in the capital costs of major projects. Contractors have cut costs to win the projects. However, at the same time the lower capital costs may have been substituted by higher maintenance costs. Better cost certainty is achieved through lump sum contracts, whereby projects are often completed within the acceptable budget. Contractors also aim to manage costs effectively and have

better opportunities to protect their profits. This differs from DBB, where cost plus fee-type contracts are used.

4.1.8 Quality

There is a common perception among road authorities that during the past ten years quality has decreased at the expense of economic benefits. DB tends to provide the bare minimum, as it is difficult to specify qualitative factors. This has resulted in lower quality in terms of aesthetics and environmental and social issues compared to DBB roads. However, there has been some over-servicing of the roads in the past. By eliminating some of this excess, benefits can be reached, provided that design specifications and the road life cycle are determined properly. Lower quality becomes a problem mainly, if the client wants to have an over-arching landscaping theme on the roads. To ensure good quality delivery, architectural and urban design aspects are often partially or fully prescribed in the planning process in Victoria, or subject to considerable input by third parties. The key architectural parameters are determined prior to the acceptance of the tender and locked in the award of the contract with a proviso that the contractor carries the risk of ensuring the structural adequacy of such designs /110/.

Contractors have not yet assumed ownership of roads, and the designers are generally not paid to be connected to the construction sites. The designer working for a contractor needs to do minimum design in order to maximise the contractor's outcome in minimum design time and to maximise his own profit. This may result in more design errors leading to an increased number of re-design efforts. There are also more chances for construction errors due to fast-tracking.

4.1.9 Change orders, disputes and claims

After the tender there is little flexibility, and changes to the project scope are very expensive. While the number of change orders tends to be low, the initiator of the changes is usually the contractor. Thus, he needs to carry contingencies for changes which makes risk analysis very important for him.

Larger contracts have reduced the number of interfaces between adjacent contracts and, therefore, also the number of claims and costs which flow from these problems /83/. Partnering has also reduced the number of disputes. The value of claims is only about 5% the project cost of claims as filing claims against the client is more difficult than with DBB. However, there are still disputes and claims, which may be substantial, and tend to be solved increasingly in the higher courts. Actually, in Victoria, the historic occurrence of unresolved contextual claims has increased dramatically as the use of DB has increased. Latent conditions cause a significant proportion of these claims.

Contractors may also raise claims against designers which makes some consultants uncomfortable with DB.

4.1.10 Innovations

There is more scope for innovation than with DBB. Generally, innovations are done during the tender stage. The key parties are involved early in the project's life cycle, when the final cost and duration of the project can best be affected and the cost of changes is low. As the cost of changes increases rapidly at the final project stages, innovations are quite limited after the award. As competition is all about price, the main motivator for innovations are cost savings. The design solutions consider better strengths and equipment of the contractor resulting in a more cost-effective solution for the contractor and a lower price for the road authority. However, risks associated with new applications and partially prescriptive specifications have led to fewer innovations than could have been expected. Savings of about 2% due to innovations are common. This is important in the climate of reduced funding for infrastructure projects /83/. To encourage innovations savings may be shared between project participants or the contract can be awarded earlier.

4.1.11 Client satisfaction and project success

In Victoria, client satisfaction has been above traditional. The clients have accepted that the quality is somewhat lower than with DBB, since in many cases it may actually be optimal. The clients believe that the contractors and the industry are more efficient and innovative in many respects. Generally, the clients perceive that they get better value for money out of the DB process. However, in Queensland and New South Wales clients have not been happy with the results of DB. DB's advantages and disadvantages are listed in Table 27.

Table 27. Benefits and disadvantages of DB procurement.

Advantages	Disadvantages
• reduced project duration • single point of responsibility • fewer claims • better value for money • optimised quality through innovations • reduced capital cost • risk transfer to contractor • better relationship between the client and the contractor	• client does not have the same influence over the project outcome as he does in traditional procurement • changes to project scope are very expensive • experience is needed to ensure expected quality through specifications • reduced competitiveness of smaller contractors

4.2 Design-Build-Maintain

4.2.1 General

DBM-type procurement is not yet used very extensively, but is becoming more common in very large infrastructure projects. In Victoria there has been only one BOOT project, while the second one is at the tender stage. In New South Wales BOOT- and DBOM-type procurement are used in all large (>AU$100 million) projects. DBM may be used in large projects which provide opportunities to innovate and/or generate money and when there is sufficient market interest willing to accept the associated project risks. Some smaller (AU$50 million) DBOM contracts have been awarded to fast-track the projects. DBM project delivery must generate savings through optimal risk allocation, integration and synergy between design, construction and operation, competitive tender process, and economies of scale to counterbalance the additional procurement costs and financial premiums /97/.

The Australian market is mature with a high level of confidence in the road projects. While banks are getting out of infrastructure financing, more infrastructure funds are coming in. However, there is a lack of the skills required to work with financiers. In Queensland it is estimated that no more than 16% of road financing will ever come from the private sector. The projects are mainly one-off projects with no PPP programme in place. There is no continuity, and no incentives to train employees. The ProjectCos are looking overseas for growth opportunities.

4.2.2 Project delivery process

Designer/contractor selection

The Public Sector Comparator (PSC) is used to evaluate the value for money achievable through DBM bids. It is based on the most likely and efficient form of public sector delivery that would normally be used to satisfy all elements of the output specification. This risk-adjusted, whole-life project cost estimate provides a consistent benchmark and bid evaluation tool that encourages the private sector to put forward its most efficient bids. /97/

On average, 15–20% of design is done in the RFP including requirements on engineering design and standards, specified urban design, aesthetics requirements and environmental parameters in the form of a concept plan, preferred option and preliminary design. Generally, performance-based specifications and fitness-for-purpose obligations are used with some more prescriptive specifications (pavement structure and aesthetic finishes, etc.). It is important that the output specification is clearly defined

and quantifiable, as it will become the basis for indicators against which performance will be measured and, in DBOM, payment made /97/.

As the project size has increased, the number of bidders has decreased. While about nine contractors can generally tender for DBOM contracts, 2–4 competitive consortia can be put together for big BOOT projects. Thus, the clients hope to entice big European companies into the Australian market to increase competition. The ProjectCos are formed by the construction and design companies, where OM experience may be provided by the service department of the construction company. EOIs are used to short-list proponents to 2–4.

The tender period (10 weeks for DBOM, 4–6 months for BOOT) is very intense, but it is considered adequate, as the longer the time, the more money bidders spend on little extra value. During the period bidders work out their financial offers, risks associated with their proposals, technical features, and non-price features. Generally 30–40% of design is done including a concept design defining cross sections, vertical and horizontal alignment, and nature of big structures. The non-conforming bids need to be submitted with the conforming bids /104/.

In Victoria, the tender cost of a BOOT project has been 0.5–1% of the project PC. The unsuccessful tenderers are compensated for 15–30% of the tender cost to keep them in reserve during the negotiations with the preferred bidder. This maintains competitive pressure and helps achieve financial closure within the timeframe. The compensation also buys the intellectual property of the reserve bidders. In New South Wales, the tender cost with DBOM is AU$2–3 million. With BOOT the tender cost for an unsuccessful tenderer is AU$5–6 million, and for a successful one AU$10 million by the time the contract is signed. As the contractors are concerned about the tender cost, the clients are seeking to reduce it minimising the amount of information required in the tender.

In Victoria, the tender assessment includes clarification meetings with each bidder. While the price tends to be the determining factor in ProjectCo selection, in some cases 5–10% weighting of non-price issues has made a difference. Especially the road user cost has affected selection in some BOOT projects. It is generally considered beneficial to select the tender that offers the greatest value in whole-life terms.

Design

Generally, BOOT projects are implemented through separate design/construct and maintain/operate contracts, while in DBOM projects one company is responsible for the whole project (see Figure 11). In BOOT, DB contractors are often members of the

private party consortia allowing them to contribute from the beginning. There is more time and effort put into finding the best overall design and improving constructability. Also, very experienced designers are generally used which enhances innovativeness and cost effectiveness of the design over what the client would traditionally produce. The design reflects what is most cost-effective to build, supervise, and maintain with the special skills and equipment of the participants.

Construction

Even though competition drives profits down in DBM projects, the contractors' margins tend to be 2–2.7 times higher than with DBB reflecting the increased risk exposure. As the DBcontractor does not have responsibility for the long-term performance of the road in BOOT projects, changes in construction techniques are generally not sought. The contractor has more incentives in DBOM to improve his processes.

Occasionally, as in Victoria, the ProjectCo is required to be a single purpose entity and is not allowed to take on other obligations that would interfere with its interest and priorities during the appropriate time span required for the project.

Periodic maintenance

In BOOT, the concession period is 30–34 years, which is contracted out through separate 10-year contracts with a review after the contract period and potential continuation. In DBOM the maintenance period is ten years. This provides the private sector a strong incentive to focus on whole-life service delivery and costs, as the risk of the excessive future costs is on it /89/. Operators may be involved at the tender stage to improve the cost effectiveness of the scheme. In BOOT, even higher operation and maintenance benefits are achievable, if the same company delivers design, construction, operation and maintenance. However, the different skill sets of the operator/maintainer vs. constructor may cause inefficiencies in delivery /89/.

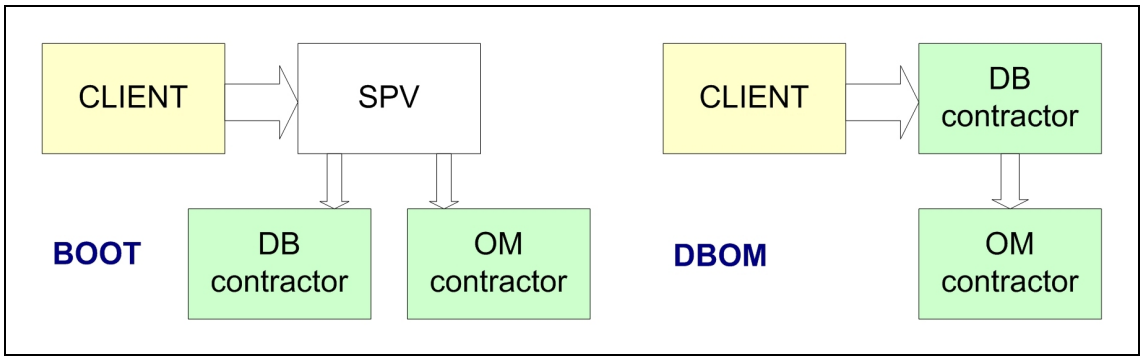

Figure 11. Organisation of DB and OM in BOOT and DBOM.

Generally the service providers put less resources into periodic maintenance, because they aim at getting things right initially (better drainage systems, over-designed pavements, etc.). As a result, many problems experienced with DBB roads are omitted. Maintenance is optimised also through a more structured approach. However, effective contract management depends on the development and implementation of the appropriate mechanisms to monitor the performance of the parties, to encourage optimum performance and to ensure that value for money is achieved continually /103/. The only problem experienced in New South Wales is inadequate cleaning of the road corridor. Since it is a relatively inexpensive task, in recent DBOMs litter collection has been excluded from the contracts as a client responsibility. Additionally, the client is considering use of a descending payment regime for maintenance to drive efficiency and to get a share.

BOOT reduces considerably the authority's ability to deal flexibly with the road network. For example, if the client builds another road parallel to the BOOT road or increases rail travel at the expense of road travel, the client has to reimburse the ProjectCo for the loss of income. By contrast, DBOM allows the client to retain control of the road /89/.

4.2.3 Risks and responsibilities

Value for money is maximised by allocating risks optimally to reduce risk premiums and overall cost of the project. Thus, BOOT typically involves maximum risk transfer to the private sector. The private sector is responsible for permits and approvals for the project, site risks, design and construction, road availability and performance, long-term maintenance and operation, traffic, technology, changes in general legislation, financing and revenues, and all risks that are not allocated in the contract /89/. As a result, both the client and bidders spend significant time in assessing risks. The ProjectCos' risk management generally involves transferral of risks to other parties, who are able to control them better /113/. The client is generally responsible only for changes in the state law and transport policy, acts of prevention, land acquisition and planning approvals /89/, and potentially for uninsurable *force majeure* events. If these risks materialise, the client pays compensation to the ProjectCo for any lost in its revenues.

It is important to maintain the preset risk profile throughout the project. The client should not allow the private sector to transfer risks back to the client. Also, the client needs to be adequately hands-off, to ensure that he is not taking on more risks than initially planned. Clients are generally content with the risk allocation, but some of the ProjectCos feel that the risk transfer is excessive, which is indicated by the problems faced due to poorly allocated or priced risks. In the future, this may lead to price increases and/or consortia withdrawing or taking on inappropriate risks. The owner may be in a better position to bear at least the risks of contamination, and native title and artefacts.

4.2.4 Project team

Generally, two thirds of project and contract management is about relationships. Maintaining good relationships between the key players is important and takes some effort. The ProjectCos tend to prefer long-term relationships with their suppliers, even though contractors are often selected through price competition that does not convey the relationship-focus to the implementation of the contract. This is why the clients need to assess how the consortia will work.

Decisions are generally made at the organisational level that is able to assess risks and make quick decisions. However, due to fast-tracking, there may be problems in dealing with government authorities who are not used to the speed, which creates friction and conflict that should be eliminated. The client should not be on the critical path that may lead to significant liquidated damages in case of delays. Fast-tracking has also led to some problems in information transfer from design to construction requiring more interaction between the teams. At the same time, there is potential to reduce public inconvenience and environmental issues. There have also been efforts to minimise accidents and raise awareness of safety. However, success in these terms is mainly affected by the structures the client puts in place to ensure the desired outcomes.

4.2.5 Administration

The client’s administrative burden is very heavy during both document preparation and tender evaluation. The amount of contract administration depends on the payment system applied and the monitoring required. If the road is paid through user tolls, monitoring is minimised, while performance-based payment mechanisms require more auditing. However, a proper system should reduce the clients’ resource needs: in DBOM monitoring is generally reduced by 30% from DBB, in BOOT by 50%. In New South Wales it is estimated that the client’s total administrative cost in a BOOT project is about a single bidder’s cost. About 65% of this is external advice, the rest is in-house costs.

The client organisation needs sophistication in order to specify the contract requirements adequately and to administer contracts effectively. The client's role is to facilitate project delivery, assess bids, negotiate contracts, protect the State's interests, acquire property and take care of legislation- and regulation-related issues. The client should also pay attention to community consultation, which cannot be built into a BOOT contract. During the operation phase, the client needs to ensure that focus is maintained, the project is resourced appropriately, and that there is succession planning as the people in administration change. The client is responsible for public safety, protecting customers, monitoring the ProjectCo’s performance, responding to the ProjectCo’s commercial requests, exploring compensable enhancement opportunities,

and maintaining the value of the asset. A cultural change, different people and capabilities, different systems, collection of different type and more accurate data, etc. may be required.

It is very important that there is a group of people in the client organisation responsible for the project who work with the consortia to get the project delivered effectively. They have to ensure that authorities do not hold back the project unnecessarily. Approvals have to be gotten quicker than normally. As most clients do not have internal capabilities to handle all contractual issues, more external advice is required. The cost of this additional advice is 1% of the total cost in big projects, while in smaller projects it may amount to 4–5%. During the tendering phase the cost of external advice with DBOM is twice and with BOOT four times higher than with DBB.

4.2.6 Schedule

Both time certainty and performance are improved. While in Victoria the BOOT project has experienced some delays, in New South Wales every DBOM and BOOT contract has been completed early. In BOOT projects, there is an endogenous, strong financial incentive to finish early: the concession period starts from the day the contract is signed, and faster completion will allow more time to collect tolls. In DBOM, no special incentives are used, only liquidated damages for late finish. However, as the maintenance period starts from practical completion, which is achieved, when the road is fit for purpose with no major defects, the contractors generally want to achieve this as early as possible. Also, there is a natural driver, as the contractor's overhead in these big projects is AU$250–300 000 per month.

As there are no budgetary constraints on private finance, BOOT roads can be delivered years earlier than they could be delivered through public funding. Even if the client had funds available, a BOOT project could still be delivered in half the time it would take the government to deliver traditionally. Shorter project duration results mainly from the project packaging and procurement process. Many of the DBM projects would traditionally be divided into six different contracts. In procuring these as one package, time can be reduced to half which leads to savings and reduces the cost of project management. Also, when problems arise, BOOT projects can be completed within the preset timeframe, while traditional projects take longer.

4.2.7 Cost

It is often argued that DBM project delivery increases the capital cost of a road, but decreases the whole-life costs. However, in New South Wales, 10–15% capital cost savings are generally expected compared to DBB. These savings are associated mainly with the faster project delivery and fewer interfaces than in DBB. On the other hand,

there has been a lot of discussion concerning the whole-life costs of DBM as the maintenance costs in DBOM are about twice the level of traditional, routine maintenance. However, it is difficult to estimate, how much of this difference is associated with risks transferred to the private sector. Despite the higher cost of maintenance, the client still considers the price reasonable due to associated the risks.

With cost overruns of only 0–2% (mostly <1%) DBM provides better cost certainty than DBB. In DBM cost certainty depends on transferral of the network risk and the payment method. The payment method in BOOT projects is user-paid tolls. In DBOM the contractor is remunerated on a basis that motivates him to outlay more initially in order to reap savings during the maintenance phase. If it is difficult at the time of tender to specify exactly what the contractor's maintenance and operating obligations will be, performance-based remuneration may be used for maintenance /89/. However, despite the payment mechanism, cost certainty is increased based on the fact that maintenance costs are factored into total project cost, while this is not considered in the other procurement methods.

The commercial outcome of a BOOT venture depends fundamentally on accurate cost-benefit analysis. These analyses have occasionally employed overly optimistic patronage figures, resulting in a lower than expected profit. This has led to adjustments to the concession period or consumer costs, or to the government providing financial relief to the concession company /89/.

4.2.8 Quality

DBOM was introduced as a response to the client dissatisfaction with the contractors' lack of responsibility for the maintainability of the road in DBB and DB. DBB and DB entail incentives to use the cheapest materials available consistent with the quality specifications and contractual requirements. In New South Wales, in the mid-90's, it was concluded that there are basically three quality drivers: 1) The contractor has to be quality-assured and have a proper quality assurance system; 2) The contractor needs to appoint an independent verifier; 3) There needs to be 'ownership' of the road and full responsibility for design and construction. To create ownership, a 10-year maintenance period was identified as the optimal time during which problems would become evident in pavements.

Thus, with DBM both design and construction quality are better than with DBB or DB, and more balanced decisions are made concerning the whole life of the road. Pavement designs tend to be more conservative than with DB in order to reduce the risk of adverse trade-off between buildability and maintainability /89/. The client and ProjectCo nominate an Independent Reviewer to act as a quality auditor during the design and construction. The verifier has a fairly heavy presence creating a cost of 4–5% of the project cost, but this has worked extremely well in ensuring quality of the delivery.

Despite the good quality, BOOT roads are strictly fit for purpose. The ProjectCos do not consider money spent on aesthetics to add value, since economic factors are emphasised in the decision making. At the same time, the client may spend up to 20% of the project cost to improve the aesthetics of the road. Also, the pace at which a BOOT project progresses has potential to affect the design and construction quality unfavourably. This is why it is very important to pre-qualify the bidders to ensure their capability and adequate resources. When assessing bids, the client should be value rather than price driven. Additionally, clients develop their specifications on an on-going basis, based on the experiences gained and the way contractors/ProjectCos act upon the specifications applied. Currently the main emphasis is on urban design and aesthetics. For example, in New South Wales the client provides the urban design plan and aesthetics design as part of his concept design. The bidders prepare an urban design as part of the bid and price urban design features. In Victoria, the client has also paid directly for some additional works to enhance the aesthetic aspects of the road.

In BOOT, there is little incentive for the ProjectCo to ensure that the road remains financially or technically viable after it has been transferred to the client. Maintenance and capital replacement costs are likely to be kept to a minimum. To guard against such action, predetermined performance criteria are established for the operation of the road and handover, and security bonds are used /89/. However, no BOOT road has reached this point yet, as the oldest BOOT road in Sydney is 20 years old.

4.2.9 Change orders, disputes and claims

There is very little flexibility after the contract is signed which makes it critical to determine the client objectives upfront. When variations are required, negotiations may take a significant amount of time and be costly to all parties in addition to being difficult to manage. Adequate flexibility needs to be built into the contract, as during the concession period there will be technological changes and advances that should be adopted into the project road. The initiator of the changes will probably be the network optimising issues and changes in traffic flows. There have been changes also in the scope due to changing community requirements on urban design, etc. Changes can be paid for in a number of ways, of which the lump sum, paid progressively as the change is delivered, is most common. Other options are negotiated changes in the toll levels or changes in the concession term.

The value of claims in DBM is extremely low, only 1–5%. Due to risk transfer, disputes are mostly between the ProjectCos, designers and contractors with no client involvement. Disputes are also reduced by the fact that the clients tend to select the best companies with a more mature way of operating.

4.2.10 Innovations

DBM has the potential to drive innovations in matters that the client values most. However, there have not been very many innovations, as they always carry the risk that the unproven technology will not deliver the intended results and will require further refinements /113/. Thus, most innovations tend to deal with scope. Significant savings can accrue during the strategic stages when decisions are made about the route, how the road is going to be built, etc. Even though these decisions are made in the concept design, clients may ask for alternatives in bids. Innovations in BOOT projects may also involve financial issues, tax minimisation, etc. Electronic tolling has been one of the significant innovations.

Often it is claimed that the tender period is too short to be the main period of innovation. Thus, innovations tend to be adopted from other industries. Innovations are also restricted by the client who goes through much of the environmental impact state before asking for bids. Changes to permitting would be very difficult and time consuming. As an exception to this, in New South Wales, a DBOM contractor can change even the horizontal alignment, as land acquisition occurs only after the contractor is selected. To encourage innovations the client should not over-specify projects in order to allow alternative ways of service delivery. For example, pavement, which is generally very strictly specified, makes up 40% of the capital cost of a project.

4.2.11 Client satisfaction and project success

Clients are very satisfied with DBM project delivery, as the projects have been successes technically, politically and socially, and they have met their objective – community benefit (better service and facilities delivered sooner, at the least cost to the community). The speed of BOOT project delivery demonstrates the power and flexibility of public private partnership. It is generally perceived that DBM provides the client better value for money and net benefits. Advantages and disadvantages of DBM are listed in Table 28.

Table 28. Benefits and disadvantages of DBM procurement.

Advantages	Disadvantages
• risk transfer • better risk identification, allocation and management • provides clear identification of service requirements • whole-life focus • better quality product • better value for money through better customer focus • improved efficiency and innovations • improved utilisation of industry skills • offers contractor no way to make claims unless client adds something new • private sector participants have long-term business opportunity • earlier and accelerated project delivery • reduced administration • certainty of funding • cost certainty • time certainty	• high tender costs reduce competition • commissioning authorities do not have the same influence over project outcome as they do in DBB • aesthetic requirements difficult to set so as to ensure adequate emphasis on them • long-term commitment restricts future changes to the transport network • lack of flexibility for the revision of project scope once contracts are being executed • lack of suitable skills in government agencies • reduced client expertise • resistance to change

Service providers are content with DBM as they are in control of the project and have greater involvement. Also, communities and road users are generally satisfied, and support of BOOT roads is increasing demonstrated by traffic growth on toll roads. There has also been a huge cultural change in the way the ProjectCos deal with customers as customer focus has become of prime importance.

4.3 Alliance contract

4.3.1 General

There is a significant movement within the construction sector towards relationship contracting /103/. In Queensland, alliancing, which represents the upper end of relationship contracting, has been used since 1999. Western Australia is starting to use alliancing, and New South Wales has awarded its first alliance project. While alliancing is new in the public road sector, it has been used in the private sector for some time. The decision to adopt alliancing has been influenced by cost and time overruns, poor quality and rework, poor stakeholder and community relations and the dissatisfied clients, designers and contractors of conventional project delivery /93/.

Project Alliance is an agreement between two or more entities that undertake to work cooperatively, on the basis of sharing project risks and rewards, for the purpose of achieving agreed outcomes based on principles of good faith and trust and an open-book approach towards costs. The client and the contractor form a team to deliver the project. Both parties develop and agree on the target cost estimate for the project. A board drawn from both organisations manages the contract /89/.

Alliance is only applicable in complex projects: brown field sites, many stakeholders, demanding engineering, existing roads and rails, community and environmental issues, new technology, tight schedule, hard to quantify, political pressure on the agency or something else that would cause too much risk and price variations with other project delivery methods. In these circumstances, alliancing provides better scope and cost management. While project size has varied between AU$3–90 million, alliancing may not be suitable in small projects (<AU$5 million).

4.3.2 Project delivery process

Designer/contractor selection

There needs to be a robust selection process that satisfies probity and transparency requirements. Thus, a two-stage tender process is used. Interested contractors are short-listed based on written submissions and half-day interviews of two bidders. These tenderers are taken into 2-day workshops. The selection of the preferred party occurs before any price is bid, requiring evaluation criteria that ensure value for money /89/. The total procurement process takes 2.5–3 months.

Design completion at this stage varies. In simple construction alliances complete design may be done, while in complex DB alliances no design is done before the award. In either case, the tender does not include any design. Rather the tender concentrates on, how the company would go about the project, who would do the work, what is their history, etc. Tendering is more expensive than with DBB but less costly than with DB. The labour cost of the tender phase is high, as people involved tend to be senior people of the companies. The total number of people involved from each company varies (on average 12).

A fair target cost estimate is established after the award, and the contractor is paid for the work that involves developing design to a level (generally 30% of design) which allows the target cost estimate to be developed. This is a significant cost incorporating a lot of consultant time. If a mutual agreement on the target cost is not reached, the process is terminated. Once the target cost is known, and accepted by all parties, the actual contract comes into force. The parties also prepare a mission statement and objectives that are weighted based on their perceived importance. These objectives are used to set KPIs to be measured throughout the project.

The potentially uncompetitive price is currently the most criticised feature of the alliances. This is why, in some cases, the target cost has been included in the final stage of tendering, where two preferred bidders compete against each other over the target cost. This ensures price competitiveness. However, the client has to pay for the two groups to go through the initial design development and target costing. It may also undermine the partnering spirit and reduce innovations. As the selection process is relatively costly, the client in Queensland is looking into multiple (6) projects being tendered simultaneously to reduce one-off costs per project (preparation, interviews, etc.).

Design

The first alliances were construction alliances. However, this often led to difficult design changes due to the unknowns of projects. Thus, today projects tend to be structured as DB alliances to gain benefits from having both the designer and contractor involved already at the design stage resulting in more likelihood of innovations. As designers are paid for the time they spend, they become more involved with the work and can better optimise the design for the construction techniques available to the contractor. Often the designers work at the construction site, and design changes can be handled flexibly. There is also more fine-tuning of design during project delivery. This has increased the design cost, but at the same time has made design better optimised and best fit for purpose is gained resulting in net savings.

Construction

There are fewer problems at the site, as the contractor is able to contribute during design. The warranty period is the same as it would be without the alliance. However, defect-free practical completion is encouraged by the fact that the cost of defect correction is part of the project cost which decreases the budget under-run and benefit share of the participants. Generally, the contractor can earn a the preset margin which leads to less variation in margins than with other project delivery methods. Additionally, the contractor has the opportunity to earn bonuses.

Periodic maintenance

There is more flexibility to deal with long-term issues. As the project team is focused on delivering what is best for the client, the client has to define his needs accurately. In Queensland, the client is moving towards a relationship approach in the delivery of maintenance services, too. The alliance is seen as a better way to operate, as it supports consistent delivery processes, provides a clearer understanding of the cost of maintenance and allows inspectors and engineers to share responsibilities to produce the best possible outcome /98/.

4.3.3 Risks and responsibilities

Alliance projects tend to be extremely risky. Generally, the biggest risks for the client are associated with getting things approved and the way the client works with other agencies, local government and communities. Thus, a lot of risks involve relationships. In an alliance all risks are shared by the participants which requires thorough risk analysis, a collective view on risks and a better understanding of them. All parties take on risks that they normally would not, but which they can best manage. Collective risk management reduces project costs, as the risk premiums are effectively reduced. This is why even the getting of approvals is often the responsibility of the alliance with significant successes experienced. However, sometimes it may be better for the client to acquire some approvals before the project starts, because the time required for the approval process may be too long. Also, funding should be in place before the alliance commences.

4.3.4 Project team

Project alliancing is characterised by proactive collaboration where all parties work together to achieve optimum outcomes, while minimising the inefficiencies associated with adversarial conduct. The enhanced ability of the alliance participants to embrace risk and uncertainty, and to deal with these factors in an innovative and collaborative fashion, is the key to optimising outcomes for all participants. The alliance seeks to align commercial interests of the participants through sharing of project success or failure and adoption of a ‘no blame, no disputes’ arrangement /89/.

During construction, the chain of communication is better, and problems are solved very quickly. The client is part of the team and understands better what he is getting. Issues of badly defined scope disappear, as they are dealt with mutually and timely. There are no arguments between the client and the contractor, and the workers enjoy working in this improved environment. Alliance deals especially well with safety, public inconvenience and environmental issues. Lost time injury frequencies and traffic management costs have been reduced, and there are more process improvements and win-win solutions. Engagement of all key stakeholders leads to better risk management.

To improve the alliance team performance further, there is generally a performance pool of money (for example 0.9% of the target cost) or a fee modifier. The KPIs are translated into a performance score that determines how much of the allotted money the participants get. This drives the team performance to scores above 60% (total range 0–100%). Monitoring of these non-cost factors verifies consistent application of the alliance process and ensures that appropriate attention and focus is placed on project goals /93/.

While in conventional contracts the biggest problems are commercial, in alliance people are the biggest ‘problem’, as the success of the alliance is dependent on the people working in the team. Contractors occasionally have problems in forming teams, and there are some challenges in getting the unions to accept the alliances. Alliancing requires a cultural change, while at the same time providing opportunities to acquire new skills, derive greater job satisfaction and develop personal and corporate relationships /93/. To facilitate processes, there should generally be no more than four alliance parties with possibly some sub-alliance parties allied with one of the main alliance participants.

4.3.5 Administration

The client’s overall administrative burden is lower than in traditional delivery, as there are no claims or disputes that would require attention. The fully integrated project team enables projects to be managed without duplication and the interface issues inherent in DBB and DB project delivery. There is no inspector, principle's representative or principle's project manager which allows these people to do more productive work for the project. However, the client's work load depends on how involved he is in the project delivery process. Generally, the more the client can engage in the process, the better the process tends to be managed. Technical issues require a lot more client involvement leading to extensive resourcing and use of different mechanisms than conventionally. The alliance team selects the best person for each job, and there may be a client’s employee working as a construction manager or quality manager, etc. In most cases, external advisors are involved in drafting the alliance contract, but not during the contract.

4.3.6 Schedule

As there are no time extensions, projects are completed early (up to 30% time savings) or at least in time (marginal delays of two weeks). The client prepares the initial schedule that the alliance team signs. Even in situations where there have been delays in the beginning of the project due to delays of approvals or funding, the project teams have strived to achieve completion on schedule. The incentive driving faster delivery is that every day saves money and increases the participants’ share of savings. This way the alliance is set up to be time efficient to improve time certainty and performance.

4.3.7 Cost

According to the clients, the alliance provides better value for money than traditional procurement. Even a project with a 70% likelihood of a cost overrun has been completed within budget. Generally, the target cost is underrun slightly (10%), but marginal overruns have also occurred (5%). Even though the design cost is higher than with DBB or DB, teamwork, innovations and better buildability drive down the

construction cost to provide net savings. The focus is on better productivity and keeping costs per km down, while still delivering appropriate quality /98/. The life-cycle cost also tends to be lower. The collaborative management structure can lead to significant cost savings because /89/:

- the contractor gains a better understanding of the client's needs
- the client can utilise other participants' skills in defining his requirements and avoiding wasteful practice
- costs associated with each party's defence of his contractual position are reduced
- problems are solved creatively and collaboratively
- there is an incentive to strive for best practice and outstanding results.

In some cases, the target cost estimate has been 10–20% higher than a traditional tender, but this is mostly due to higher risks /93/. When the final cost after the potential claims is considered, the situation is reversed. Cost reimbursement drives project management and performance of the participants efficiently towards the project objectives. Remuneration is made in accordance with a 'gain & pain sharing' mechanism and a performance-based reward structure. The client gets to share in the savings, while traditionally the contractor would retain all. However, to ensure value for money, the client needs to have a solid cost estimate that forms the benchmark for the target cost.

4.3.8 Quality

While the alliance team has ownership of the work which results in the excellent quality, quality still needs to be managed and audited. However, all quality information is available to all parties. Quality issues are handled immediately which saves money in rework. As the target cost does not include allowances for rework, it is considered expensive and inefficient use of money that affects the possible savings and final margins of the participants.

4.3.9 Change orders, disputes and claims

Flexibility is one of the major benefits for the client. There are more contractor-initiated changes that can be implemented at the right time bringing savings to the project. The alliances' preparedness to try innovative technologies demonstrates breakthrough behaviour that would not be possible with conventional delivery /93/. Sometimes though, design changes intended to result in value improvements may have led to reduced standards.

There have been minimal complaints and issues have been generally solved at low levels, as the participants agree not to use arbitration or litigation as a dispute resolution technique. All problems are resolved by the alliance board. Project completion with all

issues solved is a remarkable achievement, as in some traditional projects the money and effort spent unproductively in settling disputes may amount to 30–40% of total cost.

4.3.10 Innovations

Alliancing brings innovation to the forefront of design allowing cost savings without compromising other issues. The client is generally more inclined to accept innovations, as he is given enough information. The participants can also benefit from adapting innovations to their day-to-day operations. However, as a rule innovations should be done before target costing. Thus, the consultants play a significant role during this phase, and incentives may be used to encourage them to put more effort in design.

4.3.11 Client satisfaction and project success

Overall, this type of project delivery has exceeded the participants' expectations. Alliances have delivered infrastructure that meets the clients' service requirements and project objectives cost-effectively in terms of whole-life, innovations and quality /93/. Alliancing helps achieve better value for money than suggested by the preliminary design on which the Target Cost Estimate is based. Alliances have also allowed clients to deliver greater benefits to the community, within a shorter timeframe and with existing funding /98/. The benefits and disadvantages of alliances are listed in Table 29.

Since the competitive market has led to margins that are low on the international scale, the road construction industry is very interested in alliancing. The design parties tend to be much more satisfied with alliance projects than they are with other types of projects, since a lot of pressure is removed from them and they become equal partners in risk and reward sharing. The contractors are happy with alliancing, since they have met their margins and have been able to infiltrate the partnering culture into their organisations.

Table 29. Benefits and disadvantages of Alliance procurement.

Advantages	Disadvantages
• risk sharing • low tender costs • provides clear and mutually accepted identification of service requirements • whole-life focus • better quality product • better value for money through better customer focus • enhanced efficiency and innovations • clients have more control over project delivery • high flexibility • offers contract participants no way to make claims • earlier and accelerated project delivery • industry development • cost certainty • time certainty	• ensuring competitive price is difficult • requires skills that government agencies do not have • requires more client resources to be involved in the project • resistance to change

5. Literature review on project delivery systems

5.1 General

The building and construction industry is fragmented which causes performance-related problems including perceptions of low productivity, cost and time overruns, conflicts and disputes and resulting claims and time-consuming litigation. For these reasons, the project delivery processes have been regarded as inefficient compared to other industry sectors. Fragmentation also leads to poor provision of the clients' needs, smaller companies not achieving economies of scale, information unavailability, deficient design solutions, minimal collaboration among organisations and unnecessary design changes. Eighty-five per cent of the common problems in the industry are related to processes, not to the product /111/. This is why partnering is used in 85% of all contracts by value, including all construction projects over AU$2.5 million and all maintenance work /4/. Clients have also developed tools to select an appropriate procurement strategy for each project. The key factors facilitating project delivery are clear client/project objectives, clear responsibility allocation, adequate documentation, clear understanding of limitations of the procurement method, project personnel, adequate cost planning and contingency, adequate time planning and contingency, and reasonable risk allocation /88/.

Significant savings can be gained by grouping like projects into one package. This allows a high degree of flexibility in the timing of works and contractors' resource scheduling and provides economies in purchase and supply of materials. Generally, increasing the typical project size of AU$1 million to AU$3–5 million increases efficiencies by 20%. However, in very large projects the control aspect introduces inefficiencies and reduces competition. For larger than AU$20 million, complex projects, the packaging may be optimally determined by inviting input from the industry at a value management workshop. /89/

Best value tender assessment is rarely used. Instead strong price competition has ensured competitive tender prices and reduced margins of industry participants. Design fees have been reduced to levels where out-of-sequence and abortive work cannot be absorbed. This may lead to reduced documentation quality, whenever redesign is required /88/. Moreover, in conventional contract forms, the final outturn cost can be substantially higher than the tender price. In complex projects growth is typically 15–50% /106/. As about 67% of the construction problems are caused by inadequate communication and exchange of information, there is a need for extensive collaboration and teamwork /111/. Up to 30% of building costs could be saved if everyone involved could understand one another. Also, 65% of the profit erosion in the building industry is due to poor communication and information transfer /112/.

5.2 Innovation

As the public sector has the responsibility for ensuring the quality and effectiveness of the road network, it seeks continual improvement. Innovation is a key source of economic improvement and has a positive impact on profitability at the company level. In a mature market, like road construction, innovations are mostly adoptions of existing technologies and advanced practices of other industries. The most successful ones have been adoptions of business practices (quality systems, etc.). /3/

While the financial factors are dominant drivers in the innovation process, client actions are also influential, since the most important external driver of innovation is sustainable demand for innovation. Financial factors also dominate as obstacles to innovation, as the greatest inhibitor of innovation is perceived risk /52/. Conservative attitudes, primarily in the public sector, are an additional obstacle. Thus, public sector innovators operate in a highly constrained environment dominated by risk-averse bureaucratic attitudes /3/.

Joint ventures and collaborative efforts support and facilitate innovations. Robust knowledge flows are required between the organisations to maximise innovation opportunities. The increasing complexity of technical development and advanced

practices require a wide range of competencies for effective adoption or invention. Therefore, it is important for an organisation to have robust external linkages, and to keep up with the increasingly rapid pace of technological and organisational change. Personal contacts assist in acquiring the critical tacit knowledge required to maximise benefits of the adopted technologies/practices /3/.

Increasingly innovative businesses are those that operate in an information-intensive manner /111/. High innovators significantly outperform low innovators in every financial and non-financial aspect of business and project outcomes. High innovators record higher turnover and cost savings as a result of process and organisational innovations, create more jobs and are 50% less likely to miss their project delivery deadlines and to fail to achieve their stakeholder objectives on projects /52/. Seventy-three per cent of joint ventures and collaborative agreements are seen as successful /96/.

5.3 Maintenance

There is a trend towards contracting out maintenance delivery. Performance Specified Maintenance Contracts (PSMC) have resulted in savings of AU$101 million over 10 years (35%) (New South Wales) or savings of more than AU$40 million annually (Western Australia) /86/. Generally, a properly thought out maintenance contract with a constant work load can lead to 15% savings /100/. These savings can be attributed to ongoing benchmarking, productivity gains, more efficient packaging of contracts, and targeting of maintenance works to gain maximum benefits in terms of network life. Additional efficiency drivers are improved transparency in the cost of service delivery, reduction of overall operating costs, raised standards of quality, tightened limits on government budget allocation and increased accountability to the public /86/.

5.4 Design-Build

5.4.1 General

The contracting industry is concerned about high tender costs, as many clients invite an unlimited number of tenders. The effort, which the contractors devote to the tender process, is likely to be inversely in line with the size of the bid list. Thus, prequalification followed by short-listing is recommended /91/. Also price-driven selection limits the flexibility of the designers and contractors to explore innovative and alternative designs. Ideally, the project team should be selected based on weighted pre-qualification criteria, past performance and negotiations. This approach is suitable for experienced clients, who could benefit from using the same project team in different projects and retaining the tacit knowledge /85/. This would also facilitate the conversion

of the preferred offer into a properly reflective, signed contract, where the challenge is generally to merge the original requirements of the brief with any innovations, alternatives and solutions of the offer /91/.

Novation is a very attractive procurement alternative for the client, as it transfers design risks to the contractor, while offering a greater degree of control over design and quality. Novation ensures greater consistency in design, as the original design team remains throughout the project. Additionally, the contractor's construction experience is available to improve buildability of the design. Less adversarial relationships are encouraged and tender cost reduced. However, most contractors dislike novation, as they face risks associated with the design team's ability to perform and quality of the initial design, inadequate design fees allocated after novation and timing of novation (the earlier the better). The success of novation largely depends on the professionalism, maturity, and competence of the participants, and there is the risk that the relationship between the team members may fail due to their incompatibility. Novation is believed to be better suited for smaller and simpler projects. /48/

5.4.2 Project team

DB and DBM are used increasingly to coordinate and integrate the individuals and groups in order to facilitate inter-organisational communication and team building /85/. While DB has improved relationships between the parties, failures associated with fast-tracking are generally attributable to the lack of teamwork between the contractor and designer. These failures often lead to less than optimal design solutions. This is due to the tendency of the participants to focus on their own area of expertise /82/. Also, in 71% of the cases where partnering has failed, participants felt that the designer should have been more deeply involved in the partnering process /46/. As DB leads to a smaller number of contracts and interfaces than DBB, oversight procedures can generally be streamlined which results in a lower administrative burden /63/.

5.4.3 Schedule and cost

Non-traditional project delivery methods tend to yield perform at a 21% shorter construction time than traditional project delivery /46/. Accordingly, DB has reduced the duration from the initial commissioning of the project to completion, but not the actual construction period. The principal motive for fast building are the savings in time-related costs. DB has also kept the cost overruns down. A problem associated with fast-tracking is that it may not allow time to experiment or redesign, when necessary, and the designer may be encouraged to use repeat and tested design to offer lesser risk exposure /82/. At the same time, the common use of competitive tendering means that subcontracting is provided by the lowest-price suppliers (in the same way as in DBB)

with little or no guarantee of future work, and no incentives to develop their operations or relationships with the other parties.

5.4.4 Change orders, disputes and claims

There are fewer change orders as a result of the better design and estimating techniques, greater attention to risk management, and improved methods for scheduling construction /63/. However, at the same inflexibility is introduced to the process hindering revisions of project scope /91/.

5.5 Design-Build-Maintain

5.5.1 General

PPP is currently receiving much attention as an innovative solution for faster delivery of quality infrastructure services. It is expected to provide greater availability of flexible capital, shorter construction periods and simplified procurement processes /91/. The majority of the PPP contracts have been large (>AU$100 million) in order to ensure sufficient economy of scale that provides the contractors adequate opportunities to offset high initial tendering costs and counteract the potential downside of bearing additional risks. As a result, smaller contractors are effectively precluded from tendering, and it is becoming more difficult for them to stay in the market /59/.

The long contract period generates economic incentives for the contractor to meet the performance objectives and allows amortisation of risks and investments /59/. A significant driver towards DBM for the private sector has been the desire to generate work on more favourable terms than previously. However, when operation is included in the consortium's responsibilities, it is important to provide continuity of work to ensure that the experience developed will not be lost /100/.

5.5.2 Risks and responsibilities

As more risk is transferred to the private sector, there is more explicit recognition of risks which leads to better risk management. Negotiations over risk allocation and contractors pricing different risks provide the client the opportunity to evaluate the cost effectiveness of reduced risk exposure /59/.

5.5.3 Project team

DBM improves cooperation. Goals of the client and the service provider are congruent, as the clients are increasingly focusing on the needs of their customers at the same time

as the ProjectCos are striving to satisfy the road users /107/. However, the translation of user needs into the robust performance measures (KPIs) and the development of appropriate provisions to deal with poor performance are considerable challenges /59/. Generally, the project team members perform better, if they have a share in the development of the project and collaboration starts in the early project stages. Thus, all key subcontractors should be included in the partnering process /85/.

5.5.4 Administration

The input required from the supervisory and contract administration staff is reduced due to the change of the client's role from day-to-day surveillance to the measurement of specified performance outcomes. However, at the same time, there is a need for a higher level of skills and experience. For some clients the role change is challenging, as it creates a feeling of loss of control. DBM also inevitably leads to a partial shift of the road authorities' technical knowledge to the contracting industry /59/.

5.5.5 Schedule

A significantly shorter construction time is possible bringing significant financial benefits /114/. The design can be started immediately, and the construction generally follows soon (after 3 months) allowing fast tracking. During this lead time, the contractor is increasingly responsible for the issues previously managed by the client. The issue that generally takes most time is the preparation and approval of the environmental management plan /108/.

5.5.6 Cost

As 70% of the cost associated with the project is committed during the design phase, significant cost savings can be achieved through collaborative design development /85/. During the design phase, the lowest whole-life cost is strongly emphasised. Also, the predictability of the pavement solution is important due to the on-going maintenance responsibility of the ProjectCo. Generally, cost effectiveness is achieved through standardised structures and prefabricated elements /108/.

The ProjectCo may have 25% forward orders, and 67% of its revenue may come from long-term contracts. This way it can avoid the peaks and troughs common in the industry. It also allows the ProjectCos to have a profit margin of nearly 15% encouraging the companies to employ a long-term workforce, train employees and reward them for their ideas. /112/

5.5.7 Quality

Long-term maintenance responsibility ensures quality construction and competitive service delivery over the project's duration, as the contractor does not deliver at the lowest cost /91/. The contractor needs to assess the quality systems and condense reporting to streamline the quality processes, since there is often a tendency to ask for excessive testing. The cost of quality control and auditing tends to be 8% of the bid price or less /100/.

Generally, an independent verifier is used in quality-assured contracts. As independent verifier is appointed and paid by the contractor, the client remains at arm´s length from the delivery process, which reduces the number of contractual disputes on quality matters and project scope. Moreover, the independent verifier enables the client to demonstrate that he has taken reasonable steps to ensure appropriate project delivery and quality. The verifier also facilitates resourcing, as large projects, with tight timeframes, require large resources of skilled and experienced staff over long periods of time. /45/

5.5.8 Innovations

The current speed of technological advancement means that it is likely that during the life of the contract improved techniques will be available to the contractor. The contractor has an incentive to invest in the development of new products and techniques to reduce the cost of operation and to improve efficiency. However, this benefit may not be passed on to the client and road users /59/. Thus, long-term contracts should include provisions to renegotiate and accommodate technological or scientific advances /91/.

5.5.9 Client satisfaction

Clients have gained better value for money through performance-based contracts /65/. Additionally, there is strong agreement in the industry that these contracts have delivered the expected benefits /59/. The contractors prefer delivery systems that offer them more opportunity to manage the process and impact the final outcome. They also tend to allocate their best people to these contracts, since they expect to have better opportunities to make money /88/.

5.6 Alliance

5.6.1 General

Relationship contracting (including partnering, PPP, alliancing, etc.) was born out of industry dissatisfaction with the adversarial relationships encouraged by the traditional model /91/ and poor performance of the industry /115/. Also, more and more projects have to be delivered in an environment of uncertainty that is driven by diverse stakeholder interests, shifting business or political imperatives and rapid technological change. In these circumstances traditional risk-transfer contracting is inappropriate /106/. The difference between partnering and alliance is that partnering runs alongside the standard contracts with no contractual force, whereas alliancing arrangements are formally expressed in contractual form. Alliance is both relationship management and a delivery system /4/.

Project alliancing is suitable for large (> AU$20 million) and complex projects which, by their very nature, harness the enthusiasm of the participants /49/. It is applicable when there are numerous and/or unpredictable risks, complex interfaces, difficult stakeholder issues, complex external threats, very tight timeframes, potential for delays of project approvals or funding, high likelihood of scope changes, need for owner interference or significant value adding by the owner during the delivery or threats and/or opportunities that can only be managed collectively /106/.

Even though formalising and negotiating an alliance may take a number of months and lead to considerable costs to the client and contractor, the tendering cost is lower and the procurement process is shorter than with DB. Thus, construction can commence faster /49/. Documentation is usually fairly simple, because the parties are not meant to have recourse to the contract in case of disagreements /91/. One of the most innovative elements is the early selection of the contractor based on purely non-price factors with no reference to money. The bid includes information on the tenderers' expertise, safety records, current commitments and ability to work cooperatively within the alliance contract, etc. The tender evaluation process allows the client to get to know and understand the differences between the tenderers /91/. The contractors' suitability at a particular point in time, for a particular type of project is assessed on a case-by-case basis to ensure that the most capable contractor is selected /4/. Selection criteria include /106/:

- demonstrated technical, financial and management capacity to handle the scope of work
- understanding of and commitment to the alliance way of doing business
- track record and demonstrated capacity to deliver outstanding outcomes in safety, quality, environment, community relations, etc.

- preliminary ideas on innovations and execution strategies and the potential to deliver outstanding design and construction outcomes
- willingness to commit to the project objectives and pursue breakthrough outcomes
- track record/demonstrated ability of the proponent companies to work together and
- the quality of the key personnel and their affinity for working together and with the owner's personnel as a high-performance team.

5.6.2 Risks and responsibilities

Responsibilities are divided among the project team members /85/. As the participants share risks collectively, they have increased risk awareness and implement more effective risk management practices than in traditional forms of contract /106/. Risks are managed and issues resolved in an environment, where parties seek win-win outcomes /95/.

5.6.3 Project team

Alliancing is primarily about establishing the best team /49/. Enthusiasm and commitment of the team members is significantly improved /53/ as the client and the contractor form a joint venture that focuses on the project and its outcome. Fixed roles and entrenched positions are eliminated, incentives are aligned genuinely and ultimate project goals are tied to success and remuneration /88/. The alliance team develops a common culture focused on the best project outcomes rather than on individual corporate outcomes /94/. As a result, performance in non-cost areas has ranged from best practice to outstanding. There is a sharp focus on safety issues, traffic management, and environmental management /95/. Skills transfer, professional growth and development of project staff are improved /106/. Noteworthy is also the ability of alliances to deal with the key stakeholders more effectively than with traditional forms of contract /106/.

5.6.4 Administration

Alliances require significant involvement and commitment of owner personnel and senior management to support the process. Substantial costs are involved in establishing the alliance and developing and maintaining the alliance culture /106/. Administrative costs tend to be around 5.8% of the project cost /23/. The administration of an alliance is characterised by the following features /49/:

- more teamwork, trust and cooperation
- significantly less supervision

- no duplication of cost control, planning or document control
- open-book checking of direct costs
- less claims for extensions of time
- substantial containment of variations
- a culture of ‘no disputes’.

5.6.5 Schedule

Performance against schedule has consistently been outstanding with many alliances finishing months early /106/. Especially design can commence much earlier than with DB. Also, integration of the design and construction processes and exerted control over design changes enhance opportunities to finish early /49/. For example, alliances in the oil industry have led to 22% time savings and time-overrun savings of up to 100% /4/.

5.6.6 Cost

During the selection phase, the cost information provided in the submittals includes the normal break-even cost (Limb 1) plus the amount of profit and overhead contribution (Limb 2). The actual target cost development is done after the selection, and may take around three months. This is more like a normal DB tender, except that all parties are paid their Limb 1 costs. The required design for detailed costing is produced and costed to establish the target cost estimate (TCE). The final cost variance is shared between the client and the other alliance partners, generally on 50/50 basis (Limb 3). Sharing of the savings may be affected also by the project outcomes on non-cost KPIs. This financial model ensures that all parties either win or lose together /94/. The contractors and designers put their corporate overheads and profits at risk in return for the promise that extraordinary results will produce extraordinary returns. Remuneration is based on open-book recording /49/.

The design cost is higher than in other forms of project delivery. However, the additional design input is reflected in more economical design and an overall lower cost /95/. There is an opportunity to achieve savings as a result of the integrated team environment, streamlined administration and approvals processes and implementation of new and innovative ideas /95/. In most of the alliances the final project cost has been below the TCE. The worst outcome has been a 5% cost overrun and the best a 13% cost underrun /106/. At the same time, alliances in the oil industry have led to 25% cost savings and up to 50% reductions in cost overruns /4/.

There are some downsides to alliancing, too. There is a perceived lack of cost certainty, even though for complex projects, alliancing seems to provide much better cost certainty than traditional contracting /106/. Alliancing also remains open to criticism that the target cost, in the absence of price competition, cannot ensure value for money

delivery for the owner /106/. However, the project cost is found to be comparable to that of similar projects procured traditionally. Thus, costs are generally considered reasonable /23/.

5.6.7 Change orders, disputes and claims

Alliancing is a consensus-based approach that removes the traditional safety net of legally enforceable contractual obligations between the designers, contractors, subcontractors, operators and clients. It requires the participants to cooperate and develop projects together and to resolve disputes without recourse to the courts /91/. Thus, there have been no disputes nor outstanding issues after project completion /23/. Getting issues solved during the project enables future efforts to be directed at new projects without the time- and resource-consuming task of finalising contractual disputes, which is often the case with non-alliance forms of delivery /95/. The most pleasing aspect, according to the alliance members, is that the alliance allows energies of the parties to be focused on positive outcomes for the project without spending time and effort arguing and developing claims and variations. Even increases in project scope have been handled flexibly, since any variations need to be agreed unanimously by the Alliance Leadership Team /94/.

5.6.8 Innovations

There have been many innovations. While savings in the alliance project may be moderate, innovations provide opportunities for substantial savings in other projects. Also, the availability of designers to resolve issues arising during the construction phase ensures efficiency of the delivery /94/. There are more informed decisions on technical solutions and choice of equipment driving a better balance between the capital investment and whole-life cost /106/.

5.6.9 Client satisfaction

The alliance has clearly represented the best value outcome for the project and the client. Value for money can be measured in terms of improved functionality and aesthetic standards /95/. Also, quality tends to be well above the standard normally expected in a business-as-usual setting and to exceed client expectations /53/. Thus, the cost of alliancing is considered to be more than outweighed by the significant benefits achievable /4/. Certain projects, can gain distinct commercial advantages from project alliancing (see Table 30) /49/. The participants have also an opportunity to use the success of the alliance as a catalyst to improve performance of the wider organisations /106/.

Table 30. Benefits and disadvantages of alliancing /49, 116, 106/.

Benefits	Disadvantages
• lower tendering cost • reduced tender evaluation work • reduced project cost • earlier completion of works • safer working conditions • 'no disputes' culture • innovation • project management efficiencies and enhanced management systems • good engineering practice • improved design and better functionality • improved quality • improved cooperation • good performance in key result areas • professional and personal growth • containment of variations (budget overruns unlikely) • benefits for subcontractors • potentially good financial returns for private sector • ability to test different life-cycle options during target cost development	• no tendering on price makes contractor selection more difficult and less transparent • perceived lack of cost certainty • high training costs • high client resource commitment (especially senior people) • high costs involved with alliance culture and its maintenance • sharing of risks • payment of direct costs • pressure on quality in order to complete below target cost • reduced in range of liability • probity issues • high reliance on teamwork

6. Summary on Australian project delivery

The Australian road sector is divided into highly different markets. While some states are very conventional, the others (Victoria, New South Wales, Queensland and Western Australia) are pro-active and advanced. In urban areas competition in the road sector is fierce, but in more remote locations it is inadequate encouraging use of in-house work force. Generally, project size is growing and responsibilities of the contractors are broadening, as the client aims to concentrate on network management issues and to reduce his in-house design and construction resources. Through effective procurement the client aims to deliver projects to the satisfaction of all stakeholders. The industry has already learned to deliver through different project delivery methods, and consolidation of the market is happening through mergers and new partnerships, as larger organisations are perceived to be more competitive.

DBB, DB and DBM are all used in varying proportions. DBB is used in all states. DB is also a common project delivery method. DBOM and BOOT are used only in a few states, but they are becoming more popular. While the benefits of DBM are considered to well surpass its disadvantages and it is considered superior to DBB, views on DB differ (see Table 31). Many states have experienced quality related problems with DB and improvements are sought in various ways (more prescriptive specifications,

inclusion of maintenance responsibility, etc.). However, DB is generally considered a good way to deliver roads. Some states also use alliancing to deliver very complex projects. Alliancing has some congruencies with the early contractor involvement adopted in the UK and has potential to provide benefits in time and cost savings, innovations, buildability and programme delivery. However, while significant benefits have been achieved, some unanswered questions remain due to limited experiences on the project delivery.

Table 31. Future applicability of the project delivery methods in Australia.

Factor	DBB	DB	DBFO	DBOM	Alliance
Client satisfaction		High	Excellent	High	Excellent
Contractor satisfaction		High	High	High	High to excellent
Willingness to tender	Yes	Yes	Yes	Yes	Yes
Main advantages	Direct control, scope changes easy, predictable outcome, provides what client wants.	Risk transfer, better value for money, contractor designs the most economical structure and uses the most economical methods/ techniques, shorter project duration.	Huge risk transfer, client not involved in disputes, ProjectCo has no link back to the client if something goes wrong, community gets assets earlier, economies of scale.	Incorporation of construction, design and maintenance ensures optimum design, more cost-effective than DBB, whole-life focus due to long-term responsibility.	Risk- and reward-sharing, flexibility, no disputes/ claims, innovations, buildability, time certainty, savings, improved safety, reduced traffic managem. cost, client retains control
Main dis-advantages	Lack of risk transfer, no value for money, designer and contractor separated.	Scope changes very expensive, client experience needed to ensure wanted quality level, provides bare minimum, loss of control.	30–40 year commitment, restricts client freedom in network planning, requires client experience to ensure that fit for purpose obligation remains, loss of control.	Loss of control	Resistance to change, high procurement costs, little experience, probity issues
Applicability	Distant rural roads, small and highly constrained projects	Room to innovate, projects > $20 million.	Projects >$100 million, opportunities to generate money, room for alternatives	Projects >$100 million, room for alternatives, need to ensure whole-life focus.	Large and complex projects, potential for innovation

Competition for large DB and DBM projects is somewhat limited. Pre-qualification and mix of prescriptive and performance-based specifications are used (see Table 32). Price-based contract award is common and often preferred by the industry due to its transparency. However, price focus in DB has reduced margins of the industry and led to occasional problems associated with too low bid prices. In this very competitive environment, project partnering is often used to facilitate project delivery. The partners tend to share an office during project execution. The success of partnerships has varied, but it is generally seen to have improved over traditional, adversarial relationships. As an extension of partnering, alliance projects are bid without reference to price, and the scheme is only priced after the contractor is selected.

While client administration is reduced in DBM, in DB it is at the same level as in DBB. In both DB and DBM the contractors' risks are increased. Risk transfer is occasionally considered excessive, especially in DBM, where it is maximised. In alliances, risks are shared and the client has a more productive role. Thus, the use of new project delivery methods sets new requirements also for the client staff who need to learn to operate in various roles depending on the delivery method applied.

Table 32. Summary on procurement processes in Australia.

Factor	**DBB**	**DB**	**DBFO**	**DBOM**	**Alliance**
Design completion					
in RFP	100 %	10–80%	15–20%	15–20%	Varies
in tender	-	20–90%	30–40%	30–40%	None
Specs	Input	Output or prescriptive	Output	Output	Input and output
Award basis	Pre-qualified or open	Pre-qualified	EOI – Pre-qualified	EOI – Pre-qualified	EOI – Pre-qualified
Award criteria	Price	Price	PC or weighted	PC or weighted	Non-pricefactors + interviews
Pricing	Re-measurement	Fixed price. Increasingly target cost contracts	Mostly toll roads (user charges)	Fixed price	Target cost + pain/gain share
Risk transfer	Client carries most risks	Contractor carries most risks	Maximum risk transfer	Contractor carries most risks	Shared risks
Innovations		Price focused	Less than expected	Less than expected	Best for the project focus
Warranty/ Concession period	1 year (VIC), 3 months (QLD)	Construction 2 years, design 6 years (VIC). 1 year, fit for purpose (QLD)	15–45 years	10 years	Same as DBB/DB

DB, DBM and alliancing can deliver projects faster than DBB and improve time certainty (see Table 33). At the same time, DB and DBM put designers under more pressure. DB and DBM have also led to significant savings in capital costs and improved cost certainty (see Table 34). Moreover, DBM and alliancing have potential to improve whole- life cost performance, while DB is criticised for compromises made to achieve savings in the short term. The high tender cost involved with DB and DBM project delivery is often considered a problem which is reduced with alliancing. While change orders, disputes and claims are reduced with DB and DBM compared to DBB, alliancing tends to eliminate these fully.

Partnering (in DB, DBM) and alliancing improve relationships between the project participants enhancing communication and information transfer. DBM and alliances also enable fast decision making at low levels, while DB still involves some inefficiencies (see Figure 12).

DB tends to offer an incentive to the contractor to produce minimum (or occasionally optimum) quality. As a result, clients have recognised the need to improve their performance-based specifications continuously based on the experiences gained. Also, a cultural change is required in order to motivate the contractors to allocate adequate resources for appropriate supervision under self-certification. On the other hand, in DBM, the ProjectCos have a strong incentive to ensure adequate supervision and quality, as they will be responsible for the road in the long term. In many cases, ensuring adequate aesthetics in urban DB and DBM road projects, though, has required special steps to be taken by the client. Alliancing has delivered excellent quality and aesthetic results.

Even though both DB and DBM, in principle, offer potential for innovation, the statutory processes, risk-averse client and price emphasis tend to reduce the number of innovations effectively. As innovations are necessary to develop the industry and to improve industry margins, they are encouraged through collaborative efforts and alliancing.

Table 33. Summary on Australian schedule issues.

Factor	DBB	DB	DBFO	DBOM	Alliance
Schedule					
RFP development					EOI from contractors in 4 weeks
tendering	6 weeks	8–12 weeks	16–18 weeks	10 weeks	Interviews 4 weeks, workshops 2 weeks
tender to award		2 weeks			Tendering process 2.5–3 months
design	Shorter than DB. 1 year.	Initial design period 5–12 weeks, total design 6 months.		Initial design 3 months	Target cost development 3 months
pre-constr.	Same as DB	2 weeks			
construction		Same as DBB			
total project duration		Shorter than DBB	50% shorter than DBB		22–30% time savings. Shorter than DB.
Time overrun	30% of projects late, 70% on time or early	Generally on time	86–100% of projects early. Often 20–22% early (NSW). VIC: 28% delays.	All projects finished early	Almost always in time or early. Time overrun savings up to 100%.
Agency burden		Same as DBB, focus on other things	Should be less		Relatively high, more productive
procurement	Low		Very high	Higher than DBB	Very high
contract admin.	Requires considerable resources	Less than DBB	Depends on the payment system		High
design					High
construction					High
maintenance			Lower than DBB/DB	Lower than DBB/DB	Lower than DBB/DB

Table 34: part 1/2. Summary on Australian cost issues.

Factor	DBB	DB	DBFO	DBOM	Alliance
Tender cost (contractor)	0.15–1%	0.25–3%	1–1.2% of PC. unsuccessful bidder $5–6, winner $10 million (NSW).	$2–3 million (NSW)	Higher than DBB, lower than DB
Costs of the client		6% savings	10–15% savings	10–15% savings	Overall savings 10%. TCE 10–20% higher than DBB bid.
procurement		Higher than DBB/alliance	Higher than DBB/DB	Higher than DBB/DB	Higher than DBB
contract admin.	4% of project cost + client overhead 3.6%	4% of project cost	50% lower than DBB = Single bidder´s cost	30% lower than DBB	6% of project cost. Much lower than DBB/DB.
design	Same as DB. 5.7% of project cost.	1.4 % of the project + 3% of DB cost	Not much affected	Not much affected	Costs more
supervision		Savings. 8% of contract cost included in bid price.	Cost of independent verifier 4–5% included in bid price.	Cost of independent verifier 4–5% included in bid price.	Same, used more productively
construction	79%	47% of project, 97% of contract cost	Not much affected	Not much affected	Savings
maintenance		Higher than DBB	Lower than DBB	Not much affected	Lower than DBB
dispute resolution	Higher than DB	Some	None		None
external advice	Some technical advice		4 times DBB: in large projects 1% of total cost, in smaller 4–5%.	Twice DBB during tendering period	Required to draft the contract, not during contract
Cost over-run	Variations. 15–20%.	Within acceptable budget, less than DBB	Much lower than DBB. 0–2%, mostly < 1%. 86% of projects within budget.	Much lower than DBB. 1–2%, mostly < 1%.	25% savings. Reduction in cost overruns up to 50%.
Profit					
designer	More secure, 6-10%	Same as DBB, 6%	Lower than DBB, 6%	Lower than DBB	Higher
contractor	Profit more secure, 3%	Lower than DBB. Aim 1–2% better than DBB.	6–8%, double DBB profit. In NSW lower than DBB.	In NSW lower than DBB	Higher+more predictable than DB. Lower than could be in DBB.

Table 34: part 2/2. Summary on Australian cost issues.

Factor	DBB	DB	DBFO	DBOM	Alliance
Value of redesign		Same as DBB	Not very much		Less, done at the right time
Value of change orders (of total cost)	More	Limited	In some cases 10%, changes in scope	Changes in scope	None
Number of disputes	A lot	Some, maybe more	Some, client not involved		None
Value of claims (of total cost)	5–20%	5%	2%		None
Enhancing performance		Yes	Yes		Yes
Value for money		Better	Better	Better	Excellent

Based on the interviews in Australia the following value networks were produced for the DB, DBOM, BOOT and alliance project delivery methods (see Figures 13–16). In the value networks the yellow, coloured circles in the middle depict client values, while the white circles depict factors affecting project delivery in meeting client values. The green arrows illustrate the facilitation or improvement of the subsequent factor, while the red, dashed arrows illustrate the hindrance caused to the subsequent factor. Blue shading depicts a trend or change adopted or suggested to decrease the detrimental effect of the factor. It seems that in the Australian market the issues that affect procurement negatively have been recognised. However, different clients have different solutions to the problems experienced, and new and better solutions are sought continuously to enable more efficient project delivery in the future (see Table 35). Thus, the variation in procurement methods used in different states will persist into the future.

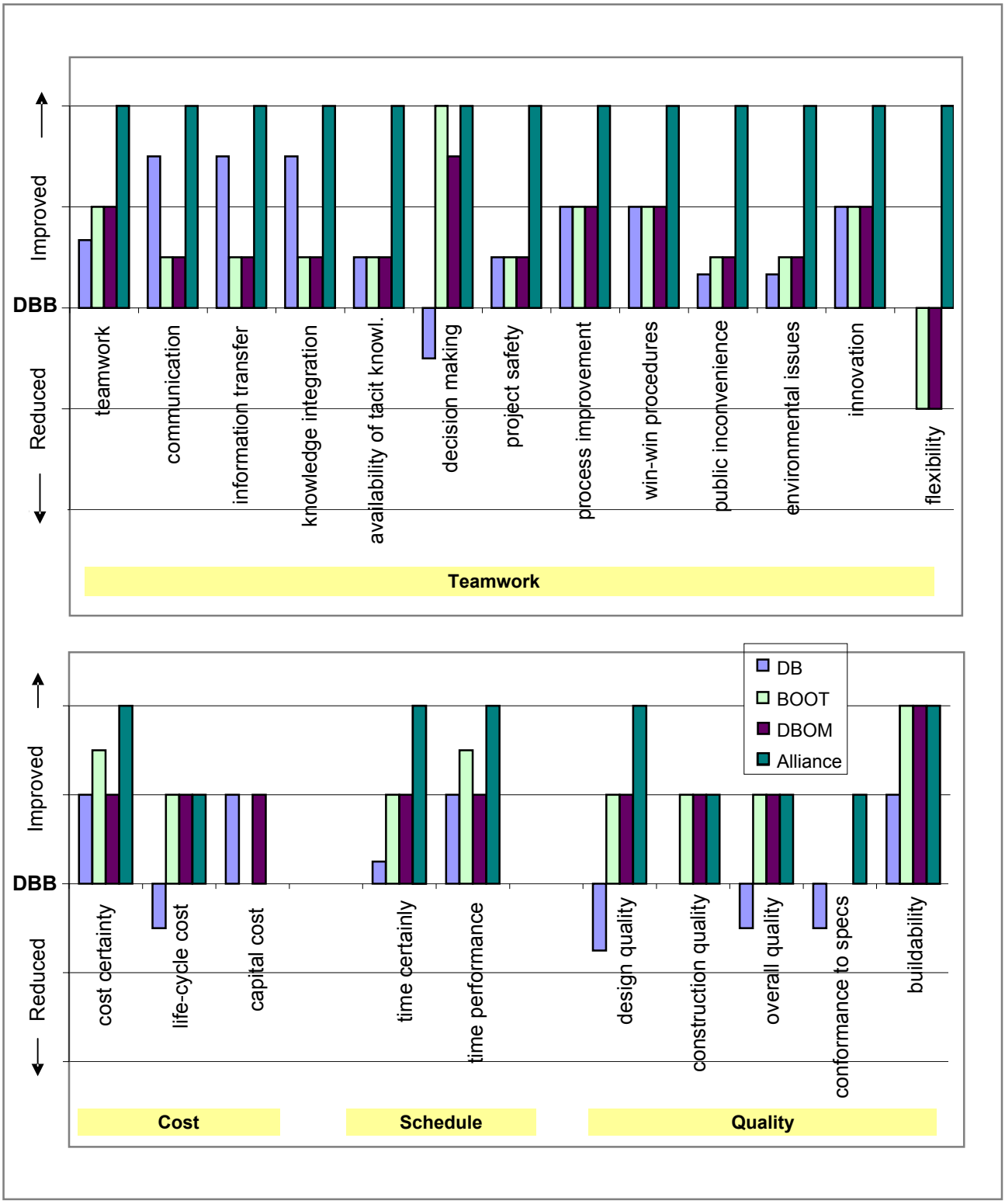

Figure 12. Summary on cost, schedule, quality and teamwork (Australia).

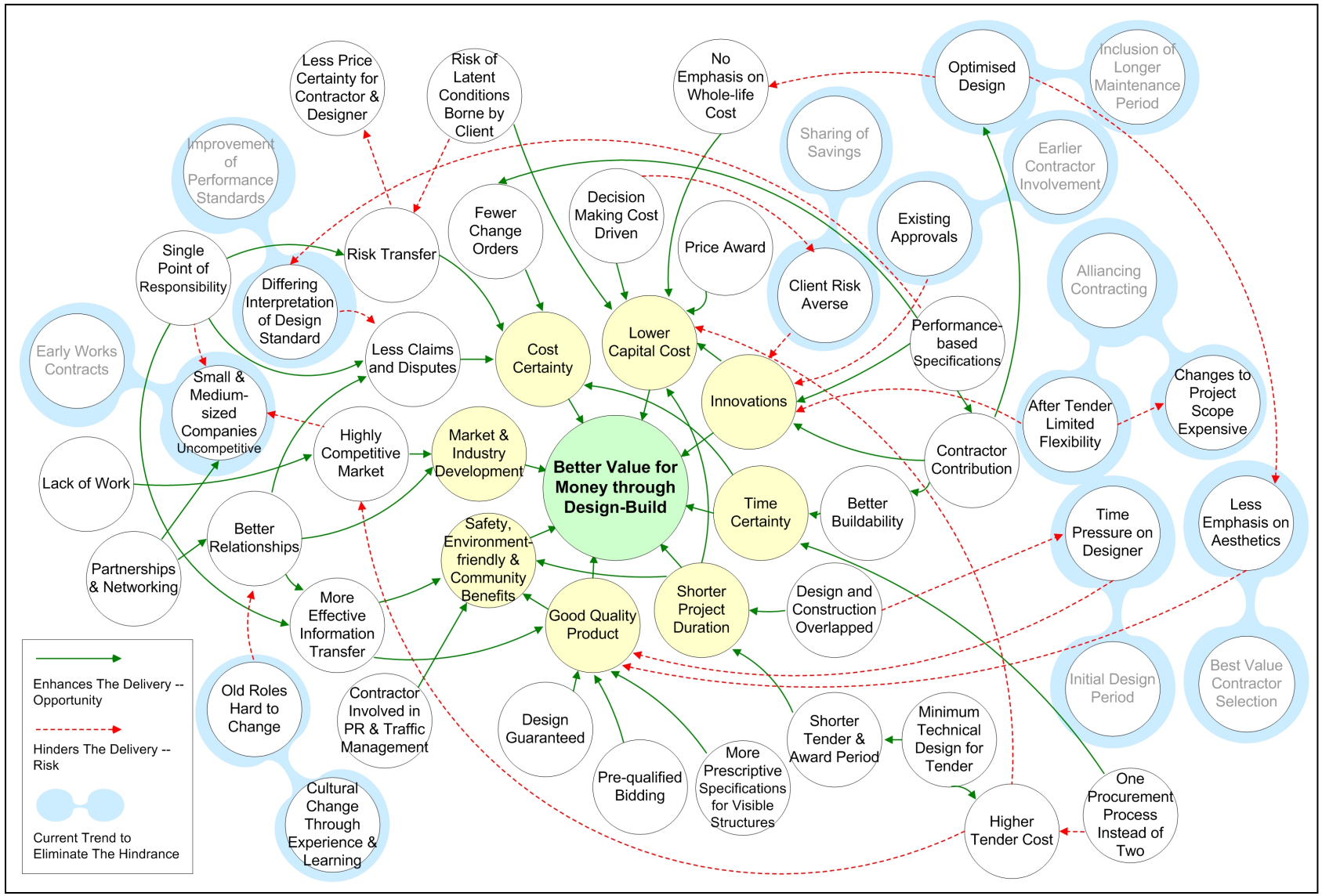

Figure 13. Value network of DB (Australia).

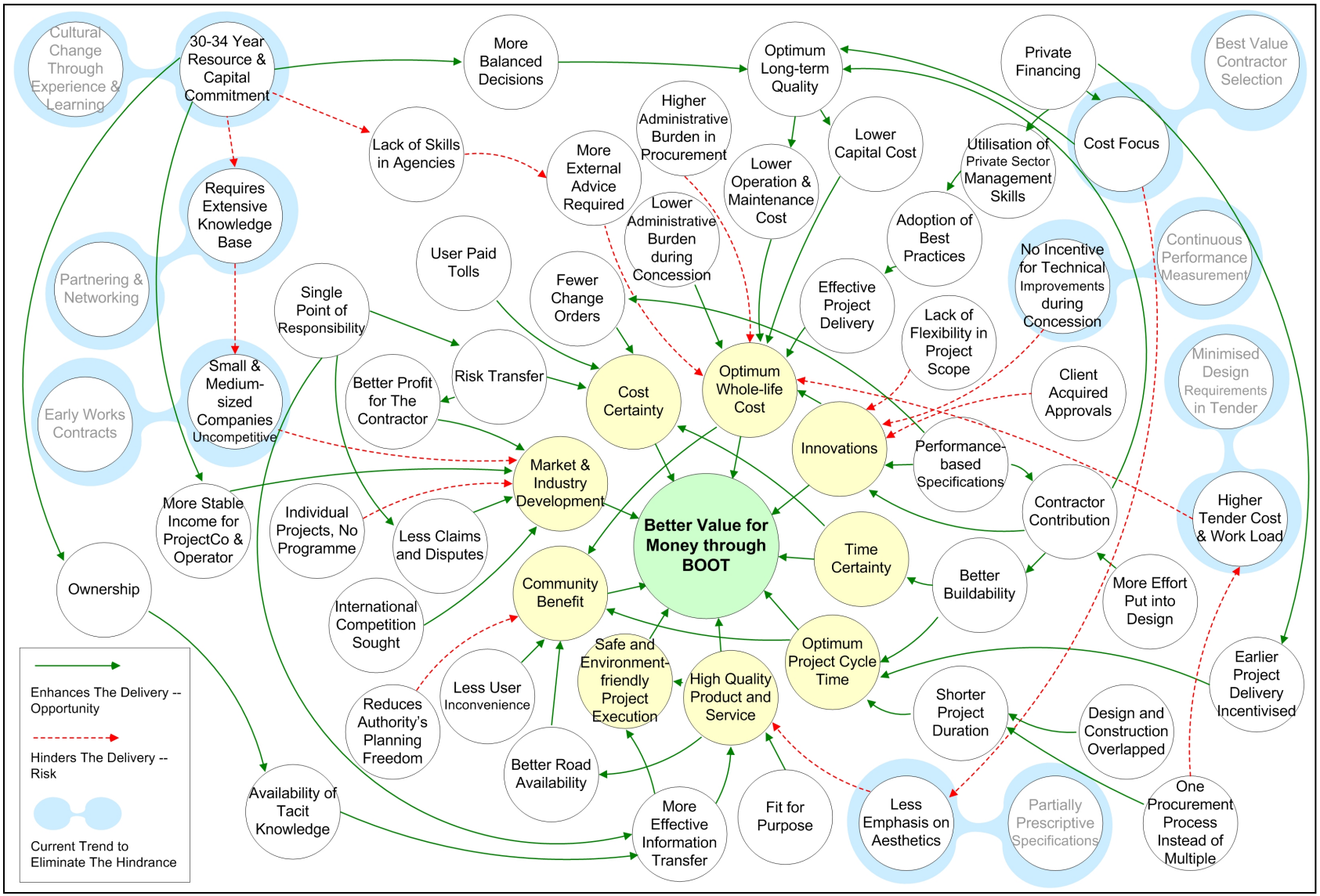

Figure 14. Value network of BOOT (Australia).

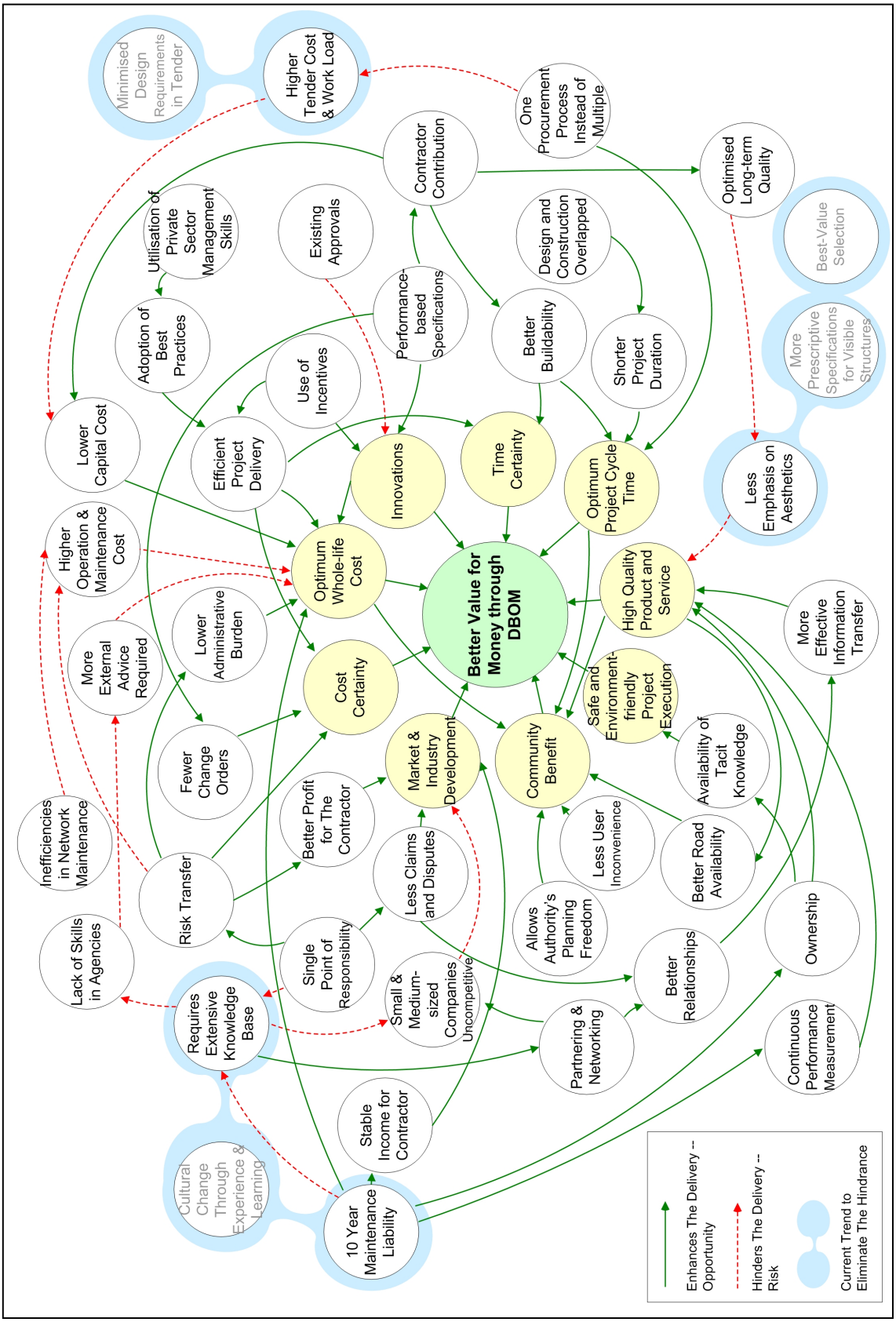

Figure 15. Value network of DBOM (Australia).

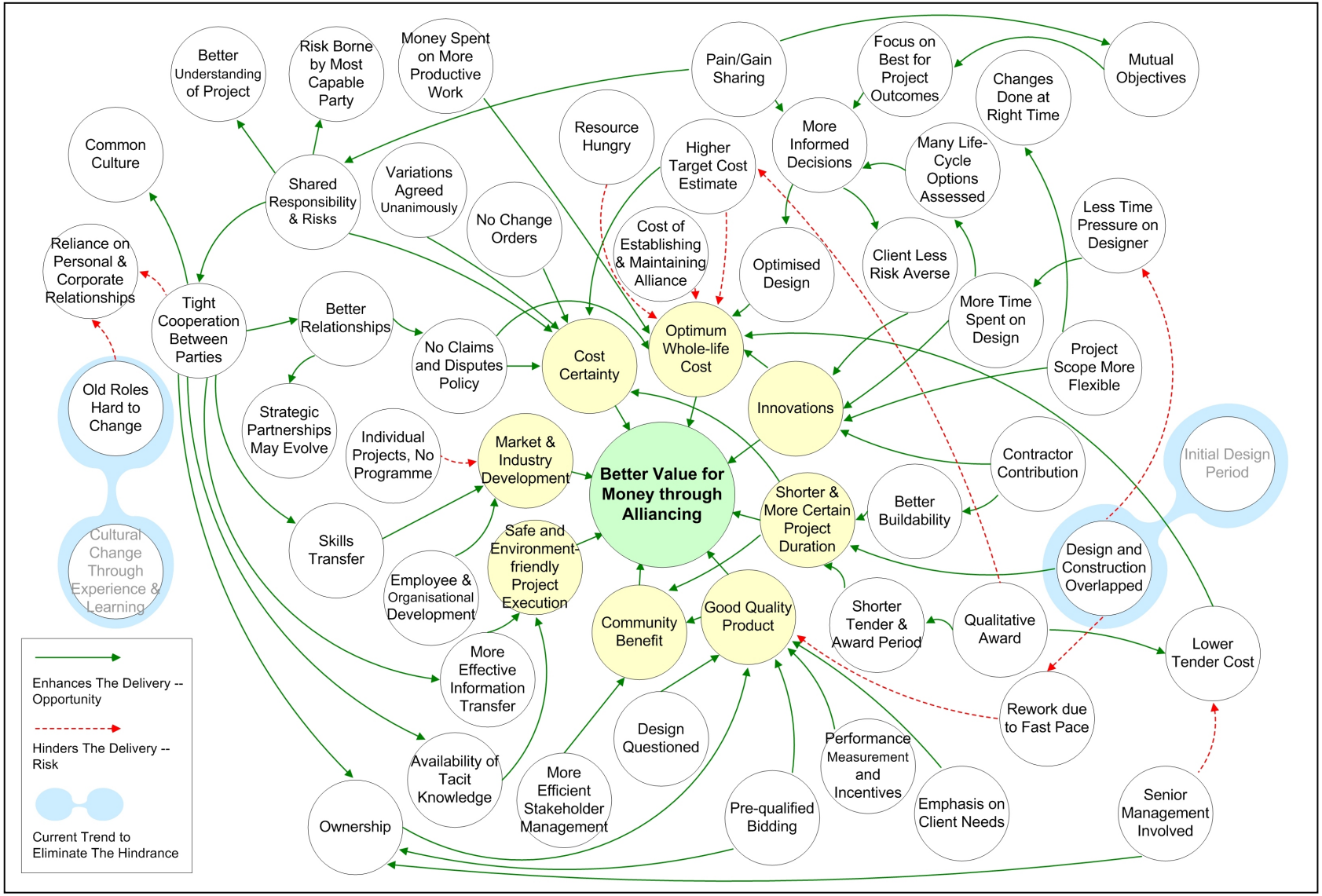

Figure 16. Value network of Alliance (Australia).

Table 35. Future improvements in Australian road procurement.

	Problems in procurement	Improvements
DB	Less emphasis on aesthetics	Best Value Selection, partly prescriptive specifications
	High tender cost	Reducing required design in tenders
	Time pressure on design	Initial design period
	Limited client flexibility	Alliancing
	Differing interpretation on specifications	Continuous improvement of performance-based specifications
	Small and medium-sized contractors uncompetitive	Early works contracts, partnerships
	No emphasis on life-cycle	Inclusion of maintenance period (DBOM)
	Lack of innovations	Alliancing, sharing of savings, earlier contractor involvement
DBM	Small and medium-sized contractors uncompetitive	Early works contracts, partnerships
	Less emphasis on aesthetics	Partly prescriptive specifications
	High tender cost	Reducing required design in tenders
	Little incentive to improve asset technically	Continuous performance measurement
	Cost focus	Best value selection
Alliance	Lack of competitive pricing	Client prepares adequate cost estimate before the project
	Probity issues	Documenting selection criteria and process properly
	Ensuring value for money	Assessing alliances to ensure value achieved

PART IV

USA

1. Market

The Federal Highway Administration (FHWA), an office of U.S. Department of Transportation, coordinates highway transportation programmes in cooperation with states and other partners, and provides financial and technical support to them for constructing, improving, and preserving the national highway system. State, local, and tribal governments own most of the Nation's highways. Each state has a State Highways Agency, usually known as the Department of Transportation (DOT) that manages and maintains major roadways in the state.

Road construction is funded through two separate sources: federal funds and state funds. Federal funds are often needed for investments. They are subject to strict rules which leaves little freedom to the client in terms of the project delivery method used. Federal requirements and specifications need to be applied. Federal funds cannot be used for daily maintenance. However, now the FHWA wants to encourage proper maintenance of roads and is piloting financing a contract that includes also maintenance. State funds, on the other hand, allow more flexibility for the client in terms of how the road is procured, but they need to be used for day-to-day maintenance, too.

The US market is more conventional than those of the UK or Australia. According to the interviewees, there still exists some inefficiency in the market. In smaller projects there has been adequate competition, but big projects have enticed only a few bids. The US industry has only a few companies capable of delivering large projects, as the companies are mostly relatively small. There is also a lack of competition in routine maintenance that has been largely provided by the State DOTs. Moreover, litigation between the contract parties is quite common.

So far project delivery has been relatively conservative. However, in major urban reconstruction the point has been reached, where major infrastructure needs to be rebuilt instead of building new. This is going to require shifting more risks and responsibilities to the private sector. Urban projects may require target cost arrangements and incentive contracts which are currently used in less than 5% of road projects. Thus, changes in road project delivery are expected.

2. Owner values

Each client (State DOT) has its own goals. However, generally the goals can be summarised as in Table 36.

Table 36. The clients' values and goals.

• economical construction • partnering – no claims • innovations • effective project delivery • safe project execution	• minimal adverse impacts on the environment • development of market • development of employees • user satisfaction

3. Project delivery methods used

DBB is, and will be, the most widely used project delivery method in the infrastructure projects. DBB is considered appropriate especially when the client wants to control the aesthetics of the project or wants a lot of public input. Generally, DBB contracts are awarded based on pure price competition. CM is seldom used in horizontal construction. However, there has been at least one large CM-at-fee project, where the CMr acted as the client's agent.

In many states, reductions in available resources, including limited funding, reductions in client staff, and additional constraints on staff time have created the need to find alternative contracting methods. As a result, the FHWA has implemented a Special Experimental Project-14 (SEP-14) program to encourage states to experiment with DB. Twenty-four states and several local highway agencies have evaluated DB as a part of SEP-14 /102/, but its actual use varies from state to state. While some states (Florida, Michigan, Utah, Pennsylvania) use DB extensively, some states (Iowa, Kansas, Louisiana) do not use it at all. Overall, DB is used in less than 1% of all road projects. However, as DB projects tend to be large, their percentage in terms of value is greater (5–10%). Since in January 2003 DB was ruled to be an officially allowed public procurement method /10/, the use of DB is expected to increase in the future with more projects in the $10–20 million range.

Even though DBM models have raised interest in many states, they are still not used without a few exceptions (e.g. New Mexico, Florida, Texas). Additionally, there are some pilots on toll highways and express lanes in major urban areas. However, use of these models is expected to increase in the future partly due to difficulties in public financing of infrastructure. At the same time more and more states look towards contract maintenance, integrated service contracts, and asset management contracts.

4. Industry experiences based on interviews

4.1 Design-Build

4.1.1 General

While most states (e.g. Massachusetts) selected a big project to start with ($100–500 million), in many states (Washington, Florida) DB is used successfully also in small projects. At the moment, 85% of DB projects are actually smaller than $50 million. According to some experts, DB is applicable to small projects, when there is a programme of projects in place. DB is also appropriate, when timing of the project and speed of the delivery are important or when there are alternative technical solutions. Especially replacement and upgrade of urban freeways are projects that benefit from fast delivery. Also, risk transfer may be sought through DB. Some states (Michigan) apply DB even to micro projects (signal installation worth $150 000) to achieve fast turn-around.

4.1.2 Project delivery process

Designer/contractor selection

While the clients consider the level of design in RFP to be 30%, service providers perceive that only the conceptual level is done (5–15%). Service providers emphasise the importance of well-defined scope and existing right-of-way. In some projects, a draft RFP has been issued for industry comments on the short-listed contractors. This is considered a beneficial practice, as the client receives feedback on risk allocations and project scope. The final RFP is then clearer and most of the issues are solved before the contract award. The client should also take responsibility for drainage plans, and do an extensive geotechnical investigation and a thorough assessment of utilities to provide an estimate of relocation costs, as the bidders do not have time for this type of assessments during the tender phase.

Today bidders are increasingly pre-qualified, even though expressions of interest (EOIs) are used in large projects. The number of tenderers varies, but generally 3–5 bidders are short-listed. As many projects have been very large requiring companies to create joint ventures in order to be able to bid, in some cases only two bids have been submitted. Thus, DB promotes competition in a somewhat limited way. To entice more competition, the losing bidders may be paid 8–33% of their tender cost as a fixed tender fee. The concern in many states is that out-of-state contractors out-of-state will win projects leaving the local companies without work. This is a difficult political issue and

the reason why the industry opposes DB. However, big companies do as a rule use local subcontractors.

While performance-based specifications are used according to the clients, in many cases the contractors consider these specifications a mixture of prescriptive and performance-based ones. Specifications are perceived to be strict and somewhat ambiguous, as they refer back to the generic, traditional design ruling that includes many ambiguous instructions. No specific level of design for the tender is required. Thus, generally 10–35% of design is prepared including basic geometry, bridge types, etc. The tender period is approximately three months, which is generally considered appropriate. However, according to some interviewees, in large projects with little design in the RFP, another month would facilitate bid preparation. The tender cost is 0.3–0.8% of the project cost. About one third of it is design costs. Often the designer bears part of the tender risk (around 40% of the tender design cost).

Often the client uses consultants to help with the procurement process. The first DB process is always expensive and time consuming, but with experience and existing documentation the process gets easier. Generally, the bidders meet with the client to present their bids. Some states are still restricted to price award, but best value award is increasingly used. Weighting of the criteria varies, but the Federal Government requires a price weight of at least 50%. However, as the price criterion requires the project scope to be well-defined, in some cases price emphasis has been inappropriate due to the ill-defined scope that has led to different interpretations of the scope and significant differences in bid prices. The client should also follow his procurement schedule to enable the contractors to plan their operations. The contract is a fixed lump sum contract, with a warranty of 1–5 years, one year being typical.

Design

The designers bear more risks than with DBB. Often the designer is a subcontractor with a fixed lump sum contract or a target cost contract including a share of savings/overruns. Lump sum contracts and inexperience in dealing with contractors have in many cases led to lower profit margins than with DBB. Thus, a joint venture provides a better status for the designer. The lead design companies are starting to accept more risks through 20–25% ownership of the joint ventures and a corresponding share of risks and rewards. As a result, designers can reduce their design fees and derive profits from the construction. The designer also has more interest in the performance of the project resulting in more cost-efficient design. The designer is also involved in management and decision making. Joint ventures are becoming more common, as they offer more opportunities for the designers to make a bigger profit than with DBB.

As it is important to complete adequate design before the construction starts, extensive design resources are needed to allow fast design delivery and to reduce rework. The main issue during the design phase is keeping the design on track with the aggressive construction schedule. As most design is developed parallel to the construction, a lot of pressure is put on the designers who are not used to it. To ensure timely design reviews and to minimise the risk of substandard design, all parties should have timely access to design, and the client should be allowed to 'look over the shoulder' to avoid spending time and money on redesign. More redesign is generally needed than with DBB.

Constructability of design is improved through contractor contributions. However, the contractor has to learn to deal with design decisions. Sometimes the contractor's strong position and pressure to minimise costs has led to design that does not necessarily meet the client standards. Moreover, contractors tend to make a lot of field changes after construction starts, as they are used to operate this way. Generally, owner input is valuable to provide feedback and clarifications and to enable the contractor to take advantage of the value-added suggestions provided by the owner /144/.

Construction

The main issue during construction is to keep the information going out to the field up-to-date and consistent. Due to problems associated with information transfer, contractors have ended up doing rework. According to the contractors, there should be better controls in place. Also, the contractor needs to have flexibility to organise the work in the most optimal way. As the most expensive cost component is equipment, it needs to be kept busy. The worst thing is a change that stops works. In DBB, the contractor may be able to recover losses from the owner, but in DB the contractor has to work around the problem. Contractor profitability is at the same level as with DBB due to the price competition that has decreased margins.

Even though local contractors may initially oppose the use of DB procurement, once they have worked as subcontractors they support DB move. Often in large projects more than half of the work is subcontracted to local contractors, and only managed by the main contractor. Selecting subcontractors is a very similar process to what the client does in DBB. To be competitive the bidders have to provide aggressive prices. The lowest bid is chosen with little potential for profit differential. Contracts are lump sum contracts that do not allow subcontractors to gain any advantages through changes.

Periodic maintenance

Generally, periodic maintenance is not affected by DB project delivery. However, many states have included a 5–30-year maintenance option in large DB contracts to improve the life-cycle focus of the project delivery. The goal is to improve maintainability of the road and to increase the contractor's 'ownership' of the road. When an optional OM is included in the contract, the contractor includes the price of OM in the tender, and the award is based on the evaluation of both phases, DB and OM. However, an OM contract comes to force only after the completion of the construction contract, and the client has can choose not to use the option. As the states have extensive experience on maintenance and well-equipped maintenance staff, outsourced maintenance is often considered uneconomic. Thus, by the beginning of 2004, no state had exercised the option. Generally, the contractors dislike this methodology, as they end up building something more expensive than they would without the potential OM responsibility. Moreover, some flexibility in design is taken away as the client is reluctant to accept the risks involved in innovative structures. The owner is not as hands-off as he could be with an actual 30-year liability on the contractor. The contractors prefer either clear DBOM or DB without options.

4.1.3 Risks and responsibilities

Generally, the risk allocation is considered appropriate. The client is responsible for environmental permits, right-of-way, and *force majeure*. Also, unexpected subsurface conditions and the risk from hazardous materials may be on the owner. Other risks are transferred to the contractor. However, some contractors complain about too extensive risk transfer, as they do not have extensive experience from risk assessment and pricing. Also, the designers take on more risks than traditionally but do not necessarily have the means to control or manage those risks. According to the service providers, environmental risks should be borne by the client. Also, the contractor's maintenance responsibility during construction is problematic due to the client wanting to direct the ill-specified maintenance work. Contractors often perceive that the client requires more from the private sector than the public sector would. If the client takes a more directing and prescriptive role in a project, he should share the risks with the contractor. In many cases, it is considered beneficial to allow the contractors to propose alternative risk allocations.

The problem with client permitting is that it is not really known, what is going to be built or how much land is needed. Thus, in some cases the contractor has been responsible for amendments to the environmental permits. However, the extensive time requirements and amount of work associated with the amendments have caused problems. Generally the client should be wary of transferring risks related to third parties to the contractor, as the client may be in a better position to deal with other

authorities. When these risks are transferred, the third party has to be willing to cooperate in an appropriate way in order to eliminate unnecessary delays or changes during the process. Agreements with third parties may be used to reduce risks during project implementation /144/. Also, dealing with third parties may be made a separate work from the typical DB contract due to the unknowns.

4.1.4 Project team

The project team with multiple stakeholders is very different from DBB and often makes the teamwork more difficult, especially, if the parties are inexperienced with DB. Environmental agencies and the client tend to have a process-perspective, the contractor is result-oriented, and the designer is in between. Moreover, the RFP is performance- and result-oriented, while the implementation, as often allowed by the client, may be process-oriented. Especially projects, where the designer is a subcontractor, have experienced problems in cooperation. The reason, according to the designer, is that he needs to do inexpensive and potentially inappropriate design which puts him in an awkward position. This has caused some inefficiency in design and added to design costs. Thus, the client should assess at the tender stage, what the relationship between the contractor and designer is, on what basis they will work together, etc.

However, in some projects, the teamwork has been very good as a result of successful partnering. Partnering is often used to facilitate cooperation and to address critical project objectives during the early project stages. Partnering includes commitment to mutual goals, an issue resolution process, and frequent, joint evaluation of team effectiveness /144/. Partnering involves also sharing of the project office throughout the project delivery which facilitates communication. Open communication is important to create a strong sense of trust between the parties. In some projects, there have been difficulties in communication between the designer and the client due to the contractor acting as a middle man. This has resulted in rework, because the client feedback is received too late in the process.

As decision making is largely transferred to the project team, it tends to be faster. Also, information transfer is better and more immediate than with DBB. Generally, effective information transfer requires use of electronic file transfers, a well formalised document control process, and electronic access to drawings. Overall, knowledge integration and availability of tacit knowledge are better than with DBB. However, due to the high stress levels experienced by the designers, there have been more changes than normally in the designer staff. Also, process improvements have been limited. While project safety may be slightly improved, the reduced public inconvenience is often mentioned as one of the largest successes. This is due to shorter project duration and strong focus on keeping the public informed which area result of placing the responsibility on the contractor and having dedicated staff. The contractors have also benefited as an

informed public is more flexible and tolerant. The importance of public inconvenience is increasingly emphasised in the project delivery.

Some interviewees also expressed their concerns over the subcontractors' position. Traditionally subcontractors are protected by the client, who ensures that they are paid timely. Often this protection is not available with DB. As there have been problems, according to the clients, future DB contracts will provide better protection for subcontractors. However, there are also benefits for the subcontractors, as the prime contractor does not require similar strict qualifications, insurances and bonds as the client tends to. This gives more opportunities for new and small companies.

4.1.5 Administration

Procurement is resource hungry and requires, on average, 35% more agency administration time than DBB. Part of the extensive time commitment in the first DB projects is due to educating the staff on DB, the performance criteria and how the client's role and overview will change. Even during contract administration, more resources may be required due to the diversity of the issues faced and to enable fast-paced delivery. It is sometimes difficult for the client to take an adequately hands-off approach. As a result, contractors have complained about clients not providing adequate flexibility for them to make decisions and to manage risks. However, generally the client's administrative burden is significantly lower than with DBB. The client's project organisation may be 33–50% smaller and the contract administration involves 5.9% less agency administrative time than with DBB. The reduction in client administration has come to the level, where the service providers actually feel that some projects might benefit from stronger client involvement, especially in the initial scope definition. In large DB projects, the client typically employs a consultant to manage and oversee the process. The cost of this additional advice is around 0.3% of the project cost.

4.1.6 Schedule

When one large DB project was reconstructed in order to assess the cost of traditional delivery of the same project, it was estimated that traditional delivery would involve five contracts and the cost of the project would be the same as with DB, but the time required would be more than twice with DB. Thus, DB accelerates project delivery by 30–50%. While the private sector needs to deliver projects fast to make a profit, in the public sector project delivery and the related additional bureaucracy tend to take more time.

Even though many projects have been finished timely or early, some projects have been 14% late. According to the clients, delays result from the contractors not being able to organise their project teams quickly enough, but according to the contractors, schedule

certainty goes back to the initial scope definition: the less the client defines the scope the greater the schedule risk. Also, incomplete permitting and land acquisition pose significant schedule risks. An additional reason for potential delays may be that often DB is used when creativity is valued. This introduces the additional uncertainty of timing and schedule. Also, timing of the contracts is important: design should be done during winter and finishing-off in the summer/autumn in order to allow final paving and marking.

4.1.7 Cost

While there have been both cost increases (up to 20%) and savings compared to DBB, DB projects have been completed mostly within budget. Risk transfer has improved cost certainty significantly. The minimal price difference between DB and DBB procurement is due to the companies bidding very aggressively in DB. According to the contractors, even though DB prices will be driven up due to the extensive risk transfer over the long term, if risks are allocated appropriately, the cost should still be less than with DBB. Generally, the construction cost is not significantly affected by the project delivery method, but there is some efficiency built into DB delivery that should lower the capital cost. Also, costs associated with design and construction interfaces are reduced /143/, and design involves only what is cost efficient, needed and constructible. Life-cycle cost may be slightly improved due to longer warranties or through an optional OM phase.

4.1.8 Quality

As projects are driven by the schedule, there is the risk that quality of design and construction are compromised. Opportunities for the normal cross checking between the disciplines are reduced. In some projects design quality has been ensured through a process similar to the client's traditional design review complemented with a rigid internal quality process. A faster delivery process is ensured by allowing only a few days for the review. At the 90% design level the client audits the design and issues an acceptance letter. After the acceptance, the DB team is still responsible for the performance and non-conformances of the product. In the long term, DB is expected to improve design quality as a result of the interaction between the designer and contractor.

As construction quality is ensured through standards, overall quality does not generally differ from DBB. However, as the client's project staff is small, he needs to rely on the contractor's quality control. Some interviewees felt that a lot of work has been allowed to proceed without appropriate quality control supervision, as the contractor has not been willing to spend adequately for the supervision. As a result, DBB may provide a

slightly higher quality product due to more time allowed to do the work and less cost pressure on the implementation.

The quality responsibility is slowly being transferred to the contractor. However, some states still consider this a violation of law: the same organisation should not construct and assure quality. Often the contractor is obliged to hire a third party to do the quality assurance. In projects, where quality responsibility has been successfully transferred to the contractor with the client only auditing the contract compliance, a quality council and weekly quality management meetings have been used to increase awareness of good quality work. Also, ISO certification may be used to ensure appropriate quality processes. The client should ensure that the oversight methodology is fully described in the contract to clearly define the roles, responsibilities and rights of both parties with respect to the oversight activities. As a primary tool for project oversight, an effective Compliance Audit Program could be implemented to monitor the contractor's project activities and to verify, on a sampling basis, the implementation of the governing contractual requirements. Compliance Auditing (see Figure 17) is a formalised technique, where an independent qualified professional takes samples of the work to verify contract compliance /144/.

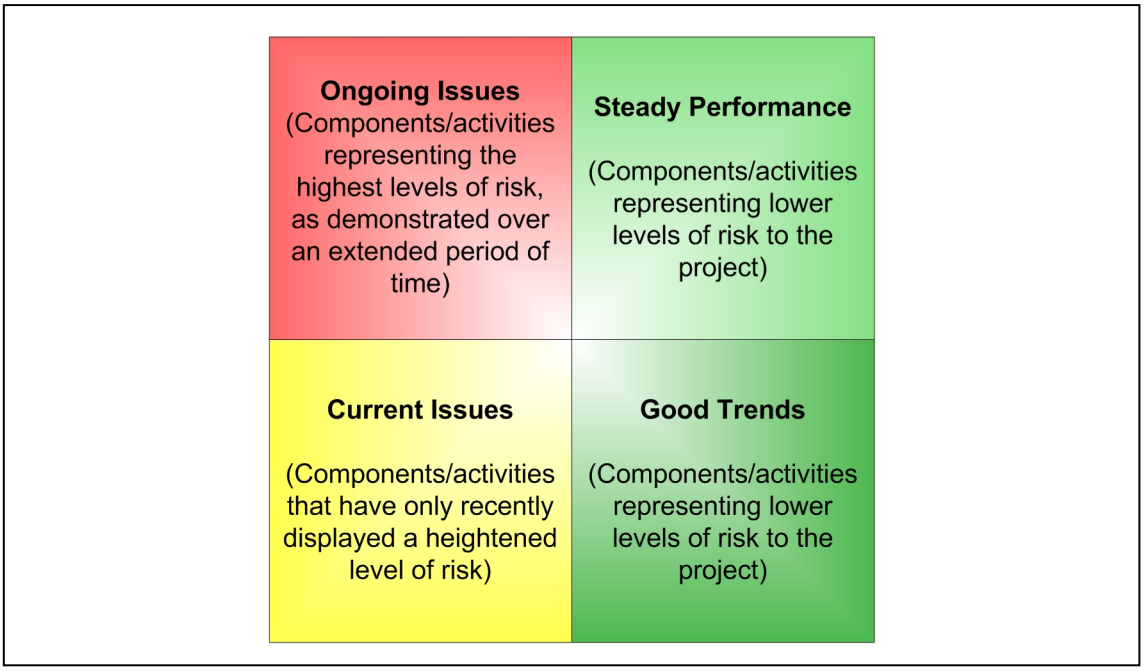

Figure 17. Compliance Auditing – Performance matrix /145/.

Even though it is generally considered difficult to ensure quality without a long-term commitment, the contractors are not willing to compete for project warranties, as they are not comfortable with the long-term responsibilities. A 5-year warranty is used only in a few projects. However, an optional OM period provides an extended road life, as

the owner is never focused on the maintenance to the degree the contractor is. This is also why there tends to be such a large cap between the bid price and the price the clients expect.

4.1.9 Change orders, disputes and claims

There are no extra work orders, and change orders have been minimal and significantly less than with DBB. There are also fewer disputes and claims than with DBB, as there are fewer interfaces. The companies selected tend to be large and successful, and defer from making claims in order to maintain their good reputation among the clients. Moreover, assessment of the claims history of the companies is one of the pre-qualification criteria. However, dispute resolution systems are generally considered inadequate, as a good dispute resolution system is important in order to solve issues quickly. As a rule, an independent third party could facilitate dispute resolution.

4.1.10 Innovations

There have been innovations that would be unlikely with DBB. DB has led mostly to innovations associated with construction management, as the contractor aims for faster delivery through quicker construction techniques. Also, most improvements have come from value engineering (VE). Generally, if the contractor comes up with cost saving ideas, he shares 50% of the savings with the client. If the client develops cost saving ideas, he retains 100% of the savings. This encourages the contractor to think of alternative ways of project delivery and the client to accept these alternatives. VE may bring 1% additional savings during project implementation. However, the most difficult task is agreeing on the value of the VE savings to be shared.

Innovations mostly happen during the tender period, when alternative technical components are encouraged. While some service providers consider the flexibility to innovate to be quite restricted, others consider the room for innovation to be adequate. Generally, road alignment can be changed ten feet vertically and two feet horizontally. To encourage innovations some clients use an industry review process during the procurement phase. This allows the bidders to suggest alternative configurations for the project. If the client accepts their suggestions, the suggestions are included in the bid. However, often the client tends to choose a traditional and perceivably less risky alternative. When the client pays a tender fee, he owns the designs of the bidding teams and ‘the best mix’ of these can be used to improve the selected design. However, due to schedule limitations, other teams’ innovations are seldom implemented. After the award, the window of opportunity for alternative designs is generally only three months, because the road geometry needs to be fixed. At the moment, the FHWA is looking into the possibility of involving the contractor earlier in the process to allow more flexibility and time for innovations.

4.1.11 Client satisfaction and project success

Overall, client satisfaction is high to excellent, even though problems have been experienced in some projects. The likely advantages and possible disadvantages of DB are listed in Table 37. Generally, the contractors see potential in DB delivery and are willing to tender for future projects. However, in the future they will likely select more carefully the projects they bid for, due to the experienced failures. The designers are not as happy with DB as the contractors. The designers, who have worked as subcontractors, prefer DBB over DB. However, the designers, who have worked in joint ventures, consider DB a good model to work with. Overall, the benefits of integrated design and construction are perceived to outweigh any experienced problems. The public perception has also been very good.

Table 37. Benefits and disadvantages of DB procurement.

Advantages	Disadvantages
• reduced project duration • single point of responsibility • reduced disputes and claims • optimised design • risk transfer to the contractor	• the client has less influence over the project outcome than in DBB • problems with quality • reduced competitiveness of smaller, local contractors • old roles hard to overcome

4.2 Design-Build-Maintain

DBM-type procurement is appropriate, when different technical approaches have different operating costs or when the client seeks financing on user basis. While DBM is not really used in road projects, almost all rapid transit projects/high-speed rails are delivered through life-cycle models. One of the reasons for not adopting DBM for roads may be that, by law, the FHWA cannot finance routine maintenance, which complicates payments arrangements in DBM. Also, as long as the public authorities are allowed to issue tax exempt bonds, fully private financing will not be economical. This is why US models tend to be managed by a quasi-public-authority that also has private parties.

Since the tender cost is high, keeping companies interested in the tendering may require paying tender fees. It is in the public interest to achieve efficient infrastructure delivery and to avoid monopolies in order to manage the cost of the infrastructure construction. A major benefit of DBM models is the increased productivity measured in terms of cost and public performance. However, it is inefficient to put all risks on the private sector. The private sector should bear enough design, cost, impact, and traffic risks to have the right incentives to act like the owner, but typically the client is in a better position to

bear large risks, as risk shifting to the private sector may be only illusionary. The payment mechanism selected creates incentives and allocates risks.

Some room for possible change should be provided in the contract. There should be incentives for timely changes, and penalties for changes that result from mismanagement. The current system tends to encourage costly changes, as there is a low qualification mechanism, a very high standard least cost bidding system, and a low standard change system. Instead, there should be a higher qualifying system in terms of creativity and innovations, and a more creative change system.

There may be more disputes and claims, as there are more independent parties involved. Often the reasons for disputes are permitting, rules and regulations, public considerations, differing geology, and failures in links between the parties. Thus, a lot of the uncertainties are related to institutional issues. These problems should be resolved fast and at the least cost. There should be a panel of legal and technical people independent of the project, who follow the project, so that, when disputes arise, they can quickly come up with a resolution.

5. Literature review on project delivery systems

5.1 Design-Bid-Build

The designer is responsible for the optimisation of design constructability. However, time and budget constraints and lack of construction experience limit the designer's ability to investigate and optimise construction means and methods. Often also the constructability review is done only after 85% or more of the design is done when time and budget are at the minimum. The net result is a design that is marginally constructible and gives no assurance that the project can be completed within schedule. Generally, the designer should focus on the design, while leaving decisions on means and methods for the qualified contractor, who is better able to optimise them. /105/

Traditional methods (CM, DBB) tend to inhibit private sector innovations, and the responsibility for implementing research lies primarily on the client /151/. However, some DBB projects have been very successful and innovative. Constructability has been improved by short-listing a few prominent contractors at the design stage and inviting them to participate in constructability reviews. Contractors are selected based on pre-qualification and allowed to submit their bids exclusively after participating in the constructability reviews and design finalisation. At first, contractors were reluctant to offer their constructive input, but partnering has encouraged them to perform a detailed evaluation of the plans, indicate potential construction difficulties and provide

suggestions for changes in the design and construction process /148/. Innovations may also be encouraged through alternative design options, pilot projects, value engineering, incentives/disincentives, warranties, multi-parameter bidding or lane rental arrangements /151/.

Some state DOTs (e.g. Arizona, California) use partnering extensively with substantial annual savings achieved /4/. Partnering has led to significant improvements in teamwork and cooperation. The project partners have ownership of the project, and there is consistency in the personnel throughout the project. The partners are committed to solving issues quickly and at the lowest possible level. This allows the contractor to participate in the field decision-making process and results in better decisions and improved productivity. Also, changes can be settled faster and by focusing on design intent rather than cost. Partnering has also improved safety performance and quality level. /148/

Often the contract is let to the lowest bidder. However, cost growth is significantly more likely, when the project is awarded to either an unusually low bid or to a certain type of bidder. As it has been shown that $7 in administrative costs are spent for every $1 awarded in changes or claims, the client should seriously consider the risks involved with the low bids. Moreover, other risks involved with the very low bids are that the contractor will not complete the project in time or to the specified standards. /134/

5.2 Design-Build

5.2.1 General

Owners most frequently select DB to shorten project duration. The other reasons are establishment of the cost, cost reduction, fostering construction innovation, reduction in claims, establishment of the schedule, large project size /72/, more efficient processes, and improved professionalism/quality /68/. Generally projects that meet the following criteria are appropriate for DB project delivery /102/:

- clearly defined scope, design basis and performance requirements
- free from complicating issues such as right of way acquisition, utility conflicts, hazardous materials, and environmental concerns
- non-controversial in nature
- room for innovation in design and construction
- tight time constraints
- involves a significant design effort with potential to save time and money and
- requires expertise not available in-house in the client organisation.

Pre-qualification is used to select prospective bidders /8/, who are provided 0–50% of the design, including mandatory requirements, in the RFP. Currently the trend is towards reducing the amount preliminary design /146/, but the client needs to clearly define the scope of work and the performance-based specifications /29/. Performance-based and prescriptive specifications and their different combinations are used equally /8/. Significant benefits can be derived from having the short-listed bidders review and comment on the draft RFP before tendering. Particular specifications or requirements may be identified that drive the cost, are potential 'deal killers' or might otherwise force qualified bidders to drop out. The review typically results in a better RFP and a better project for all concerned. The process will result in fewer ambiguities in the documents and should reduce contingencies in the pricing of the proposals. Also, early knowledge of the RFP allows the bidders to jump-start their bid preparation /146/.

The bidders tend to be larger companies than with DBB. The tender cost is about 0.3% of the project value, while preparation of the pre-qualification submittals may cost 0.05% of the project value /149/. The tender cost is increased by 300–400 % compared to DBB /29/. The size of the tender fees (stipends) has varied, but has most often been 0.1–0.2% of the contract value covering approximately 50–66% of the tender cost /68/. Payment of the stipends to unsuccessful proposers has provided the client access to the bidders' innovations, which can be applied in the project. In general, the stipends encourage more participation and competitive pricing, promote innovation, and improve project quality and delivery /29/.

Based on the award process, there are four categories of public-sector design-build procurement (see Table 38). Due to the low design level in the RFP, low-bid selection is difficult to use, since the bids cannot be compared accurately. Thus, the use of a combination of price and qualifications is the primary selection method usually accomplished through a weighted scoring system /8/. About 63% of projects have been awarded based on this type of best value criteria, while 37% have been awarded based on the bid price /69/. When best value award is used, typically the contract is awarded to the company that provides the best value offer considering four major criteria: cost of the project, quality of the proposed design/innovations, time required to complete the entire project, and management capability of the bidder. The best value award encourages innovation and allows contractors to optimise their work force, equipment and schedules /29/.

Table 38. Primary categories of public-sector design-build procurement methods /8, 9/.

DB-category	Bridging	One-step	Two-step	Qualifications
Description	The standard process used in DBB (Lump sum, sealed bidding)	Competitive evaluation of technical proposals	1) Technical proposals received, bidders pre-qualified. 2) Qualified bidders submit bids.	Contractor selected through competitive negotiations
RFP design	30–50%	0–50%	0–35%	0–10%
Pre-qualif.	No	No	Yes	Yes
Selection criteria	Price	Price or technical + price	Technical + price	Qualifications or technical + price
Contract	Lump sum	Lump sum	Lump sum	Negotiated
Use		50% of projects	37%	13%
Cost growth		4%	3%	5.6%
Time growth		3.5%	2%	3.5%
Conforms to specs.		4.9 (out of 6)	4.6	4.5
Admin. burden		2.2 (out of 6)	2.6	4.8
Client satisf.		4.9 (out of 6)	4.9	4.5
Advantages	• Client has control over design, but transfers risk of errors and omissions in detailing to contractor • Allowed by most States • Facilitates tender preparation	• Allows award on best value • Design exceeds minimum specs • Product most closely conforms to user expectations • Facilitates tender evaluation	• Allows award on best value • Short-listing saves client & bidder time & money • Offers design alternatives • The best budget, schedule & overall performance	• Allows award on qualification • Can be negotiated in a single step • Requires the least design information • The least burdensome on client administration
Dis-advantages	• Risk of differing interpretation of plans • Loss of innovation • Multiple bids: costly to prepare and evaluate • More change orders • Risk of ill-equipped company winning	• Burdensome to evaluate • Greatest chance of delays due to protests from losing bidders • Costly tendering • Requires a lot detail in the RFP • May lead to selecting a bidder with poor cost and time performance	• Technical and design review process can be lengthy • Chance of delays due to protests from losing bidders during technical evaluation • With low bid award low-bid problems exist • More burdensome on client administration	• Selection may not consider scope • Evaluation of techn. proposal lengthy • Chance of delays due to protests • Intensive client design staff involvement • Lack of competition • May lead to cost growth
Other comments	Most like DBB. Simple projects.	Mostly used. Resembles DBB. Problems with defining quality.	Large and complex projects. Selection criteria have to be clear.	When limited number of qualified bidders. Not often used.

5.2.2 Risks and responsibilities

Risks should be allocated to the party who can best manage them. However, risk allocation depends largely on project goals. When cost certainty or schedule is one of the most important goals, the client may prefer to transfer risk to the contractor even though it will involve a risk premium /68/. While DB assigns a much greater risk on the contractor, the client should try to limit the risks by managing high-risk items such as right of way and environmental clearances /29/. Risks that are generally perceived as the most problematic for transportation projects include right of way, utilities, differing site conditions, hazardous materials and *force majeure* events /68/.

5.2.3 Project team

DB largely benefits from partnering, and the partnering process has an excellent chance of succeeding in a DB environment. Thus, a majority of state DOTs practice partnering to some degree. Partnering has resulted in increased communication, alignment of goals, development of dispute resolution systems, a significant decline in claims and savings in contract administration costs /109/. Also, pre-qualification of bidders, who have a proven track records with budget and schedule performance, has improved project performance /8/. However, due to the shorter schedule, DB projects tend to have more minor accidents but fewer major accidents compared to other contracting approaches /102/. At the same time, some clients report DB projects introducing a heightened awareness of safety /64/.

The DOTs are beginning to recognise their responsibility to communicate directly with the people affected by their work. Especially in urban areas, strong public relations programmes are deemed critical to project success. Often the responsibility to communicate to regional and local levels has been successfully transferred to the contractor. /118/

5.2.4 Administration

The procurement process requires extensive resources for a relatively compressed period of time during the RFP development and tender evaluation stages, which could make scheduling challenging, if multiple DB projects are ongoing simultaneously /2/. Overall, though these is less client administration with DB than with DBB /152/, and the cost of construction administration, inspection and testing is 26% less than with DBB /2/. The reduction in personnel requirements concerns mainly technicians and lower level engineers /64/. While less than half of the administrative support staff needed in DBB is required, the staff needs to be more senior due to the nature of the decisions being made and the urgency of these decisions in the fast-track environment /2/.

The successful public clients have removed the management of DB projects from their normal organisations and created small, separate offices with specially selected individuals that embrace the concepts of DB. The staff administering the contracts needs to fully understand and support DB, the new and different responsibilities of the contractor and the client's role in oversight of the implementation. Also, continuity of personnel is important /146/. Some concerns have been expressed about the possibility that the use of DB diminishes the agencies' level of design expertise /29/.

5.2.5 Schedule

Even though in 73% of cases the contractor is hired with 25% or less design developed, 77% of the projects are within 2% of schedule showing significant time certainty /8/. As the construction can begin at the 0–50% design level /102/, duration of design and construction are also reduced /150/ generally leading to a 33% shorter duration than with DBB /152/. Some findings indicate that a DB project may reach completion 16–71% faster than a DBB project. Generally, the smaller DB projects provide greater time saving opportunities than the large ones /69/. To encourage good time performance, almost all contracts include liquidated damages. Early completion incentives are not rare, but not universally provided either /68/.

Interestingly, even though it takes longer to prepare the proposal documents for a DB project which lengthens the procurement stage (380 days on average), this is more than offset by the length of the design contract in DBB (average 685 days). Moreover, DB moves approximately at the same pace during construction (average 661 days) as DBB (average 647 days) even though the design time is running concurrently /152/. Generally, construction speed can be improved by 12% compared to DBB and delivery speed by 30% /5/.

5.2.6 Cost

Even though in 73% of cases the contractor is hired with 25% or less design made, 59% of the projects are within 2% of budget showing significant cost certainty /8/. However, some cost growth (-14–9%) may be experienced, the mean value being -1% /69/, which is a significant improvement from DBB, where cost growth is approximately 10% /152/. DB projects tend to be awarded for the same amount as DBB projects, even though they involve greater risks and design to a 100% level /69/. There have been both cost increases and savings compared to DBB. Some clients report non-traditional methods resulting in savings of 5–40% compared to the average traditional low-bid contracts /102/. In small bridge projects DB has led to up to 45% savings, with significant savings achieved in design (76% savings of the traditional cost estimate) /147/. Generally, unit costs may be 13% lower than with DBB /5/. Also, labour costs tend to be lower, but at the same time there are greater fluctuations in quantities and productivity. The key

factor in increasing productivity and reducing cost is the elimination of duplicated efforts, particularly in quality control/assurance /29/.

In relatively many cases, though, the cost of the DB project has been 10–60% higher than the traditional cost estimate. This higher cost may be driven, in part, by extremely aggressive schedules /64/. Also, novelty of the delivery system may lead to inefficiencies and increased costs that outweigh potential benefits /2/. However, there is a general perception that the contractors benefit from DB project delivery as they can earn higher profits than with DBB. Profit may be 3.5–9.4 percentage points greater /13/.

5.2.7 Quality

The quality of the majority of projects has met or exceeded the client's expectations /8/ comparing favourably with a DBB project of similar size /69, 2/. However, views on the quality are somewhat mixed /29/. According to some literature, there is not much difference in the quality between DBB and DB /152/, while some clients report quality problems with DB. These clients aim to ensure quality by increasing the size of the quality staff on the project, conducting a testing programme equivalent to 10–20% of job control testing, and monitoring quality issues, such as compliance with procedures that cannot be measured by testing /64/.

Even though the best value concept along with extended warranties are generally considered appropriate in large and complex projects, warranty clauses may also be viewed unduly expensive, of limited value on standard-type projects and difficult to enforce by the designers and constructors. However, the warranty clauses are believed to have a positive effect on project quality and reliability and to help build trust between the client and the contractor. Use of 5-year warranties has reduced requirements on the client personnel, delivery costs and overall construction costs /147/. Warranted pavements perform better than similar non-warranted pavements /102/. There have been no disputes. Warranties have encouraged innovations and new technology has been implemented. Also, the contractors support warranty programmes, even though warranties limit the opportunities of small contractors to bid /147/. A warranty provision can also be in the form of maintenance responsibility of multiple years (DBOM) /29/.

5.2.8 Change orders, disputes and claims

DB projects have resulted in only 0.6% /69/ – 1% /2/ worth of change orders which is about 1/10 of the changes with DBB. All change orders should not be considered negative, if the intent is to improve the finished product and to promote innovations. Thus, occasionally there have been more contract modifications than with DBB, but these are primarily cost savings for the project. However, where extra work or changes are warranted, negotiations on unit prices often become a cumbersome task which may

lead to possibly higher costs for the owner. Thus, it is necessary to ensure the accuracy of the scope or predetermine the unit prices in the contract /29/.

From the client's point of view one measure of quality is the absence of claims. When the designer and contractor are jointly responsible for the overall quality of the final product, the potential for disputes and litigation between them is diminished /29/. Thus, claims have been reduced to less than 1% of change orders /64/. DB produces also fewer professional liability claims against the designers. The front-end decisions on the composition of the construction team are important in establishing a favourable atmosphere and reducing claims /87/.

5.2.9 Innovations

Even though the low design completion level at the time of selecting the contractor should lead to innovations and design/construction integration efficiencies /8/, in some cases, due to the tight schedule, innovations have not manifested themselves with the exception of traffic maintenance /64/. Also, when design specifications are very narrow in scope, innovations and cost savings tend to be hindered /29/. However, DB has potential for innovations, since partnering, value engineering, incentives/disincentives and performance specifications are generally perceived to be the best contracting and procurement approaches in promoting innovations. They are also integral parts of DB /151/.

5.2.10 Client satisfaction

The clients are satisfied with DB /8/ which has brought benefits that outperform experienced disadvantages (see Table 39). As the contractors can earn higher profits, and the clients can expect less cost and schedule growth, everybody wins /13/.

5.3 Design-Build-Maintain

Even though some roads have been delivered through DBOM, the industry tends to oppose longer than 10-year maintenance responsibilities. In DBM, the private sector faces political, financial, construction, operational, and market risks. Generally, the construction and operation risks are considered manageable, as they can be minimised by contracting out responsibilities and using well-proven technologies. However, the political, financial and market risks are considered more difficult /141/. DBM has brought benefits through innovative solutions that have improved construction efficiency and quality. User inconvenience has been kept reasonable, and projects have been completed timely.

Table 39. The advantages and disadvantages of DB. /87, 37, 8/

Advantages	Disadvantages
• single point of responsibility • accelerated project delivery • utilises designer/contractor synergies • allows multiple design alternatives • availability of performance guarantees • avoids adversarial relationships • establishes price early • requires less client supervision • increased constructability • less change orders and claims • innovation • allows warranties promoting better quality	• requires the client to fix his needs early and in considerable detail • leads to a complex and potentially subjective selection process • proposal preparation is costly • client must commit himself to the contract before all design details are known • client's strict design control is not practical • client's review/approvals must be timely

6. Summary on USA project delivery

The road sector in the USA is still somewhat conventional in the way services are procured, despite the trend towards adoption of new procurement methods to improve service delivery. DBB is the most widely used procurement method and is expected to keep its status into the future. It is perceived to work well, and the industry and clients are used to it (see Table 40). CM is used only exceptionally, but in the future construction consulting is expected to increase. At the same time, some states are increasingly using DB project delivery. These clients consider the opportunities of DB to well surpass its potential disadvantages. DBM is not used except in a few pilot cases, but the interest for it is increasing as public infrastructure financing is expected to become more constrained in the future. In the future, the project size will grow slightly and the responsibilities of the contractors will broaden. Through effective procurement the client aims to reduce his own resource requirements and project cycle times. However, changes in procurement place extensive requirements on the industry and client. Thus, cultural change and training are required.

Low bid is the most common award criterion (see Table 41), even though best value award is used increasingly, especially with DB. Also, pre-qualification is considered increasingly important to eliminate potential quality and relationship problems beforehand. DBB involves prescriptive specification while more performance-based specifications are used in DB projects. Generally the clients consider the current performance-based specifications adequate, but some contractors consider them still too prescriptive. The development of better performance-based specifications is continuing in many states.

Table 40. Future applicability of the project delivery methods in USA.

Factor	DBB	DB
Client satisfaction		Medium to high
Contractor satisfaction		High
Willingness tender to	Yes	Yes. Some resistance exists.
Main advantages	Well known and accepted delivery method	Single point of responsibility, less work for the client, risk transfer
Main disadvantages	Slow, no emphasis on life cycle, uninnovative, no contractor input in design, high administrative burden for the client	Barriers between designer and contractor, old roles, additional resources and expertise needed
Applicability	When the client wants to control project delivery	Large projects or when timing of the delivery and speed is the key

Table 41. Summary on USA procurement processes.

Factor	DBB	DB
Design completion		
in RFP	100%	5–50%
in tender	None	10–50%
at start of work	100%	0–50%
Specifications	Prescriptive	Performance based or mixed
Award basis	Open competition	Prequalified bidding
Award criteria	Price	Best value (weighted, price at least 50%) or price
Pricing	Unit prices, remeasurement	Fixed price
Risk transfer	Client carries most risks	Contractor carries most risks
Innovations		Price & time focused
Warranty/ Concession	1 year	1–5 years

DB accelerates project delivery by 30–50% compared to DBB (see Table 42). Time certainty is also improved as many DB projects are completed timely or early. In cost terms there have been both cost increases and savings compared to DBB, but mostly DB projects have been on budget. Additionally, risk transfer has improved cost certainty significantly (see Table 43).

Project partnering is used widely to facilitate project delivery. The partners share an office during project execution which facilitates communication and cooperation (see Figure 18). Partnerships have generally been successful, and partnering is embraced with any project delivery method. However, the importance of continuous partnering is emphasised, as often partnering fades away after the project initiation.

Table 42. Summary on USA schedule issues.

Factor	DBB	DB
Schedule		
RFP preparation		1 month
tendering period	1–1.5 months	3 months
design		6 months before construction, in total 1.5–2 years
construction		Same as DBB
total duration	2–3 times DB. 1 year longer.	16–50% shorter than DBB
Time overrun	30.7%	77% of cases within 2% of schedule. 25.6% early…14% late.
Agency burden	6% of project cost	33–50% less work than DBB. 4.5% of project cost.
procurement		Extensive resources required. 35% more than DBB.
contract admin.	Requires extensive client inspection/supervision	6% less than DBB. 50% of DBB staff. More senior staff.
design	More than DB	
construction	More than DB	
maintenance	Same as DB	If optional OM, less than DBB

Table 43. Summary on USA cost issues.

Factor	DBB	DB
Tender cost (contractor)		0.3–0.8% of project cost. 3–4 times higher than DBB.
Costs of the client		10–60% more…5–40% less than DBB
procurement	Lower than DB	RFP development 2.7% of project cost. Evaluation cost more than DBB. Stipends 0.4% of project cost.
contract admin.	Higher than DB	1.6% of project cost. 26% less than DBB (includes supervision)
design	9–10% of project cost	8–10% of contract cost. 24–106% of DBB.
supervision	10% of project cost	Lower than DBB
construction	71% of project cost	89–91% of contract cost. Same as DBB. Labour/unit cost lower than DBB
maintenance		Same or lower than DBB
external adv.	Not used	Higher than DBB (0.3% of total cost)
Cost overrun	8–12%. Cost underestimated in 90% of projects.	59% of cases within 2% of the budget. Mean saving 1%.
Profit		
designer		Lower than DBB
contractor		0–3.5% higher than DBB
Value of redesign		More than DBB
Value of change orders (of total cost)	6–14%, changes less substantial	0–2.2%, often savings
Disputes	More than DB	Some, minimal
Claims	Some	Minimal, 1% of change orders

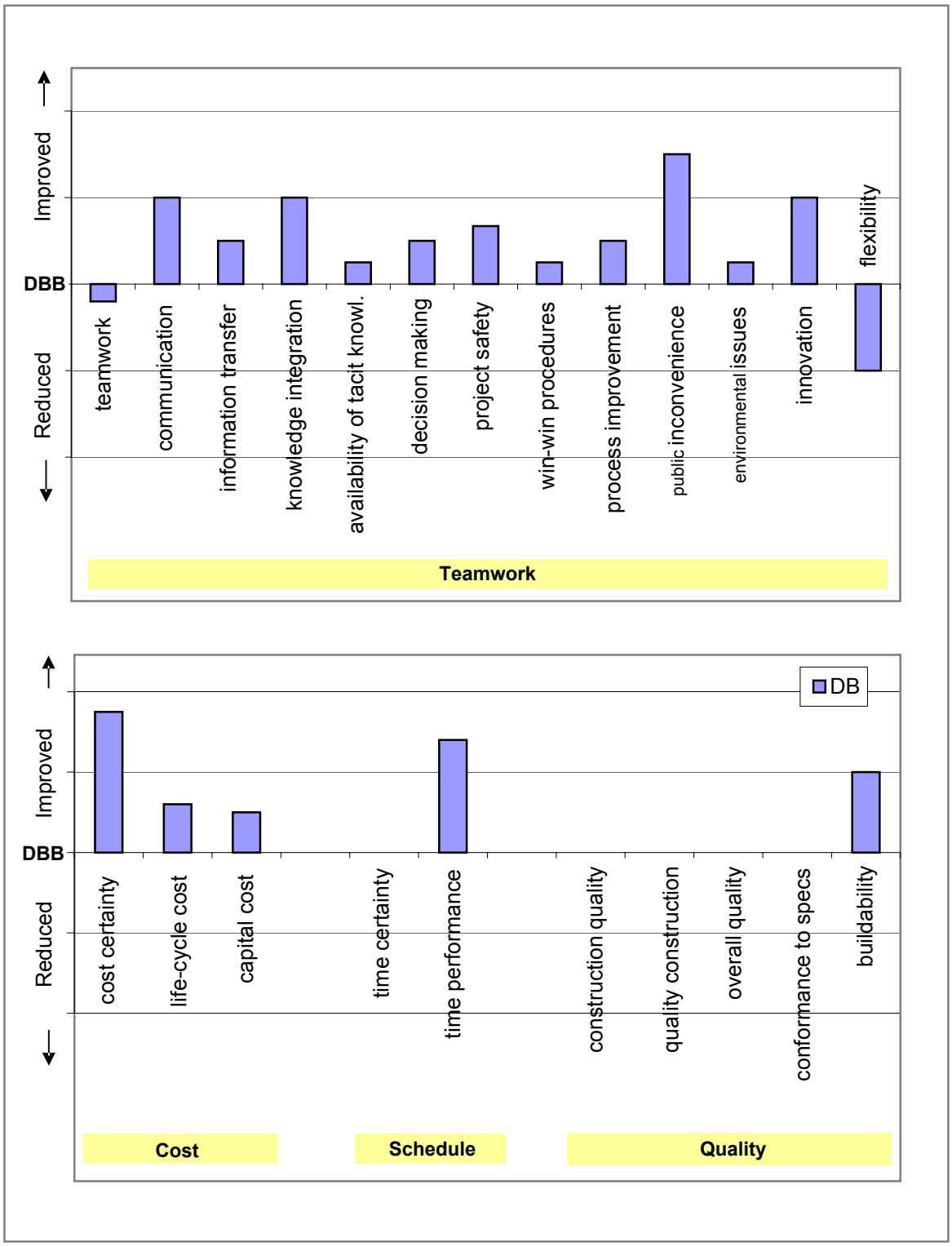

Figure 18. Summary on cost, schedule, quality and teamwork in USA.

While quality with DB is generally perceived to be of the same level as with DBB, there is a risk that the quality of design and construction may be compromised due to the tight timelines and cost emphasis. As a result, the quality responsibility has not yet been fully transferred to the contractor. Even though DB, in principle, offers potential for innovation, permitting and technical specifications, client resistance due to risk reluctance and time limitations often reduces the number of innovations.

Overall, DB is considered an effective project delivery method. The value network of Figure 19 was produced for DB based on the interviews in the USA. In the value network the yellow, coloured circles in the middle depict client values, while the white circles depict factors affecting project delivery in meeting client values. The green, solid arrows illustrate the facilitation or improvement of the subsequent factor, while the red, dashed arrows illustrate the hindrance caused to the subsequent factor. Blue shadings depict a trend or change adopted or suggested to decrease the detrimental effect of the factor. It seems that in the USA market there are still many hindrances to the process that have been largely recognised. As a result, changes to road procurement have been planned in order to enable better project delivery in the future (see Table 44).

Table 44. Future improvements in road procurement in the USA.

	Problems in procurement	Improvements
DB	Inadequate emphasis on qualitative parameters	Best Value Selection, pre-qualification
	High tender cost	Reducing required design in tenders, standard documentation, pre-qualification
	Inefficiencies due to professional division	Cultural change, experience
	Designer position unfavourable	Joint ventures, designer/contractor relationship assessed at the tender stage
	Lack of life-cycle emphasis	Optional OM period, longer warranties
	Lack of innovations	Early contractor Involvement, partnering, sharing of savings
	Excessive quality monitoring	Contractors' quality responsibility, less client quality monitoring

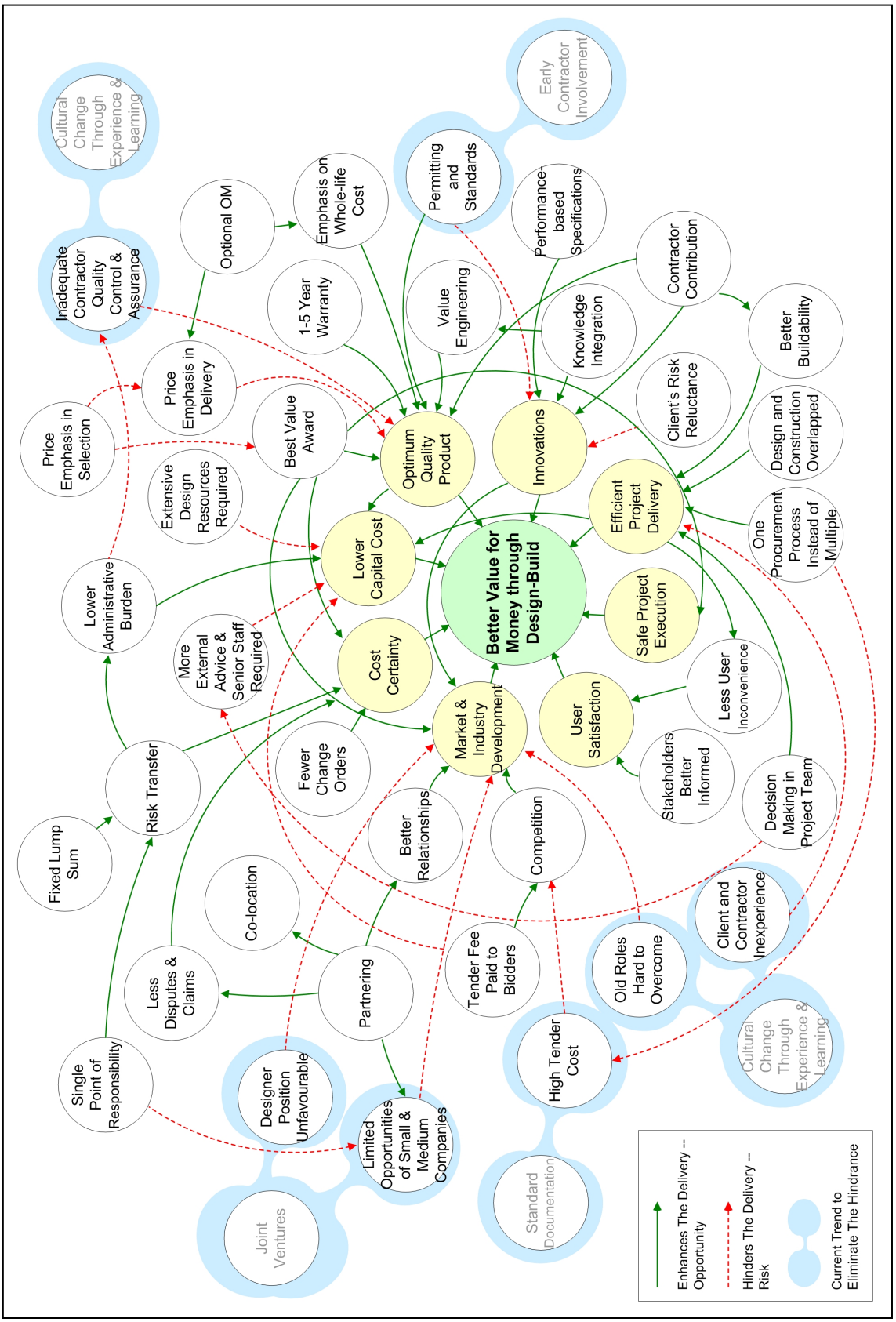

Figure 19. Value network of DB (USA).

PART V

OTHER

COUNTRIES

1. New Zealand

1.2 Market

In New Zealand, road administration and production are separated. The major client, Transit New Zealand, is required to outsource the development and delivery of all capital and maintenance projects according to the competitive tendering initiative adopted in 1995. There are enough capable contractors in the market to drive competition, while smaller contractors often operate mainly as subcontractors. The contractors are knowledgeable in traditional procurement, but have somewhat limited experience in DB. Especially lump sum pricing and the associated risk transfer are new to them. Qualitative criteria are used extensively in contract award. Also, use of performance-based specifications is increasing. The clients aim to get the designers and contractors to work more closely together in order to encourage innovations. They also aim for a competitive market, good quality service, optimal risk allocation, and improved risk management and project development /117/. Partnering is, and will be, used extensively. Moreover, it is expected that the more integrated future transportation systems will increase project scope and size encouraging use of DB and alliancing.

1.3 Project delivery methods used

Transit's goal is to use DBB in 60%, DB in 35% and full delivery (alliance) in 5% of road projects. However, today only about 20% of the projects are procured through DB and alliancing is just being piloted. Alliance is used only in complex or fast tracked projects that are larger than NZ$40 million. Project size and complexity are determining factors also in selecting DB. Generally the project should be larger than NZ$20 million and risks should be quantifiable and best managed by the contractor. The project should allow alternative solutions and potential for innovations. There also needs to be a number of DB projects to provide tenderers an opportunity to recover their tender costs. Generally, the smaller clients tend to use only DBB, as the scale of their projects is not conducive for DB. Traditional delivery is used in relatively small and easy projects with standard specifications, and no opportunities to innovate. DBB offers opportunities for companies, which lack the expertise and/or financial support for DB.

Pre-qualification is not used, but generally bidders have to pass a quality hurdle (i.e. meet certain quality criteria; post-qualification). The criteria used are relevant experience, track record, technical skills, management skills, resources and methodology. The tendering period for small DBB contracts is 2–3 weeks, and for an average size DB 12–16 weeks. As a result of the strong desire for an interactive tender process, meetings are held between the client and the tenderers before the tendering to

clarify potential problem issues. While in DB these meetings have been beneficial, in DBB too much interaction between the client and bidders may be dangerous, since contractors may try to renegotiate risk allocation.

In DBB, contractors are allowed to make alternative tenders, but they also have to submit also a fully conforming tender. In DB, 30% or more of the design is included in the RFP, and the approvals act as additional constraints. The site investigations may be the responsibility of bidders in order to encourage more site-specific investigations and to optimise their usability during the subsequent project phases. This lengthens the tender process, but creates value in more efficient utilisation of the investigations. The contractor selection is mostly based on weighted attributes and quality-price trade-off. However, some interviewees felt that the contract award is still largely price-determined.

In DBB, it is easy to demonstrate genuine competition which provides transparency of the expenditure of public funding. The client can better insist on a certain quality level and manage it, and the designers prefer working in this environment. However, client administration requires more resources, as there is more quality testing to be done. Also, more claims are expected due to adversarial relationships. Despite this, the interviewees agreed on the fact that any project delivery method can deliver with the right drivers, attitudes, people and approach at tender time. In DBB, this is achieved through partnering that encourages the participants to work together, to seek opportunities for improvement and to resolve disputes quickly. Project delivery is further enhanced by value engineering that allows the contractor to promote new ideas and better ways of doing things in order to reduce overall costs and eliminate redundancy in design. Value engineering can be encouraged through incentives, for example, by having a proportion of the savings or the bonus based on early completion. Appropriate risk transfer can be achieved through lump sum contracts that encourage the contractor to manage the work as efficiently as possibly /117/.

DB has been used in road construction only recently. A fixed lump sum contract is predictable for the client and requires the contractor to adjust his cash flows according to the work requirements. Buildability of designs is improved through close cooperation between the parties and construction innovations, which generate time and/or cost savings and eliminate problems during construction. However, often the contractor is not actively involved in the design during the tender period, as he works on other projects. Even though the contractor certifies the work for the client, DB tends to focus on minimum construction cost, which may affect negatively the whole-life cost. Often DB encourages the contractor to tender the lowest acceptable quality which results in 10% capital cost savings compared to DBB. While maintenance liability might align better the objectives of the different parties, the difficulty is that the length of the road

project does not generally provide enough economies of scale for cost efficient maintenance.

Time certainty is not much affected by DB even though the contractor's input may make time estimates more realistic. DB project duration is 3–6 months shorter than with DBB due to a single procurement process and no lead-time for construction. Sometimes, however, the statutory processes come into play, and the client has to wait for approvals for long periods of time before the DB contract can be tendered. In these circumstances, it could actually save time to get the design procured separately, and to procure construction traditionally after approvals are in place.

1.4 Alliance

1.4.1 General

In full delivery (i.e. alliance), the contractor is selected to work with the consultant on the project's development and to take the entire project through to its conclusion /117/. The higher the risks, the faster the delivery, and the more complex the project, the more benefits alliance will provide. Alliance projects should be over NZ$100 million, since economies of scale are required to achieve management efficiencies due to the relatively high preliminary and general costs related to establishing and managing the contract /44/. Alliance projects should provide opportunities to innovate. Alliancing also allows quick start-up and extensive interaction with external parties /92/.

1.4.2 Project delivery process

Designer/contractor selection

Generally design is 30–60% complete when tenders are asked. Initially, interviews were used to short-list bidders to 2(–3). However, as the client did not consider interviews very successful, future short-listing will be based on written submittals. Short-listed bidders go through a 2-day workshop with the client. The contractor selection criteria are: relevant experience, how good the company is in similar type of work, track record, skills of people appointed for the job, management skills, resources and methodology with no price consideration. As alliance is a people-led project delivery method, 70% of the criteria are based on the people in the project team and the systems used while only 30% focus on the physical companies. The initial submittals and potential interviews will have 40% weighting in the final selection, while 60% is determined during the workshop based partly on professional estimates.

The selection process takes 1.5–3 months, and the tendering cost is less than with DB /92/. The cost reflects mainly the extensive time spent by the project team and senior management of bidding companies on the task. As every partner bears his own costs, the cost of the contractor is relatively low, while the designer is tendering cost is higher (1.2–1.5% of design cost). There are also costs due to training facilities, travelling, team building, coaches, etc. As a result, the bidders develop an ownership of the project already during the tendering phase.

Design

A clear project scope is provided in the RFP. It acts as a basis for the project team to develop the functional requirements for the project. The client is involved in the process, and all alliance parties have to sign the final document. This gives the client greater flexibility to compare alternative service levels, etc. The designers are involved throughout the project delivery, and design continues to be optimised during construction. Urban design, landscaping and other aesthetic issues are taken into consideration better than in other project delivery methods. The key to success is that the whole project team is located in the same office which maximises communication and facilitates cooperation. Out of this interaction comes alignment of the objectives and innovations, while testing each other´s views drives efficiencies. Approximately 15% more time is spent for design which increases the design cost. However, according to the contractor, 90% of the achievable savings can be gained through design. Only 10% of the savings are achievable through increased productivity.

Construction

Alliance allows better optimisation of the delivery process, as everything is done in a much more integrated fashion than normally. A significant amount of work is done based on partial design. This has caused rework and redesign, but also allowed faster project delivery. Some of the advantages gained through alliance may be lost due to inexperienced people. However, as the participants can select the project team, they are able to select the most capable people for each job, which drives team performance. This prime-team is able to deliver above average results leading to gain sharing between the participants and to better margins than in business as usual.

Periodic maintenance

Quality tends to be very high, and the client is expecting savings in periodic maintenance. Alliances allow more freedom to focus on the entire life of the road and to make more balanced decisions, because there is more balanced representation in decision making. Alliance drives a culture that rewards quality workmanship. However,

as the client needs to ensure that the road has the optimum whole-life cost, there are plans to include a long-term measure in the performance criteria (KPI). For example, the contractor could estimate the total maintenance cost during the first ten years after the road is completed. If the actual cost differs from this a bonus/sanction would be paid.

1.4.3 Risks and responsibilities

A fully priced risk register is prepared by the client /34/. All risks are then shared leading to maximum mitigation of risks. When the contractor and designer are engaged early, maximum effort is put into risk management. Everybody managies risks well, as they have to carry their portion through pain sharing (i.e. by carrying part of the cost overrun). Issues are handled quickly and effectively with no blaming between the parties. This is why cost performance has been very good. Even though risk management has been good, there is still potential for improvement in risk assessment systems.

1.4.4 Project team

Alliance is an agreement to do the work in a certain way, not a contract as such. Alliances have a pre-agreed compensation structure that is designed to drive the ‘best for the project’ behaviours /34/ and to remove barriers between the parties /92/. As a result, alliance greatly enhances teamwork, since it ensures that all win and lose together aligning the objectives of the parties. Communication and information transfer have been excellent. There are also more sources of information and knowledge available leading to excellent and very quick decision making. People working in the alliance learn from each other benefiting the companies and industry. Emphasis on environmental issues has been one of the most important successes of alliance. Also, public inconvenience and stakeholders are taken into consideration much better than normally. Alliance facilitates best practice management of health and safety, and allows skill transfer, professional growth and development of project staff /34/. However, there is still some room for improvement in the communication between alliance and client due to the virtual organisation structure and the bureaucracy the client is used to.

1.4.5 Administration

Alliance causes more work for the client than DBB or DB, especially for senior people, both during procurement and implementation. It requires an intensive focus on selecting and training the best people to develop and sustain relationships that will lead to high performance /92/. However, the client is not doing contract administration as such. Instead the client´s representatives have a more productive role in the projects, for example acting as quality managers and liaisons between the alliance and the client.

Due to the client's resource limitations, though, there have been only two client representatives in the alliance team of 40–50 people. This is considered inadequate by other alliance team members, as generally the number of client people should be maximised. The more the client is involved, the more he is exposed to the culture and the less there are interface risks between the delivery team and the client. The cost of client involvement is about 1% of the project cost with no additional costs for external advice.

The liaison between the alliance and the authorities is seen to play a key role in facilitating interaction with the maintenance providers and in providing a link to key stakeholders. As the client has credibility and long-term tenure in the alliance, it facilitates dealing with other stakeholders, such as local authorities and utility companies. The client can extract more trust and cooperation from them. Also, many internal and external bureaucratic processes can be fast-tracked, as the speed of the project delivery does not allow unnecessary slowdowns during the process. Prerequisites for successful project delivery are fast client decisions made at the correct levels, timely approvals, and people with the correct attitudes.

1.4.6 Schedule

The schedule is prepared parallel to target costing before the contract is signed. Both the schedule and target cost are driven to be, what participants think is the most likely outturn case. Design development and pricing takes about 3.5 months, which is very tight time-frame. According to team members, time performance could not be better in any other project delivery method. Project duration is much shorter than what it would be with DBB and somewhat shorter than with DB. The biggest gain is achieved upfront when the client decides to go further with the project to get the alliance running, because there is no need for preparing extensive documents for the RFP. Also, tendering takes less time. Design and construction may be a bit shorter, but generally relatively close to DB. The project was finished early which improves time certainty. Generally there are incentives to be early, with no traditional liquidated damages for being late and no claims resulting in extensions of time.

1.4.7 Cost

There is a perceived lack of price certainty at the beginning of the project /117/. However, even in DB and DBB the client knows that the final cost is higher than the bid price due to variations of at least 10%. In alliance, it is very likely that the cost will be somewhat less than TCE, as the initial cost estimation process ensures a relatively accurate estimate. When TCE is developed, design needs to be 30% done. TCE is structured in the following way:

- Limb 1 – production cost, project management cost and site overhead plus risk contingencies based on open book accounting. There is an external auditor of cost performance.
- Limb 2 – lump sum fee and corporate overhead based on the agreement between the client and alliance (business as usual).
- Limb 3 – consists of two components: share of cost overrun/underrun plus non-cost performance bonus based on KPIs. Share of overrun is capped at the total fee payable to the party.
- Limb 4 – Limb 3 share increase/decrease (-15…+15%) based on KPIs. The purpose of Limb 4 is to maintain the contractors focus, even if cost overruns occur.

The total project cost contains the designer's (10%), contractor's (89%) and client's costs (1%). Both the designer and contractor get a business as usual profit, set based on their historic performance plus their potential share of savings (5%). This may be lower than what it would be with DBB, but at the same time variation is decreased. Moreover, the capital cost of the project may be higher than with DB or DBB. However, if higher quality, benefits gained and functional performance are taken into consideration, the final outturn cost is lower than in other project delivery models. Most savings result from scope and quantity reductions. There are no separate supervision costs. Also, the life-cycle cost is lower providing better value for money for the client. To improve cost performance further, there needs to be optimisation between speed (the overhead costs) and errors (cost of rework).

1.4.8 Quality

The integrated team relies on the common, centralised quality control system that eliminates duplication of paper work between the organisations. Everyone has access to the same base data through the central system. Quality is assured also by dividing the project into separate subprojects. The alliance team has to perform well in the first subproject to get the second one. Performance is measured through KPIs, and the team tends to score well above average (77 out of 100). There are also two incentives tied to KPI (limb 3 and 4 described in Chapter 1.4.7). All these measures have led to the delivery of a very high quality product, better than with DB or DBB. This is indicated by more the durable pavement structure used and bridge design life of a hundred years.

1.4.9 Change orders, disputes and claims

Alliancing allows flexibility by facilitating changes during construction in order to achieve better overall outcomes /92/. Scope definition needs to be accurate enough to define what is included in the contract and what is considered a variation. There have

been some variations as a result of the client driven changes to the original agreement. Most of them have been scope increases. However, overall there are significantly less variations than with DBB or DB. Many issues, that would be changes in traditional procurement and cause additional costs, are considered normal business in alliance. Thus, the participants are focused on solving issues quickly and finding the one to blame becomes unimportant. In traditional project delivery, work would be delayed significantly as the parties try to find out who is responsible for the problem and should bear the consequences. As a result, a construction manager generally spends 90% of his time on contractual matters, disputes, claims and variations leading to significant costs in DBB.

1.4.10 Innovations

There is a very strong incentive for innovations and non-cost performance – a culture that has been effectively embedded. The implementation of innovations has been easy due to the commitment of the management team and the drivers of the project. There have been multiple innovations resulting in savings or other benefits. The biggest benefit may be the effect alliancing has on the industry as a benchmark. When people start to understand the principles of alliancing, they can utilise them in their own organisations.

1.4.11 Client satisfaction and project success

The client satisfaction is excellent. The designers and contractors also consider alliance a significantly better way to work than DBB or DB, since less time is spent unproductively. The success of the project puts pressure on the industry in terms of what will be considered acceptable in the future. Alliance is perceived to provide the clients better value for money (see Table 45). However, there are also opposing views on the issue and continuing discussion about whether alliancing really offers value for money. It is argued that the reason alliances have been successful is that they were loosely budgeted, since negotiating the TCE after contractor selection does not produce a competitive price. Also, government organisations are not typically good at making the judgment decisions required in alliances, and self-managing project teams are difficult to organise due to the more familiar master-servant relationship. There are also some concerns over the intensity demanded by the alliance team that may affect the client’s other projects /92/.

Table 45. Benefits and disadvantages of Alliance procurement.

Advantages	Disadvantages
• risk sharing • low tender costs • provides a well-thought identification of service requirements • whole-life focus • better quality product • better value for money through customer focus • enhanced efficiency and innovations • high flexibility • less variations • fast-tracking • industry development • cost certainty • time certainty	• ensuring a competitive price is difficult • requires suitable skills (that may be lacking) from government agencies • resistance to change

1.5 Maintenance

In New Zealand and internationally, there is a strong trend towards outsourcing highway maintenance activities. The road controlling authorities are increasingly assembling the various components together into a single contract and moving from input specification to outcome specification. A single contract is let for all contractor and consultancy inputs, which provides the authority a single point of responsibility for extended periods of time (up to 10 years). The contractor is responsible for identifying the required work and for prioritising and programming the works. He is also responsible for ensuring the quality of the work /101/.

The competitive market along with the quality-based selection criteria drives a strong culture of continuous improvement in the tendering organisations, which in turn drives the introduction of innovative practices. There is also a trend towards quality-based contract extensions, if the contractor achieves the predefined quality. This provides a very positive incentive for improving quality. It is difficult to quantify the savings achieved through outsourcing, as the level of service often differs from that provided under the previous regime. However, all agencies report savings, the early indications are around 25% /101/.

2. Hong Kong

2.1 Design-Build

In Hong Kong, DBB is still the primary infrastructure project delivery method, while DB is used whenever practical benefits follow. DB has produced significant time savings (5–20% /50/). Also, capital cost savings (15–50% of the government estimate) are generally expected, with a significant portion of them being related to the time savings. One of the main benefits of DB is the increased number of alternatives available to the client. Some of the options have been very innovative /25/.

A disadvantage associated with DB is the extensive efforts and costs involved in bid preparation and bid evaluation; tender cost is 0.18–0.32% of the project cost compared to 0.04–0.15% with DBB /35/. This is why the number of pre-qualified, short-listed bidders is generally limited to 3–5. Bid evaluation is mostly based on weighting of qualitative and price factors, even though in simple, tightly scoped and clearly defined projects price award may be used. The benefits and concerns of different parties related to a DB contract are listed in Table 46 /30/.

2.2 Design-Build-Maintain

Private financing is used extensively in the Asian transportation sector. Hong Kong has utilised private sector participation in infrastructure development through BOT schemes for over 30 years. International firms have delivered road projects with bridges and tunnels during the early years of concession development, but currently local developer participation is high /90/. The benefits of BOT are generally perceived to be deployment of private sector management expertise, innovative technologies, and operational efficiencies, in addition to, mobilising private funds to meet the tremendous demands of infrastructure systems /24/.

The crucial issue of BOT procurement lies in the selection of the most suitable partner – the franchisee – through competitive tendering /24/. The tendering cost (0.48–0.62 % of the project cost) is much higher than with DBB or DB /35/. Evaluation of the tenders normally covers three main aspects: financial (65%), engineering (20%) and planning of operation and transport (15%). Occasionally the client uses a ‘reverse tender system’, where he sets up toll levels/project costs and asks the tenderers to offer what they can do for the project with that money. This ensures that the price of the project remains at the set level. The concession period is usually 30 years from the day the franchisee is entitled to start works /24/.

Table 46. Benefits and concerns in using DB. /30/

	Benefits	Concerns
Client	• Fosters innovative solutions • Reduces total project delivery time • Reduces number of change orders • Reduces total project cost	• Loss of independent professional consultant • Lack of flexibility to respond to changing client needs • Issues of durability, flexibility of systems, future expansion, etc. • Substituted materials • Inspection services
Designer	• Single point of responsibility • Offers clarity of liability • Reduces number of change orders • Reduces response time to change requests • More control over in-place project quality • Improves business performance • Improves interdisciplinary design decisions • Rewards innovation	• Costly bid preparation • Limitations of DB as a delivery method • Need for determination of project requirements • Reluctance, resistance, initial early difficulty in joining a construction team • Impacts of changes • Liability and difficulty in obtaining design liability insurance • Diminution of design issues in project delivery
Contractor	• Rewards innovation • Increases designer/contractor interaction • Reduces project risks • Increases project control • Improves business performance	• Inability to shift responsibility for errors and omissions • Increased obligation to owner • Complexity of DB may make organising and assigning roles difficult • Extended warranties • Costly bid preparation that involves several alternatives that may not mature into a contract

The client acquires and clears at his cost all land within the conforming scheme and hands it over to the franchisee. The franchisee, then, should have the capacity to bear the financial risks of significant cost escalation in construction and operation, and considerable revenue variations over the franchise period. While risk allocation is generally considered workable, in some occasions it is considered unreasonable for the franchisee. /24/

The franchisee lets the DB contract to a strong contractor, and the client requires the franchisee to appoint an independent design and construction auditor. The design favours simple structures and innovative construction methods that facilitate speedy, repetitive, and mechanised construction techniques /24/. There are built-in incentives to innovate in rapidly changing technological areas (traffic control, electronic tolling, etc.) /25/. Private sector participation leads to a flexible decision-making process and significant efficiencies in management and coordination resulting in a shorter construction programme and lower construction costs. Generally, projects have been

completed 7–33% ahead of schedule. A common concern is that the design life may suffer from the hastiness of the franchisee to initiate the revenue stream after contract award /24/. However, DBM has produced extraordinary improvements in life-cycle cost with the common trade-offs in aesthetics /25/.

Sharply defined common goals have contributed to better teamwork minimising the number of disputes /16/. When private tunnels have been compared with publicly owned tunnels, the services provided by the private sector have always been found better. A minimal amount of complaints have been received, and the projects provide high rates of return, as in BOT environmental business decisions are always cost driven /19/. The ProjectCos are satisfied with the delivery method and experienced companies have returned to bid for the new DBM projects /16/.

3. Canada

3.1 Design-Bid-Build

In DBB, the contractors are mere providers of labour, equipment and materials. The management team polices quality of design and construction. Continued erosion of product quality has resulted in increased costs of client inspections, which have been unable to remedy the lack of commitment to quality management within the contracting organisation. While acceptable quality is achieved, it comes at a high administrative cost. A by-product is the lack of responsibility for the finished product within the contracting organisation. Thus, DBB results in higher costs, duplication of tasks, attraction of liability to the client, and contractual conflicts. /99/

3.2 Design-Build-Maintain

Now there is a trend towards procurement of transportation projects through private finance and concession-type agreements due to the desire of the client to reduce or avoid the effect of high capital costs on the taxation and to shorten the overall delivery time, while still satisfying the transportation demands of the increasing population. DBM allows the client to realise improvements in operational efficiencies and to share risks with third parties. Also, the amount of knowledge and expertise required to manage the planning, delivery, operation and maintenance of the infrastructure is large requiring extensive resources that are available in the private sector. /99/

DBM allows early determination of project costs, encourages innovative use of materials and construction systems, and creates a single point of responsibility. Output

specifications ensure that the methods and tools used in achieving the required end result can be chosen by the contractor leading to the most cost-effective methods. Quality of the finished product is enhanced and the number of claims is reduced /99/. DBM also results in lower cost of changes due to the mutual cooperation of all parties involved in the project (see Table 47) /12/.

Table 47. The number and average cost of changes in different types of contracts /12/.

Type of contract	**Number of changes / project**		**Average cost / design change** (C$)	**Average cost / constr. change** (C$)
	Design	Constr.		
Design-Bid-Build	8.1	28	4 050	9 000
Design-Build	16.8	7	6 150	8 250
DBM	9.5	18.1	340	680

DBM is a win-win proposition for all parties. The client and public win because of the benefits of the relief from the financial and administrative burden, reduced size of inefficient bureaucracy, better public service, encouragement of efficiency and growth of the economy. The ProjectCo and the contractor win because they share in construction profits and savings, have the ability to exercise greater control over the project and are able to manage risks. /99/

4. Additional countries

4.1 Design-Bid-Build

Delays are more evident in traditional or adversarial type of contracts, where the contract is awarded to the lowest bidder. The most important factors affecting construction delays are client interference, inadequate contractor experience, restrictions on public financing, labour productivity, slow decision making, improper planning and subcontractors. /31/

4.2 Design-Build

France and Portugal: DB is the primary project delivery method of major road projects. The design level in the RFP ranges between 10–50%. Relatively simple projects contain more design in the solicitation than complex projects or those that include OM components. These projects utilise performance-based specifications. The client defines performance requirements and audits the quality, while the contractor is responsible for quality control and quality assurance. The most successful clients only

review the design instead of accepting it, as an acceptance would transfer the risk associated with the technical solution, at least partly, to the client. /7/

Ireland: DB is the most suitable project delivery method for simple, uncomplicated projects. DB projects can be completed in a shorter time period than those implemented by other project delivery methods. However, while 60% of DBB projects meet the client's quality expectations, only 50% of DB projects do that. The majority of clients, consultants, contractors and subcontractors perceive that DB produces a lower design quality, aesthetics and quality of finished product than other project delivery methods. This is explained by rushed decisions, lack of effective briefing, poor communication and cost cutting for short-term gain. However, ultimately the quality of design is largely dependent on the quality of the performance-based specifications prepared by the client. The tougher the client's quality requirements, the more likely a successful project outcome. The changes suggested by the client are often difficult to incorporate into the design, construction and programme schedule. Also, the client is likely to be charged excessive rates for changes, because of the lack of a bill of quantities against which to value the variations. /11/

4.3 Design-Build-Maintain

The interest towards DBM-type procurement is increasing globally with many countries using these broader service packages (France, Portugal, Ireland, Norway, Greece, Spain, Italy, Germany, Netherlands, Bulgaria, Hungary, Poland, Romania, Japan, South Africa, India, South Korea, Kuwait, Singapore, Argentina, Brazil, Chile, Mexico, etc.). DBM projects tend to be larger than other types of projects. Generally, gathering multiple road sections into the same package presents two advantages: 1) the possibility for the private sector to optimise the use of its equipment and 2) a reduction in transaction costs (bank and consultant fees, administrative and socio-political costs, etc.) which are high in a concession system /20/.

As the tender cost is high, the quality of bids can be significantly improved through tender fees paid by the client and by keeping the number of pre-qualified bidders relatively low. An excessively large number of pre-qualified candidates increases transaction costs and may reduce the quality of bids. /17/

The key word is risk. The private sector can only become involved in a project where the expected remuneration is commensurate with the level of risk /17/. Risks have to be borne by those who can control them effectively. Also, an entity can only bear risks that do not exceed its financial capacity. Political and legal risks should generally be borne by the client, while technical risks are borne by the ProjectCo, which generally transfers them to the general contractors through lump sum, turnkey contracts. Commercial risks

are often borne by the ProjectCo, but as they can be extensive, it might be better to consider this an open, negotiable question /20/.

A private company is able to design, build and operate infrastructure more efficiently than a public organisation, because it can work on a time-scale that is longer than an annual budget and operate more flexibly by taking into account the overall cost and by optimising investment, maintenance and management of operations /17/. The important elements are clear, independent accounting that identifies costs and income safeguarding the image of the operator, and technical know-how and experience improved through stable project teams /20/.

Besides potentially bringing new funding to a concession project, a ProjectCo introduces new industrial methods and design innovations. While the potential for development of new ideas should not be tempered by strict compliance with specifications /20/, contracts often specify too much technical detail, limiting the private partner's freedom to innovate and propose better solutions. Also, private sector attitudes towards innovation are rather conservative, since innovations are often perceived to increase risks. The construction and design risks are minimised by adopting conservative designs and by using well-known materials. The majority of innovations are derived from the need to promote easy and cost-effective long-term maintenance. Thus, both the designer and operator should be involved during the early stages of negotiation in order to foster innovation /28/.

5. Summary on experiences of the other countries

The experiences the other countries have had with road project delivery coincide well with the experiences gained in the UK, USA, Australia, and Finland. It seems that the use of DBB has been somewhat problematic and led to increased use of DB and DBM. These project deliver methods help deliver projects in time and to budget, while also reducing other experienced problems (adversarial relationships, etc.). However, some problems have been recognised even with DB (reduced quality, etc.) and DBM (reduced aesthetics, etc.). Solutions to these problems are sought by largely similar actions taken or planned in the UK, USA, Australia, and/or Finland. Alliancing also seems to provide an interesting alternative for complex and large projects. Use of CM was not, dealt with in the literature reviewed.

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Appendix A: Interview forms

16 May 2003

Dear Recipient,

THANK YOU for your promise to participate in the research project called
"The Performance and Development potential of Project Delivery Methods for Infrastructure".

These interview forms are sent to you in order to inform you on the issues the research is mainly involved with and to give you a chance to prepare for the interview if necessary. There is no need for you to fill in the form before the interview, as the questions will be gone through during the meeting. However, as the questions are very detailed, it may be advantageous to spend a few minutes with them before the meeting.

There are two separate forms, each for different occasions:

Case specific interview:
This is for those interviewees with whom I will be talking about a specific case and only the project delivery method used in that case. This form contains more specific questions about the project outturn.

Procurement issues in general:
This is for those interviewees with whom I will be talking about project delivery in general. This form contains questions on all of the project delivery methods, their comparisons and about the company values and how these could be better met through project delivery.

The forms include many questions concerning costs or amount of work required. In all of the questions the numbers are compared to an estimated outturn in a similar type of project procured traditionally (with Design-Bid-Build method). I would like to emphasise the importance of this numeric information in order for me to be able to make any kind of useful value analysis for the different procurement systems. However, I am aware of the difficulty of getting this information. This is why I would appreciate your **best estimates** when there is no exact number available.

If you don't have any objections, I would prefer using a tape recorder during the interview. This way I will be able to better concentrate on the discussion. The recording will be just for myself to make notes after the meeting. No individual interviews, nor cases, will be reported during the course of the research. All the interviews will be summarised at the country level in the final report and presented as general trends and views of the actors in that market. I will e-mail the country-specific chapter for you to comment before it is published.

To thank you for the participation in this research, VTT Technical Research Centre of Finland and the commissioners of the research will provide you with a copy of the final report when it is published in the fall 2004. I hope it will give you useful insights into procurement.

Kind regards

Tiina Koppinen
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CASE SPECIFIC INTERVIEW

Date ☐ Time ☐

Interviewee

Name	
Title	
Company	
Department	
Company expertise	
Address	
Phone/Fax	
E-mail	
Individual expertise	

The project information

Client	
Consultant	
Designer	
Contractor	

Facility type
- ☐ Multi-lane road
- ☐ Single-lane road
- ☐ Bridge
- ☐ Tunnel
- ☐ Mega project
- ☐ Other - specify

Project type
- ☐ New alignment
- ☐ Expansion/widening
- ☐ Reconstruction
- ☐ Resurface
- ☐ Rehabilitate
- ☐ Other - specify

Project size ☐ €/£/$ ☐ lane-km

Work contents ☐

Opened for traffic ☐ Duration of the project ☐ months/years

Role in the project
- ☐ Client
- ☐ Designer
- ☐ Consultant
- ☐ Contractor
- ☐ Design-builder
- ☐ Project manager
- ☐ Other - specify

Project delivery method
- ☐ Traditional
- ☐ Construction management
- ☐ Design-Build
- ☐ Design-Build-Operate-Maintain
- ☐ Design-Build-Finance-Operate
- ☐ Other - specify

In what percentage of projects do you use/ are involved in this project delivery method? ☐ %

IF DESIGN-BUILD OR DBOM/DBFO:

How were the design and construction stages organised?
- ☐ Integrated design
- ☐ Contractor led
- ☐ Designer led
- ☐ Project company
- ☐ Other - specify

IF DBOM/DBFO:

How was the project divided into work packages?
(Circle or join with a line the integrated tasks)

Design Operation
Construction Maintenance

Concession period ☐ years

Commercial terms of …

designer	☐ Lump sum ☐ Unit price ☐ Guaranteed maximum	☐ Cost plus % fee ☐ Cost plus fixed fee	☐ Other - specify	
consultant	☐ Lump sum ☐ Unit price ☐ Guaranteed maximum	☐ Cost plus % fee ☐ Cost plus fixed fee	☐ Other - specify	
contractor	☐ Lump sum ☐ Unit price ☐ Guaranteed maximum	☐ Cost plus % fee ☐ Cost plus fixed fee	☐ Other - specify	
design-builder	☐ Lump sum ☐ Unit price ☐ Guaranteed maximum	☐ Cost plus % fee ☐ Cost plus fixed fee	☐ Other - specify	
project manager	☐ Lump sum ☐ Unit price ☐ Guaranteed maximum	☐ Cost plus % fee ☐ Cost plus fixed fee	☐ Other - specify	

What is your normal warranty period? ____ months/years

What was the warranty period in this project? ____ months/years

Project complexity	☐ Very high	☐ High	☐ Medium	☐ Low	☐ Very low
Schedule urgency	☐ Very high	☐ High	☐ Medium	☐ Low	☐ Very low
Project scope flexibility	☐ Very high	☐ High	☐ Medium	☐ Low	☐ Very low
Regulatory constraints		☐ Many	☐ Few	☐ None	
Onerous contract clauses		☐ Many	☐ Few	☐ None	

Critical project objectives		Were these objectives met?	Why?
	1. ____	☐ Yes ☐ No	Why?
	2. ____	☐ Yes ☐ No	Why?
	3. ____	☐ Yes ☐ No	Why?

Percent completion of …		… when contracts were issued
	permit clearance ____ %	
	environmental clearance ____ %	
	right-of-way acquisition ____ %	

Specification type ☐ Prescriptive ☐ Performance-based ☐ Combination

Was partnering used? ☐ Yes ☐ No Why? ____

Describe any unique features about this project that influenced its cost, schedule or quality?

PROJECT DELIVERY PROCESS

Contractor/ Designer/ CM/ Design-builder selection

Percent completion of design …	in the project	in traditional projects
in Request for Proposal (RFP)		%
in tender proposals		%

Did the project delivery method and the procurement process promote competition? ☐ Yes ☐ No How? ____

How crucial were the external market factors/ outside demands for the project?

How would you promote competition in the future?

Award basis ☐ Open bidding ☐ Prequalified bidding ☐ Negotiated contract ☐ Other - specify ____

Was there a pool of qualified tenderers? ☐ Yes ☐ No Number of bidders ____

IF PREQUALIFICATION USED:

Ability to restrain tenderer pool ☐ Excellent ☐ High ☐ Medium ☐ Low ☐ Very low

Was the tendering period adequate for bidders? ☐ Yes ☐ No How long? ____ weeks/months

Award criteria

- ☐ Low bid
- ☐ Low bid - meets technical criteria
- ☐ Low bid - net present value
- ☐ Fixed price - best design
- ☐ Cost-technical trade-off
- ☐ Adjusted bid
- ☐ Adjusted score
- ☐ Weighted criteria
- ☐ Other - specify ____

Was the award criteria appropriate? ☐ Yes ☐ No Why? ____

Did the process select truly qualified contractor/designer? ☐ Yes ☐ No Why? ____

What is the total tendering cost up till contract award?	in the project	in traditional projects
		% of total cost

Are the bidders willing to tender for similar work in the future? ☐ Yes ☐ No Why? ____

Did the selection process in this project differ from a typical process in other projects procured with the same method? ☐ Yes ☐ No Why? ____

Were… | considered | met | … during tendering stage?

	considered	met	
project objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?
client objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?
contractor objectives	☒ Yes ☐ No	☐ Yes ☐ No	Why?

How would you improve efficiency of the tender stage to speed up delivery and to reduce tender costs?

Other comments

Design

Did the design process in this project differ from a typical process in other projects procured with the same method? ☐ Yes ☐ No — How? Why?

Did the contractor/CM make any contribution? ☒ Yes ☐ No — How? What?

What is the designer's profit?	in the project	in traditional projects	
			% of total cost

Were… | considered | met | … during design stage?

	considered	met	
project objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?
client objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?
contractor objectives	☐ Yes ☒ No	☒ Yes ☐ No	Why?

How would you improve design stage?

Other comments

Construction

Did the construction process in this project differ from a typical process in other projects procured with the same method? ☒ Yes ☐ No — How? Why?

What is the contractor's profit?	in the project	in traditional projects with similar work packages	
			% of total cost

Were… | considered | met | … during construction stage?

	considered	met	
project objectives	☐ Yes ☒ No	☐ Yes ☒ No	Why?
client objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?
contractor objectives	☐ Yes ☐ No	☒ Yes ☐ No	Why?

How would you improve construction stage?

Other comments

Periodic maintenance

Did the maintenance process in this project differ from a typical process in other projects procured with the same method? ☐ Yes ☐ No — How? Why?

Were… | considered | met | … during periodic maintenance?

	considered	met	
project objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?
client objectives	☒ Yes ☐ No	☒ Yes ☐ No	Why?
contractor objectives	☐ Yes ☐ No	☐ Yes ☐ No	Why?

How would you improve periodic maintenance stage?

Other comments

PROJECT OUTPUT

Risks and responsibilities (Risk matrix, if available)

Was the risk allocation appropriate? ☐ Yes ☐ No Why? _____

How would you optimise risk allocation:

What risk would you transfer from contractor to owner?

What risk would you transfer from owner to contractor?

Other comments

Project team

Did the project delivery method have an affect on…

	Very positive				Very negative
teamwork	☐5	☐4	☐3	☐2	☐1
communication	☐5	☐4	☐3	☐2	☐1
information transfer	☐5	☐4	☐3	☐2	☐1
knowledge integration	☐5	☐4	☐3	☐2	☐1
availability of tacit knowledge	☐5	☐4	☐3	☐2	☐1 ☐1
decision making	☐5	☐4	☐3	☐2	
project safety	☐5	☐4	☐3	☐2	☐1
win-win procedures	☐5	☐4	☐3	☐2	☐1
process improvement	☐5	☐4	☐3	☐2	☐1
public inconvenience	☐5	☐4	☐3	☐2	☐1
environmental issues	☐5	☐4	☐3	☐2	☐1

How would you improve project team performance?

Other comments:

Administration

What is the degree of agency burden during …

	in the project	in traditional projects	
procurement			€/£/$ or man months
contract administration			€/£/$ or man months
design			€/£/$ or man months
construction			€/£/$ or man months
periodic maintenance			€/£/$ or man months

	in the project	in traditional projects	
What was the client's additional cost for external advice?			€/£/$ or % of total cost

Was the procurement process adequate/ appropriate? ☐ Yes ☐ No Why? _____

How would optimise agency burden?

Other comments

Schedule

What was the duration of …	in the project	in traditional projects	
RFP development			weeks/months
RFP release to award			weeks/months
Design			weeks/months
Pre-construction			weeks/months
Construction			weeks/months
Total project duration			weeks/months

What was the as planned total project duration compared to as built duration (+ increase, - decrease) ____ %

Were there any extra savings/expenses due to the schedule compared to traditional projects? ____ €/£/$

Did the procurement method have an impact on …

	Very positive		Neutral		Very negative
time certainty	☐5	☐4	☐3	☐2	☐1
time performance	☐5	☐4	☐3	☐2	☐1

What features of the process explain the success/failure of the project in terms of the time performance if compared to the traditional delivery?

How would you improve schedule performance?

Other comments

Cost

What was the cost of …	in the project	in traditional projects	
design			% of total cost
construction			% of total cost
administration			% of total cost
periodic maintenance			% of total cost
Total project cost			€/£/$

How did the final project cost compare with the budget?
(increase +, decrease -) ____ %

What features of the process explain the success/failure of the project in terms of the cost performance if compared to the traditional delivery?

Did the project delivery method have an affect on …

	Very positive		Neutral		Very negative
capital cost	☐5	☐4	☐3	☐2	☐1
life cycle cost	☐5	☐4	☐3	☐2	☐1
cost certainty	☐5	☐4	☐3	☐2	☐1

How would you improve cost performance?

Other comments

Quality

Did the project delivery method have an affect on …

	Very positive		Neutral		Very negative
design quality	☐5	☐4	☐3	☐2	☐1
construction quality	☐5	☐4	☐3	☐2	☐1
overall quality	☐5	☐4	☐3	☐2	☐1
conformance to specifications	☐5	☐4	☐3	☐2	☐1

What features of the process explain the success/failure of the project in terms of the quality performance if compared to the traditional delivery?

How high was …	in the project	in traditional projects	
number of re-design efforts			
value of re-design			% of total cost

How would you promote better quality in a project?

Other comments

Change orders

How high was …	in the project	in traditional projects	
number of change orders (CHs)			
value of change orders			% of total cost
number of extra work orders			
value of extra work orders			% of total cost

Reasons for major changes in project costs

☐ Client additions/subtractions
☐ Contractor additions/subtractions
☐ Uncontrollable events
☐ Poor design
☐ Designer delays
☐ Contractor delays
☐ Client delays
☐ Other - specify _____

Did the project delivery method have an affect on flexibility during…

	Very positive		Neutral		Very negative
design	☐5	☐4	☒3	☐2	☐1
construction	☐5	☐4	☒3	☐2	☐1
periodic maintenance	☐5	☐4	☐3	☐2	☐1

How would you optimise change orders and project flexibility?

Other comments

Disputes and claims

How high was …	in the project	in traditional projects with similar work packages
number of disputes		
number of claims		
number of approved claims		
value of claims		% of total cost

Effectiveness of dispute resolution ☐ Excellent ☐ High ☐ Medium ☐ Low ☐ Very low

How would you reduce disputes and claims?

Other comments

Innovation

Number of innovations in in the project …

		Savings due to innovations €/£/$	% of total cost
design			
construction techniques construction methods			

Number of innovations in in the project …

		Savings due to innovations €/£/$	% of total cost
materials			
overall innovativeness			

Other benefits due to innovations

Did the project delivery have an affect on innovations? Very positive ☒5 ☐4 Neutral ☐3 ☐2 Very negative ☐1

Was the implementation of innovations difficult? ☐ Yes ☐ No Why?

How would you promote innovations during:

Design

Construction

Periodic maintenance

Other comments

Client satisfaction

Overall client satisfaction ☐ Excellent ☐ High ☐ Medium ☐ Low ☐ Very low

Service provider satisfaction ☐ Excellent ☐ High ☐ Medium ☐ Low ☐ Very low

How would you improve satisfaction?

Other comments

Project success

What was the overall success of the project? ☐ Excellent ☐ High ☐ Medium ☐ Low ☐ Very low

What features of the process explain the success/failure of the project when compared to the traditional delivery?

Could this project have been better delivered or more successful? ☐ Yes ☐ No Why?

Do you believe that the performance level achieved was normal for this procurement method? ☐ Yes ☐ No Why?

Considering the company objectives and project outturn would you promote using this procurement method more than traditional? ☐ Yes ☐ No Why?

How would you improve the project success?

Other comments

Lessons learned in this project

List lessons you learned on this project about the project delivery system used (personal experiences, industry feedback, expert advice etc.)

Did the delivery system enhance or hinder your ability to perform or the progress/success of the project? How?

Did the project meet the intended needs? Why/how?

Other comments

INTERVIEW ON PROJECT DELIVERY METHODS IN GENERAL

Date ☐ Time ☐

Interviewee

Name	
Title	
Company	
Department	
Company expertise	
Address	
Phone/Fax	
E-mail	
Individual expertise	

PARTICIPANT OBJECTIVES

Client/owner objectives

The company key objectives are	In the future, the importance of these objectives will	These objectives are better met through
	☐ Increase ☐ Decrease	☐ T ☐ CM ☐ DB ☐ DBM
	☐ Increase ☐ Decrease	☐ T ☐ CM ☐ DB ☐ DBM
	☐ Increase ☐ Decrease	☐ T ☐ CM ☐ DB ☐ DBM
	☐ Increase ☐ Decrease	☐ T ☐ CM ☐ DB ☐ DBM
	☐ Increase ☐ Decrease	☐ T ☐ CM ☐ DB ☐ DBM
	☐ Increase ☐ Decrease	☐ T ☐ CM ☐ DB ☐ DBM

How are client objectives taken into consideration during procurement process in ...

traditional	
construction management	
design-build	
DBFO/DBOM	

PROJECT DELIVERY IN GENERAL

General experience on project delivery:

How often do you use / are involved in ...		Specification type used generally
traditional	☐ % of projects	☐ Prescriptive ☐ Performance-based ☐ Combination
construction management	☐ % of projects	☐ Prescriptive ☐ Performance-based ☐ Combination
design-build	☐ % of projects	☐ Prescriptive ☐ Performance-based ☐ Combination
DBFO/DBOM	☐ % of projects	☐ Prescriptive ☐ Performance-based ☐ Combination

In what type/size of projects do you use / have been involved in ...

traditional	
construction management	
design-build	
DBFO/DBOM	

Major changes done in recent years in the project delivery to improve effectiveness of ...

traditional	
construction management	
design-build	
DBFO/DBOM	

Have the changes accomplished their intended purpose?

traditional	☐ Yes ☐ No	*Why?*	
construction management	☐ Yes ☐ No	*Why?*	
design-build	☐ Yes ☐ No	*Why?*	
DBFO/DBOM	☐ Yes ☐ No	*Why?*	

Other comments

Applicability

Under what conditions would you consider/ prefer to use …

traditional	
construction management	
design-build	
DBFO/DBOM	

Main **advantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

Main **disadvantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

Do the advantages exceed the disadvantages in …

traditional	☐ Yes	☐ No	*design-build*	☐ Yes	☐ No
construction management	☐ Yes	☐ No	*DBFO/DBOM*	☐ Yes	☐ No

Other comments

PROJECT DELIVERY PROCESS

Contractor/ Designer/ CM/ Design-builder selection

Percent completion of design when the contractor is selected in …

traditional	%	*design-build*	%
construction management	%	*DBFO/DBOM*	%

	What is the total tendering cost up till contract award?		Award basis generally	
traditional		% of total cost	☐ Open bidding ☐ Prequalified bidding	☐ Negotiated contract ☐ Other
construction management		% of total cost	☐ Open bidding ☐ Prequalified bidding	☐ Negotiated contract ☐ Other
design-build		% of total cost	☐ Open bidding ☐ Prequalified bidding	☐ Negotiated contract ☐ Other
DBFO/DBOM		% of total cost	☐ Open bidding ☐ Prequalified bidding	☐ Negotiated contract ☐ Other

How is best value defined generally in projects delivered through …

traditional	☐ Low bid ☐ Low bid - meets technical criteria ☐ Cost-technical trade-off	☐ Fixed price - best design ☐ Adjusted bid ☐ Adjusted score	☐ Weighted criteria ☐ Other
construction management	☐ Low bid ☐ Low bid - meets technical criteria ☐ Cost-technical trade-off	☐ Fixed price - best design ☐ Adjusted bid ☐ Adjusted score	☐ Weighted criteria ☐ Other
design-build	☐ Low bid ☐ Low bid - meets technical criteria ☐ Cost-technical trade-off	☐ Fixed price - best design ☐ Adjusted bid ☐ Adjusted score	☐ Weighted criteria ☐ Other
DBFO/DBOM	☐ Low bid ☐ Low bid - meets technical criteria ☐ Cost-technical trade-off	☐ Fixed price - best design ☐ Adjusted bid ☐ Adjusted score	☐ Weighted criteria ☐ Other

	Does the procurement system promote competition?		Is there a qualified pool of interested tenderers?	
traditional	☐ Yes	☐ No	☐ Yes	☐ No
construction management	☐ Yes	☐ No	☐ Yes	☐ No
design-build	☐ Yes	☐ No	☐ Yes	☐ No
DBFO/DBOM	☐ Yes	☐ No	☐ Yes	☐ No

How would you promote competition in the future?

How would you improve efficiency of the tender stage to speed up delivery and reduce tender costs?

Other comments

Design

During design, which are the main **advantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

During periodic design, which are the main **disadvantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

How would you improve design stage?

Other comments

Construction

During construction, which are the main **advantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

During construction, which are the main **disadvantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

How would you improve construction stage?

Other comments

Periodic maintenance

During periodic maintenance, which are the main **advantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

During periodic maintenance, which are the main **disadvantages** of …

traditional	
construction management	
design-build	
DBFO/DBOM	

How would you improve periodic maintenance stage?

Other comments

PROJECT OUTPUT

Risks and responsibilities (Risk matrixes, if available)

Is the current risk allocation appropriate in …

traditional	☐ Yes	☐ No
construction management	☐ Yes	☐ No
design-build	☐ Yes	☐ No
DBFO/DBOM	☐ Yes	☐ No

How would you optimise risk allocation?

Which risks would you transfer from client to contractor	contractor to client

Other comments

Project team

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
teamwork					
communication					
information transfer					
knowledge integration					
availability of tacit knowledge					
decision making					
project safety					
win-win procedures					
process improvement					
public inconvenience					
environmental issues					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you improve project team performance?

Other comments

Administration

What is the degree of agency burden in different project delivery methods on the given scale during …

	Very high	High	Medium	Low	Very low
procurement					
contract administration					
design					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

What is the degree of agency burden in different project delivery methods on the given scale during …

	Very high	High	Medium	Low	Very low
construction					
periodic maintenance					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

What is the additional cost for external advice in …

traditional ____ % of cost *design-build* ____ % of total cost

construction management ____ % of cost *DBFO/DBOM* ____ % of total cost

How would optimise agency burden?

Other comments

Schedule

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
time certainty					
time performance					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you improve schedule performance?

Other comments:

Cost

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
capital cost					
life cycle cost					

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
cost certainty					
contractor profitability					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you improve cost performance?

Other comments

Quality

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
design quality					
construction quality					
overall quality					
conformance to specifications					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you promote better quality in a project?

Other comments

Change orders

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
change orders					
extra work orders					
flexibility					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you ensure that change orders are made only for the project benefit?

Other comments

Disputes and claims

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
disputes					
claims					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you reduce disputes and claims?

Other comments

Innovation

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
desig innovations					
technological innovations					
methodological innovations					
material innovations					
implementation of innovations					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you promote innovations during:

Design

Construction

Periodic maintenance

Other comments

Client/user satisfaction

On the given scale, what is the affect of different project delivery methods when considering …

	Very positive	Positive	Neutral	Negative	Very negative
client product satisfaction					
client service satisfaction					
user satisfaction					

Traditional = T, construction management = CM, design-build = DB, DBFO/DBOM

How would you improve client/user satisfaction?

Other comments

COMMENTS ON PROJECT DELIVERY

Lessons learned (personal experiences, industry feedback, expert advice etc.) in the projects delivered through …

traditional	
construction management	
design-build	
DBFO/DBOM	

Any other issues

MARKET ISSUES

How would you characterise the national road/infrastructure sector?

Which market characteristics/constraints/trends/changes (financial, political, legal, cultural, technological, labour etc.) **favour** the use of …

traditional	
construction management	
design-build	
DBFO/DBOM	

Which market characteristics/constraints/trends/changes (financial, political, legal, cultural, technological, labour etc.) **hinder** the use of …

traditional	
construction management	
design-build	
DBFO/DBOM	

How do these trends/changes affect the competitiveness of the project delivery method considering the learning curve of market actors …

traditional	
construction management	
design-build	
DBFO/DBOM	

Other comments

Appendix B: Interviewees

Finland

Client – Finnish Road Administration
Markku Teppo, Procurement Director
Matti Lahti, Procurement Manager, Häme Road Region
Raimo Pitkänen, Team Leader, Investment Planning, Häme Road Region
Pekka Jokela, Regional Director, Turku Road Region
Sami Petäjä, Construction Procurement Expert
Katri Eskola, Maintenance Procurement Expert
Heikki Koski, Project Manager, Häme Road Region
Pekka Järvinen, Project Manager, Häme Road Region
Matti K. Hämäläinen, Planning Manager
Pekka Pakkala, Project Manager, International Affairs
Mika Räsänen, Project Manager, Uusimaa Road Region

Contractor
Hannele Kulmala, Finnish Road Enterprice
Seppo Kilpeläinen, Skanska Asfaltti
Risto Pelttari, Business Development Director, Finnish Road Enterprice
Tom Schmidt, Managing Director, Tieyhtiö Nelostie Oy

Designer/consultant
Markku Hanhela, Andament Oy
Pekka Kuorikoski, SCC Viatek Oy

England

Client – Highways Agency
Graham Taylor, Group Manager
Jim Forster
Ray Simpson, Group Manager Procurement
Stephen Edwards
Alan Talbot

Contractor
Andy Beauchamp, Director of Operations, Connect A 50 Ltd, Connect Roads Ltd.
Nigel Roberts, Commercial Manager, Balfour Beatty Civil Engineering Limited

Designer/consultant
John Watson, Design Manager, Mouchel

Australia

Client
Victoria
Rob Aitken, Manager Major Projects, Department of Infrastructure
Mike Butler, Manager Project Delivery, VicRoads
Bill Peyton, Project Manager, VicRoads
Peter Balfe, Deputy Chief Executive, VicRoads
Ian McLennan, Assistant Director, Finance, Department of Infrastructure
Mary Baker, Department of Infrastructure

Queensland – Main Roads
Derek Skinner, Executive Director, Main Roads
Mike Neale, Director, Main Roads
David Kelly, Principle Advisor (PPP), Main Roads
Mike Swainston, Principle Manager (Industry Direction), Main Roads
Phil Clutterbuck, Project Manager, Main Roads

New South Wales - Roads and Traffic Authority
Les Wielinga, General Manager, Private infrastructure, Roads and Traffic Authority

Contractor
Victoria
Greg Vincent, Project Manager, Abigroup
Ken Reynolds, General Manager, Transurban

Queensland
Ray Whitehead, Business Development Manager, Barclay Mowlem

New South Wales
Joe Hauser, Civil Engineering Manager, Barclay Mowlem

Designer/consultant
Victoria
Paul Robinson, Principal Consulting Engineer, arrb Transport Research
Bruce Clayton, Senior Consulting Engineer, arrb Transport Research

Mark Percival, Executive Engineer, Sinclair Knight Merz
Arun Kumar, Professor Infrastructure, RMIT University
Ashish Shah, Project, Co-ordinator, CRC Construction Innovation

New Zealand

Client – Transit NZ
Colin Crampton, National Capital Works Manager

Contractor
Kim Barret, Project Manager, Freeflow

Designer/consultant
Alan Powell, Design Manager, Freeflow
Tony Porter, Road Asset Management Sector Leader, Opus International Ltd.
Melvyn Maylin, Sector Leader Highway Asset Development, Opus International Ltd.

United States of America

Client
Isaac Machado, Deputy Chief Counsel, The Commonwealth of Massachusetts
Gerald Yakowenko, Highway Engineer, Federal Highway Administration
Jennifer Balis, Federal Highway Administration
Larry Warner, Project Manager, Colorado Department of transportation

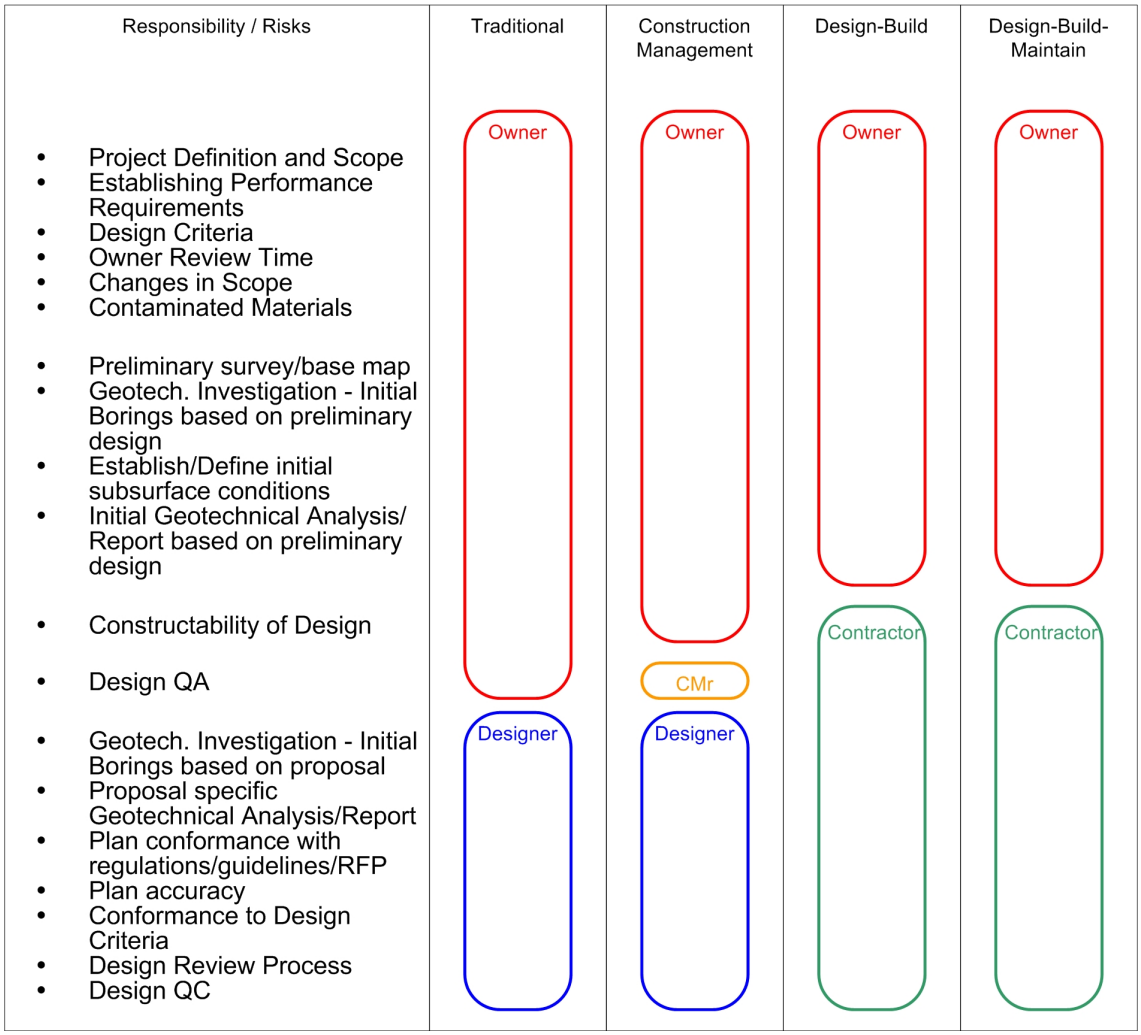
Contractor
Eric Cederholm, Project Manager, Modern Continental Construction Company

Designer/consultant
Donald Lessard, Deputy Dean, Massachusetts Institute of Technology (MIT)
Mark Shamon, Vice President, URS Greiner Consultants
Ned Corcoran, Foley Hoag
Shirley Ybarra, The Ybarra Group
Karen Hedlund, Attorney At Law, Nossaman
Mark Robinson, Senior Transportation Engineer, SAIC
Porter Wheeler, Director, Infrastructure Management Group, Inc.
Jim Klemz, Parsons Transportation Group
Keith Molenaar, Professor, Colorado University of Technology at Boulder
Jennifer Shane, Graduate Research Assistant, Colorado University of Technology at Boulder

Appendix C: Risk allocation matrixes

These road project risk allocation matrixes are based on the information provided mainly by /21, 153/ and the interviewees during the initial test interviews. However, as risk allocation tends to vary from one country to another, and even from one project to another, the matrixes do not depict the whole truth. Rather they aim to make a generalisation of the ambiguous issue of risk allocation to assist in gaining an adequate understanding of the differences between the project delivery methods.

RISK / DESIGN ISSUES



RISK / CONSTRUCTION ISSUES

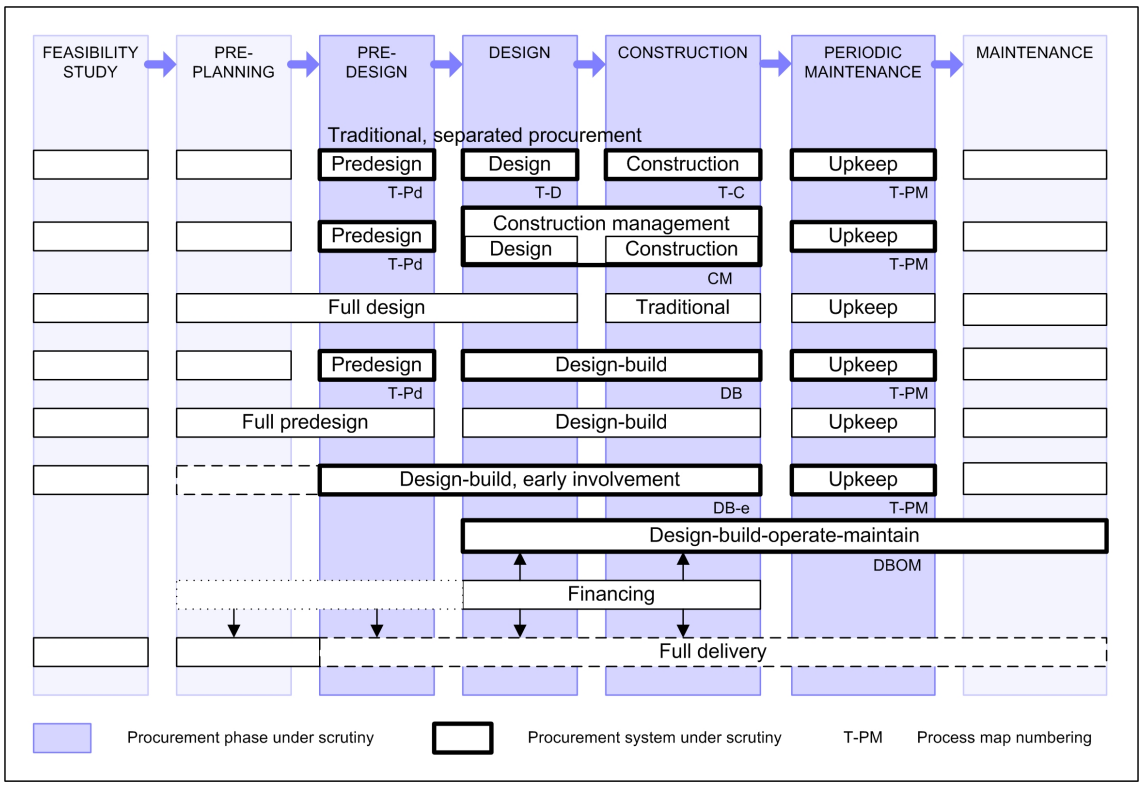
Responsibility / Risks	Traditional	Construction Management	Design-Build	Design-Build-Maintain
• Initial performance requirements of QA plan • Construction IA testing/ inspection • Community relations • Construction QA procedural compliance auditing • Performance of defined mitigation measures • Construction/materials QA • Final construction/materials QC/QA plan • Quantity/cost of WSP callbacks	Owner	Owner	Owner	Owner
			Contractor	Contractor
		CMr		
• Early construction • Construction staking • Erosion control • Spill prevention • Schedule	Contractor	Contractor		
• Construction compliance • Safety • Construction quality • Material quality, documentation and availability • Construction QC • Accidents within construction zone/liability • Operation and maintenance during construction • Maintenance of traffic • Damage to utilities/third party during construction • Falsework • Shop drawings • Equipment failure/breakdown • Work methods • Warranty				

OTHER RISK ISSUES

Responsibility / Risks	Traditional	Construction Management	Design-Build	Design-Build-Maintain
• Right-of-way • Environmental impacts, permits and compliance • Force majeure • Third party agreements • Regulations • Final responsibility	Owner	Owner	Owner	Owner
• Traffic amounts • Changes in conditions • Long term ownership				Contractor
• Traffic safety • User traffic information • Maintenance • Environmental issues			Contractor	
• Latent conditions • Initial local agency impacts • Initial utility identification & permits				
• Modification to local agency permits • Modified agreement with utilities • Coordination with utilities • Coordination with third parties • Coordination with other work		CMr		
• Verification of utility locations • Relocation of utilities • Damage to utilities during construction • Insurance	Contractor	Contractor		

Appendix D: Process maps

The figure below depicts the road project delivery process options in full.



This survey concentrates on the part of the delivery process that starts from the preparation of the road scheme (predesign) and ends with periodic maintenance. Feasibility study, preplanning and operation (i.e. daily maintenance) are omitted. Procurement methods of interest are DBB, CM, DB, DB with the contractors' early involvement at the road scheme preparation and DBM with its variants. The process as a whole is mapped for DBB, and the other project delivery methods are mapped only where the processes differ from those of DBB procurement. As a result, predesign and maintenance processes often apply to those depicted in connection with DBB. The process charts presented represent with adequate accuracy the road procurement process in general, even though there may be slight differences between countries in the level at which certain tasks are done. Also, the terms used may vary.

To facilitate the comparison of the different project delivery systems the project delivery process maps in this section are divided into the following stages:

STATUTORY REQUIREMENTS. Statutory requirements have to be met in order to initiate a road delivery process. The project should be part of the annual program and fit into the budget. The result of this phase will be a contract notice submitted through official channels when required. In European Union countries this generally means publishing an EU contract notice in the official paper, if a design contract is worth more than €750 000 or a construction contract is worth more than €6 242 028.

TENDER. Tender stage can be seen as a part of the subsequent phase (predesign, design, construction, or periodic maintenance). The number of tendering stages the project goes through depends on the project delivery method used and the extent of work packages. The tender stage can be divided into the following phases:

Prequalification. The result of this phase will be a list of pre-qualified designers and/or contractors (generally 3–6) to whom the request for proposal is sent. The prequalification process is mainly aimed at reducing the number of interested consortia/companies to ensure that unsuccessful tenderers do not incur unnecessary tendering costs.

Tender. As a result of this phase the pre-qualified designers and/or contractors will submit their tender packages.

Contract award. The result of this phase will be the signed contract and the final terms of the contract for the project.

ROAD SCHEME. The preparation of the Road scheme may be packaged with design, design-construction, design-construction-maintenance or it may be subject to a separate contract. The road scheme stage can be divided into following phases:

Predesign. The result of this phase will be the road scheme that still needs to pass public obligations.

Public obligations. The result of this phase will be the approved road scheme that fulfils all the public obligations and is the basis for the final design.

DESIGN. Design may be packaged with construction, preparation of the road scheme, construction-maintenance, road scheme-construction-maintenance or it may be subject to a separate contract:

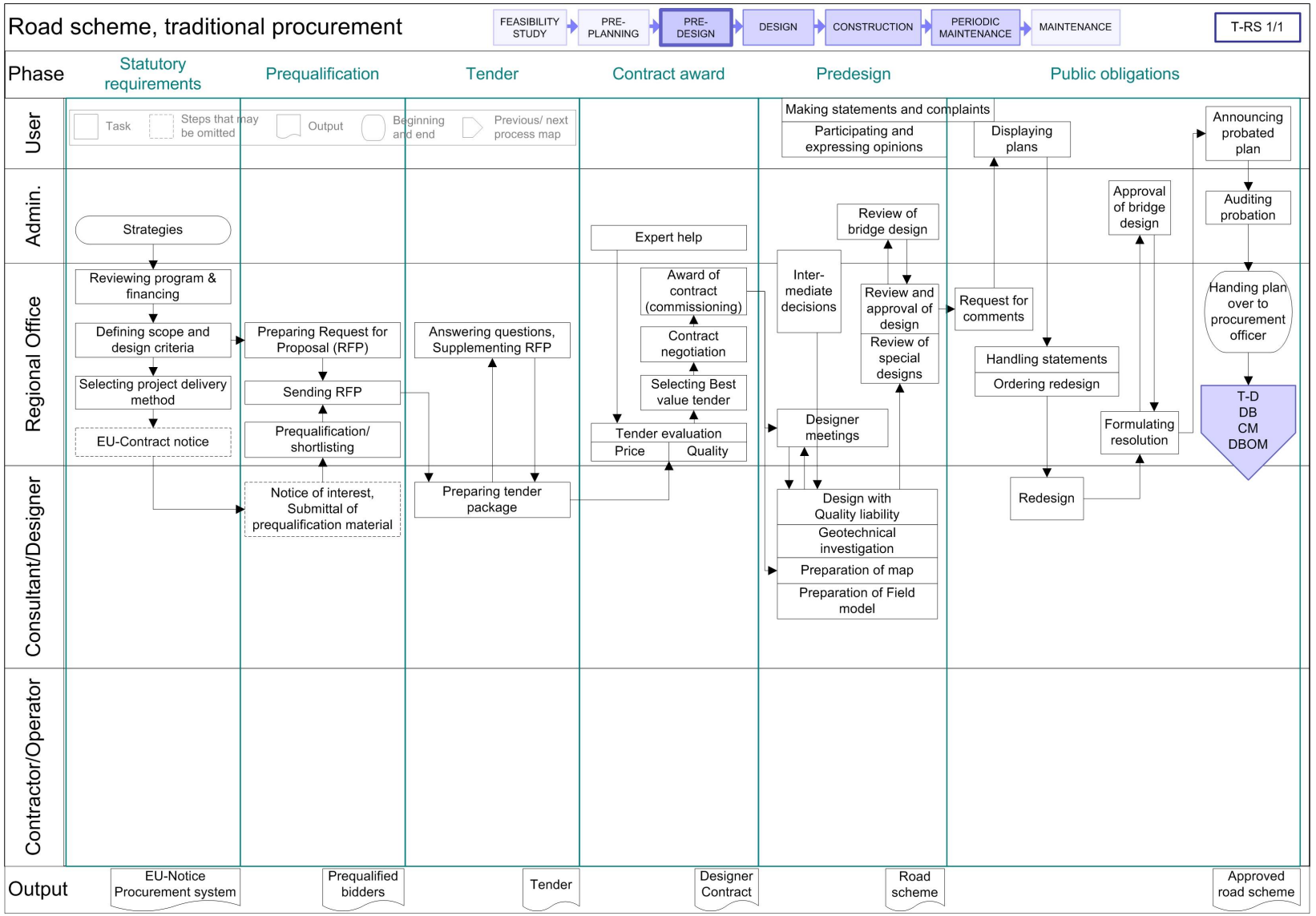
Final design. The result of this phase will be the final design or construction plan.

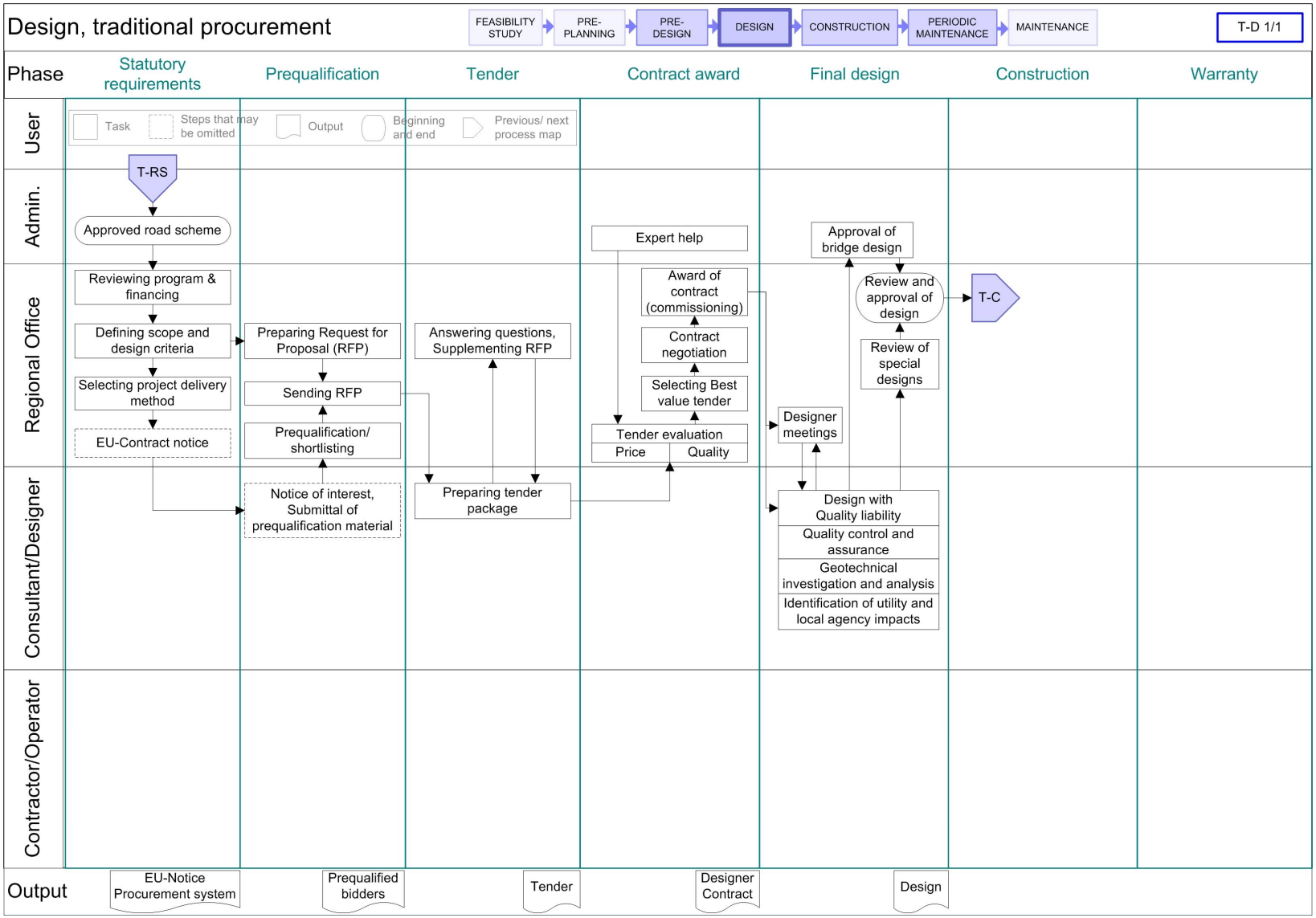
CONSTRUCTION. Construction may be packaged with design, design-maintenance, road scheme-design-maintenance or it may be a separate contract. As a result of this stage normal traffic will start on the road.

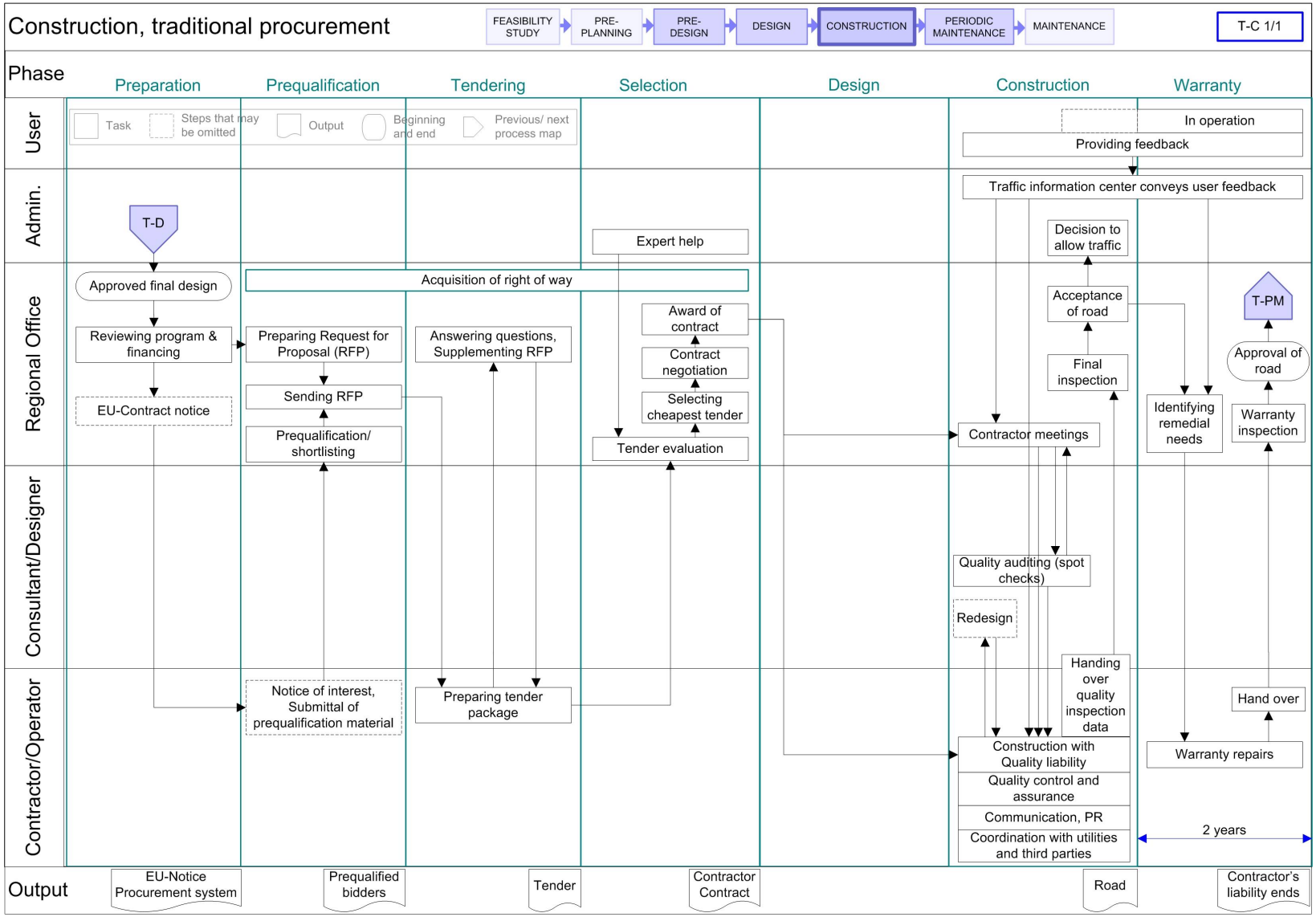
MAINTENANCE. In this research, the daily maintenance (operation) is omitted. The research concentrates on the periodic maintenance which can be packaged with design-construction or it may be a separate contract.

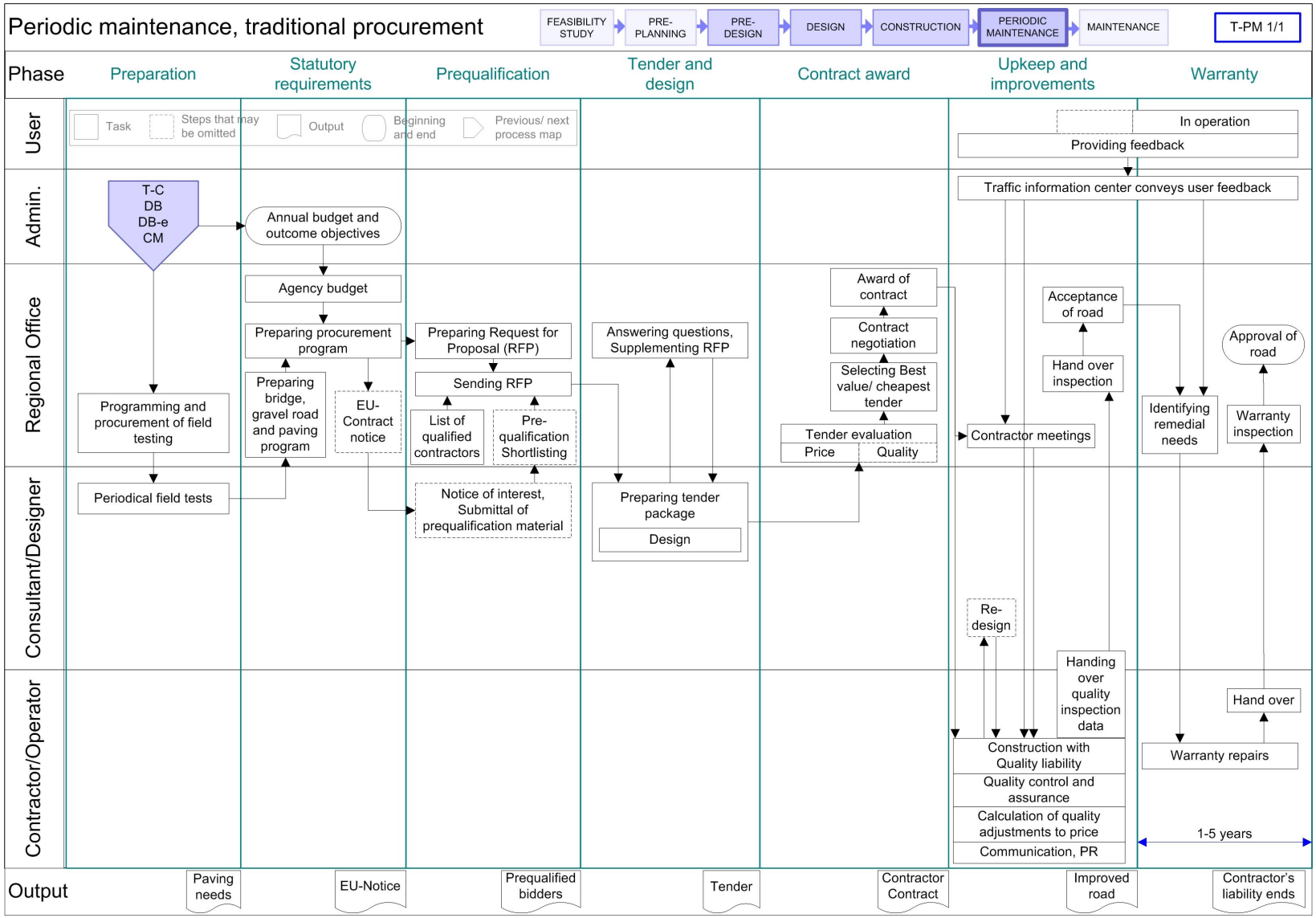
Warranty. Warranty is included in the maintenance stage even though it is an extension of construction. The reason for it being under maintenance is that during this period the road will be used and operated normally, but the responsibility for road failures is on the construction company. As a result of this phase, the contractor will be relieved of his contractual liability. The length of the warranty period varies. After the warranty period, in a situation where gross negligence and breach of contract is discovered, the contractor will be liable according to legal provisions.

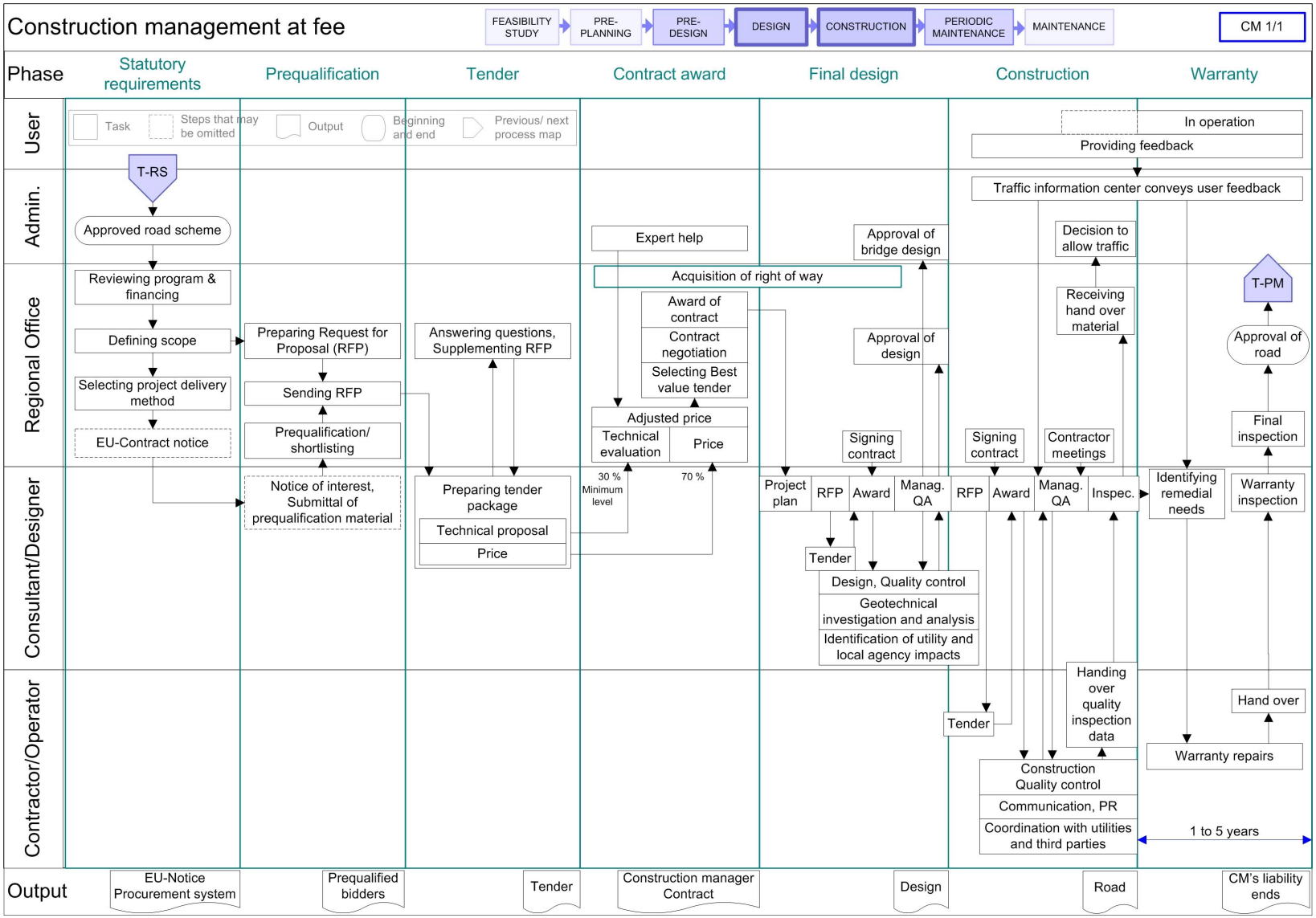
Periodic maintenance. Periodic maintenance includes contracts that are neither for daily maintenance nor for investments. The result of this phase will be an improved/maintained road.

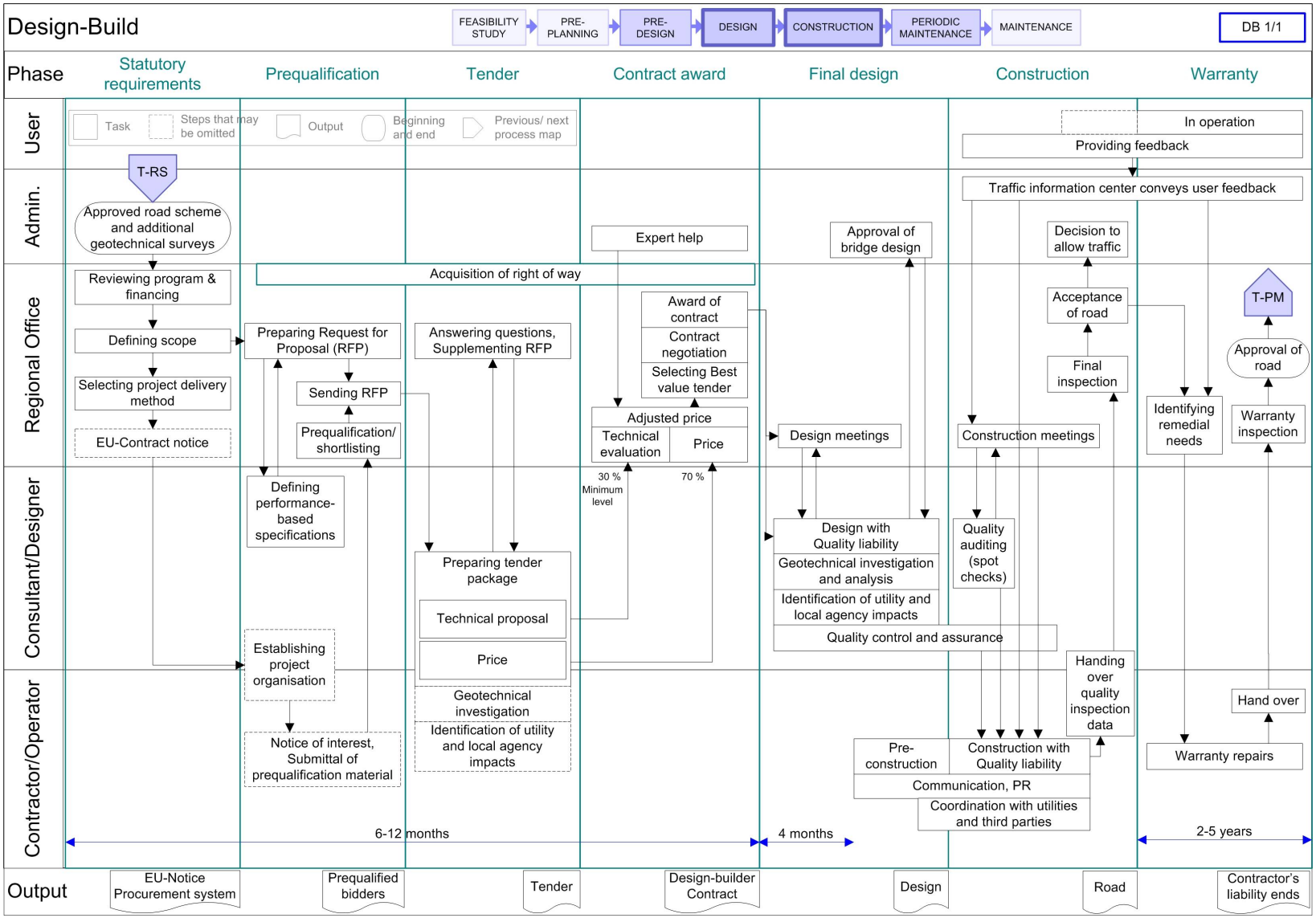

Road scheme, traditional procurement
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
T-RS 1/1
Phase
Statutory requirements
Prequalification
Tender
Contract award
Predesign
Public obligations
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
Making statements and complaints
Participating and expressing opinions
Displaying plans
Announcing probated plan
Approval of bridge design
Auditing probation
Strategies
Expert help
Review of bridge design
Reviewing program & financing
Award of contract (commissioning)
Inter-mediate decisions
Review and approval of design
Request for comments
Handing plan over to procurement officer
Defining scope and design criteria
Preparing Request for Proposal (RFP)
Answering questions, Supplementing RFP
Contract negotiation
Review of special designs
Handling statements
Ordering redesign
Selecting project delivery method
Sending RFP
Selecting Best value tender
T-D
DB
CM
DBOM
EU-Contract notice
Prequalification/ shortlisting
Tender evaluation
Price
Quality
Designer meetings
Formulating resolution
Notice of interest, Submittal of prequalification material
Preparing tender package
Design with Quality liability
Redesign
Geotechnical investigation
Preparation of map
Preparation of Field model
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Designer Contract
Road scheme
Approved road scheme

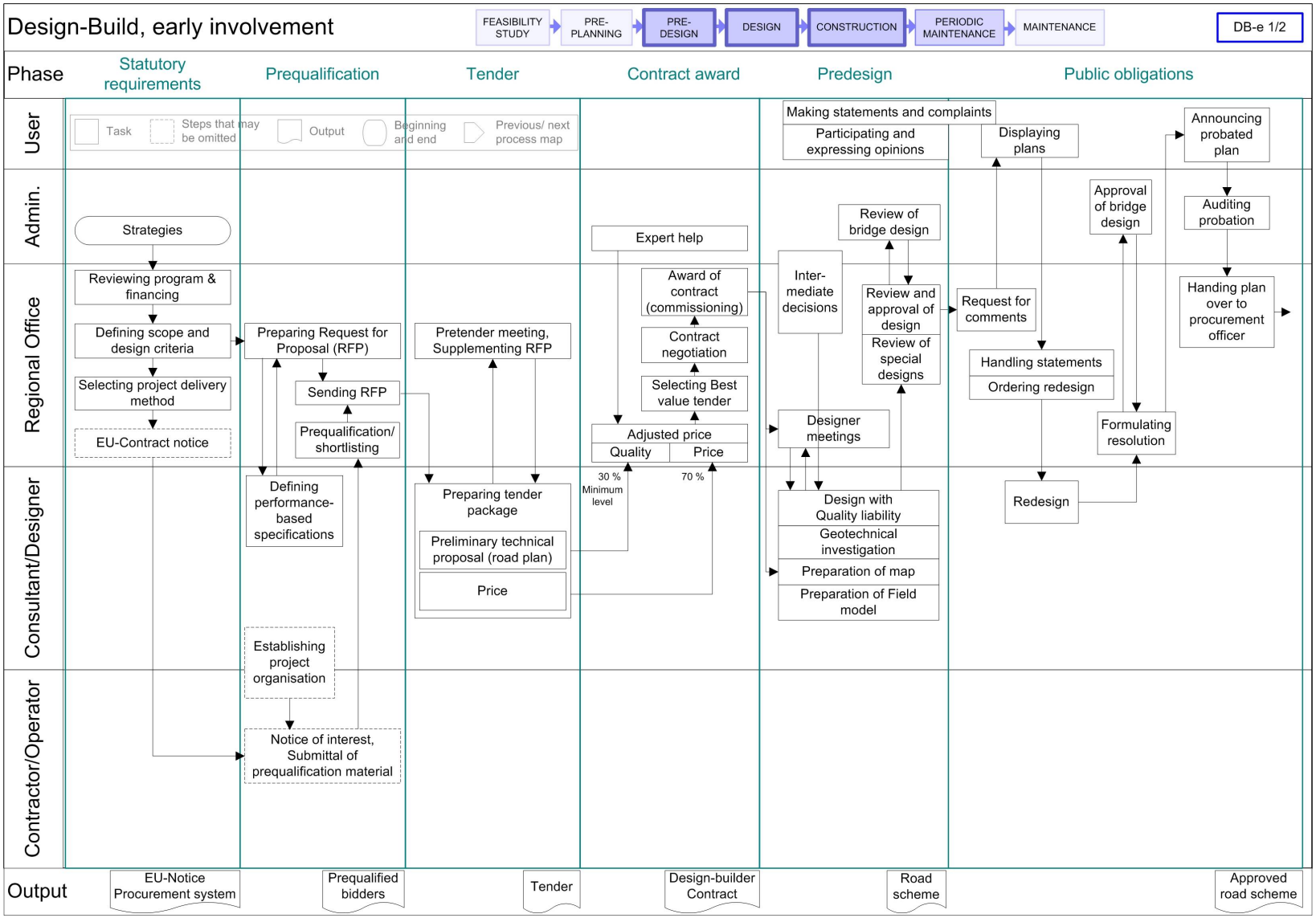

Design, traditional procurement
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
T-D 1/1
Phase
Statutory requirements
Prequalification
Tender
Contract award
Final design
Construction
Warranty
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
T-RS
Approved road scheme
Reviewing program & financing
Defining scope and design criteria
Selecting project delivery method
EU-Contract notice
Preparing Request for Proposal (RFP)
Sending RFP
Prequalification/ shortlisting
Notice of interest, Submittal of prequalification material
Answering questions, Supplementing RFP
Preparing tender package
Expert help
Award of contract (commissioning)
Contract negotiation
Selecting Best value tender
Tender evaluation
Price
Quality
Approval of bridge design
Review and approval of design
Review of special designs
T-C
Designer meetings
Design with Quality liability
Quality control and assurance
Geotechnical investigation and analysis
Identification of utility and local agency impacts
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Designer Contract
Design

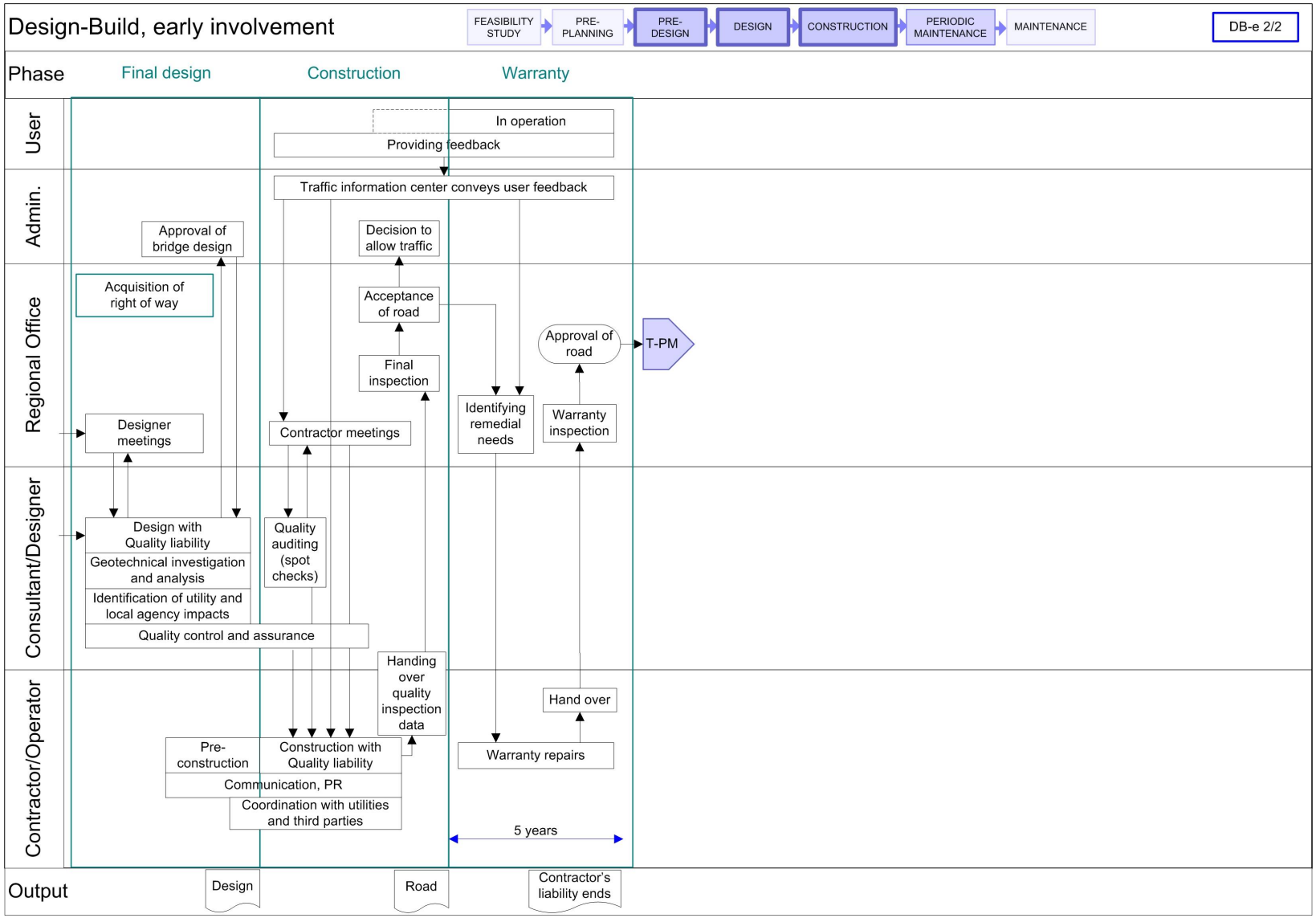

Construction, traditional procurement
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
T-C 1/1
Phase
Preparation
Prequalification
Tendering
Selection
Design
Construction
Warranty
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
In operation
Providing feedback
Traffic information center conveys user feedback
T-D
Expert help
Decision to allow traffic
Approved final design
Acquisition of right of way
Acceptance of road
T-PM
Award of contract
Reviewing program & financing
Preparing Request for Proposal (RFP)
Answering questions, Supplementing RFP
Contract negotiation
Final inspection
Approval of road
Sending RFP
Selecting cheapest tender
Identifying remedial needs
Warranty inspection
EU-Contract notice
Prequalification/ shortlisting
Tender evaluation
Contractor meetings
Quality auditing (spot checks)
Redesign
Handing over quality inspection data
Hand over
Notice of interest, Submittal of prequalification material
Preparing tender package
Construction with Quality liability
Warranty repairs
Quality control and assurance
Communication, PR
2 years
Coordination with utilities and third parties
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Contractor Contract
Road
Contractor's liability ends

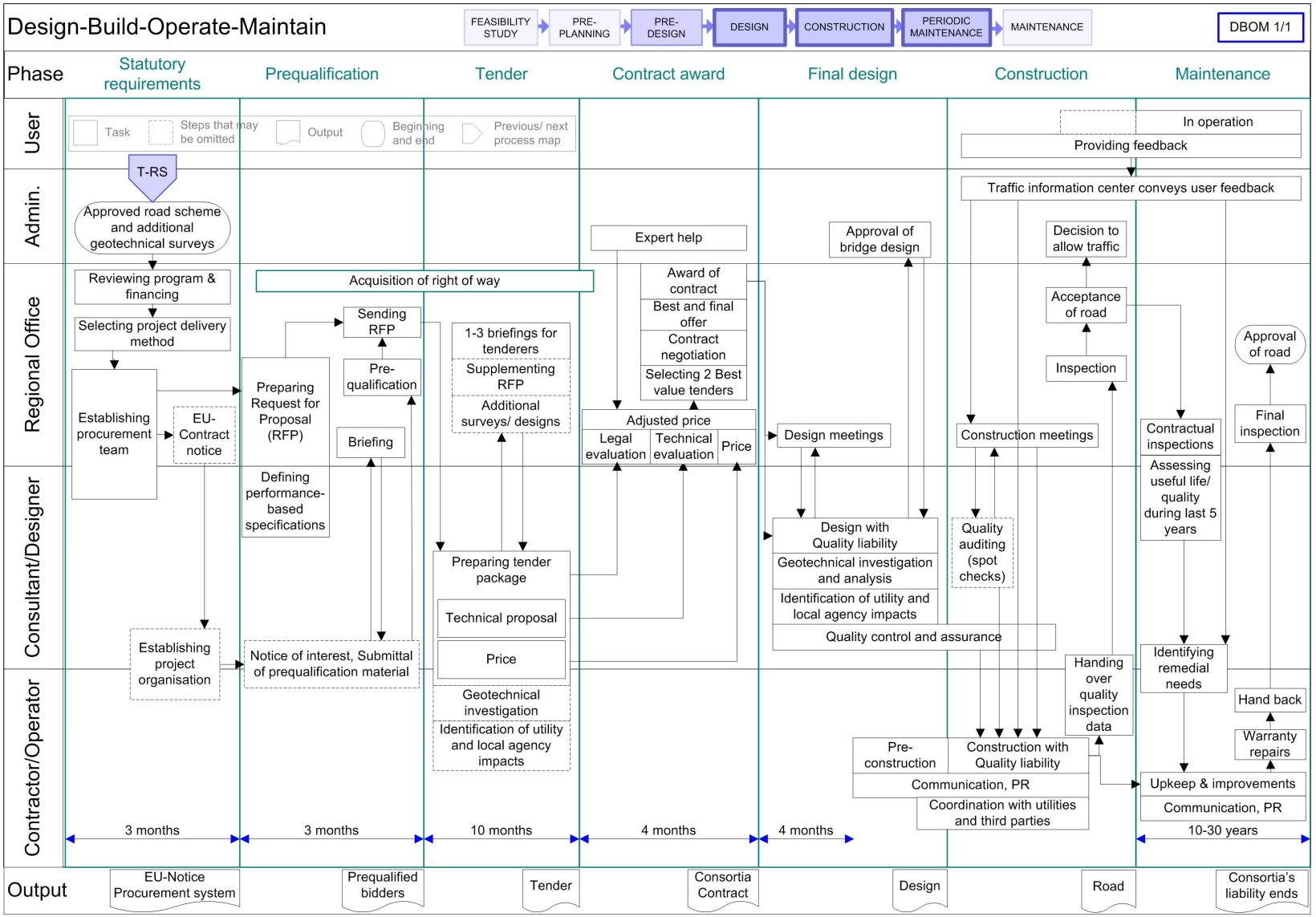

Periodic maintenance, traditional procurement
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
T-PM 1/1
Phase
Preparation
Statutory requirements
Prequalification
Tender and design
Contract award
Upkeep and improvements
Warranty
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
In operation
Providing feedback
Traffic information center conveys user feedback
T-C
DB
DB-e
CM
Annual budget and outcome objectives
Agency budget
Award of contract
Acceptance of road
Approval of road
Preparing procurement program
Preparing Request for Proposal (RFP)
Answering questions, Supplementing RFP
Contract negotiation
Hand over inspection
Preparing bridge, gravel road and paving program
Sending RFP
Selecting Best value/ cheapest tender
Identifying remedial needs
Programming and procurement of field testing
EU-Contract notice
List of qualified contractors
Pre-qualification Shortlisting
Tender evaluation
Price
Quality
Contractor meetings
Warranty inspection
Periodical field tests
Notice of interest, Submittal of prequalification material
Preparing tender package
Design
Re-design
Handing over quality inspection data
Hand over
Construction with Quality liability
Warranty repairs
Quality control and assurance
Calculation of quality adjustments to price
Communication, PR
1-5 years
Output
Paving needs
EU-Notice
Prequalified bidders
Tender
Contractor Contract
Improved road
Contractor's liability ends


Construction management at fee
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
CM 1/1
Phase
Statutory requirements
Prequalification
Tender
Contract award
Final design
Construction
Warranty
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
In operation
Providing feedback
T-RS
Approved road scheme
Traffic information center conveys user feedback
Expert help
Approval of bridge design
Decision to allow traffic
Reviewing program & financing
Acquisition of right of way
T-PM
Defining scope
Preparing Request for Proposal (RFP)
Answering questions, Supplementing RFP
Award of contract
Contract negotiation
Selecting Best value tender
Approval of design
Receiving hand over material
Approval of road
Selecting project delivery method
Sending RFP
Adjusted price
Technical evaluation
Price
Signing contract
Contractor meetings
Final inspection
EU-Contract notice
Prequalification/ shortlisting
30 % Minimum level
70 %
Notice of interest, Submittal of prequalification material
Preparing tender package
Technical proposal
Price
Project plan
RFP
Award
Manag. QA
RFP
Award
Manag. QA
Inspec.
Identifying remedial needs
Warranty inspection
Tender
Design, Quality control
Geotechnical investigation and analysis
Identification of utility and local agency impacts
Handing over quality inspection data
Hand over
Tender
Warranty repairs
Construction Quality control
Communication, PR
Coordination with utilities and third parties
1 to 5 years
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Construction manager Contract
Design
Road
CM's liability ends


Design-Build
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
DB 1/1
Phase
Statutory requirements
Prequalification
Tender
Contract award
Final design
Construction
Warranty
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
In operation
Providing feedback
T-RS
Approved road scheme and additional geotechnical surveys
Traffic information center conveys user feedback
Expert help
Approval of bridge design
Decision to allow traffic
Reviewing program & financing
Acquisition of right of way
Acceptance of road
T-PM
Defining scope
Preparing Request for Proposal (RFP)
Answering questions, Supplementing RFP
Award of contract
Contract negotiation
Selecting Best value tender
Final inspection
Approval of road
Selecting project delivery method
Sending RFP
Adjusted price
Technical evaluation
Price
Identifying remedial needs
Warranty inspection
EU-Contract notice
Prequalification/ shortlisting
Design meetings
Construction meetings
30 % Minimum level
70 %
Defining performance-based specifications
Design with Quality liability
Quality auditing (spot checks)
Preparing tender package
Technical proposal
Price
Geotechnical investigation and analysis
Identification of utility and local agency impacts
Quality control and assurance
Establishing project organisation
Handing over quality inspection data
Hand over
Geotechnical investigation
Identification of utility and local agency impacts
Notice of interest, Submittal of prequalification material
Pre-construction
Construction with Quality liability
Warranty repairs
Communication, PR
Coordination with utilities and third parties
6-12 months
4 months
2-5 years
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Design-builder Contract
Design
Road
Contractor's liability ends


Design-Build, early involvement
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
DB-e 1/2
Phase
Statutory requirements
Prequalification
Tender
Contract award
Predesign
Public obligations
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
Strategies
Reviewing program & financing
Defining scope and design criteria
Selecting project delivery method
EU-Contract notice
Preparing Request for Proposal (RFP)
Sending RFP
Prequalification/ shortlisting
Defining performance-based specifications
Establishing project organisation
Notice of interest, Submittal of prequalification material
Pretender meeting, Supplementing RFP
Preparing tender package
Preliminary technical proposal (road plan)
Price
Expert help
Award of contract (commissioning)
Contract negotiation
Selecting Best value tender
Adjusted price
Quality
Price
30 % Minimum level
70 %
Making statements and complaints
Participating and expressing opinions
Review of bridge design
Inter-mediate decisions
Review and approval of design
Review of special designs
Designer meetings
Design with Quality liability
Geotechnical investigation
Preparation of map
Preparation of Field model
Displaying plans
Request for comments
Handling statements
Ordering redesign
Redesign
Approval of bridge design
Formulating resolution
Announcing probated plan
Auditing probation
Handing plan over to procurement officer
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Design-builder Contract
Road scheme
Approved road scheme


Design-Build, early involvement
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
DB-e 2/2
Phase
Final design
Construction
Warranty
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
In operation
Providing feedback
Traffic information center conveys user feedback
Approval of bridge design
Decision to allow traffic
Acquisition of right of way
Acceptance of road
Approval of road
T-PM
Final inspection
Designer meetings
Contractor meetings
Identifying remedial needs
Warranty inspection
Design with Quality liability
Geotechnical investigation and analysis
Identification of utility and local agency impacts
Quality control and assurance
Quality auditing (spot checks)
Handing over quality inspection data
Hand over
Pre-construction
Construction with Quality liability
Communication, PR
Coordination with utilities and third parties
Warranty repairs
5 years
Output
Design
Road
Contractor's liability ends


Design-Build-Operate-Maintain
FEASIBILITY STUDY
PRE-PLANNING
PRE-DESIGN
DESIGN
CONSTRUCTION
PERIODIC MAINTENANCE
MAINTENANCE
DBOM 1/1
Phase
Statutory requirements
Prequalification
Tender
Contract award
Final design
Construction
Maintenance
User
Admin.
Regional Office
Consultant/Designer
Contractor/Operator
Task
Steps that may be omitted
Output
Beginning and end
Previous/ next process map
In operation
Providing feedback
T-RS
Approved road scheme and additional geotechnical surveys
Traffic information center conveys user feedback
Reviewing program & financing
Acquisition of right of way
Expert help
Approval of bridge design
Decision to allow traffic
Selecting project delivery method
Award of contract
Best and final offer
Contract negotiation
Selecting 2 Best value tenders
Acceptance of road
Approval of road
Sending RFP
1-3 briefings for tenderers
Supplementing RFP
Additional surveys/ designs
Pre-qualification
Inspection
Establishing procurement team
EU-Contract notice
Preparing Request for Proposal (RFP)
Briefing
Adjusted price
Legal evaluation
Technical evaluation
Price
Design meetings
Construction meetings
Contractual inspections
Final inspection
Defining performance-based specifications
Assessing useful life/ quality during last 5 years
Design with Quality liability
Geotechnical investigation and analysis
Identification of utility and local agency impacts
Quality control and assurance
Quality auditing (spot checks)
Preparing tender package
Technical proposal
Price
Geotechnical investigation
Identification of utility and local agency impacts
Establishing project organisation
Notice of interest, Submittal of prequalification material
Handing over quality inspection data
Identifying remedial needs
Hand back
Warranty repairs
Pre-construction
Construction with Quality liability
Communication, PR
Coordination with utilities and third parties
Upkeep & improvements
Communication, PR
3 months
3 months
10 months
4 months
4 months
10-30 years
Output
EU-Notice Procurement system
Prequalified bidders
Tender
Consortia Contract
Design
Road
Consortia's liability ends

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Series title, number and
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Author(s)
Koppinen, Tiina & Lahdenperä, Pertti

Title

Road sector experiences on project delivery methods

Abstract

Globally, innovative delivery methods involving broader service packages are increasingly used in infrastructure projects. In addition to construction and technical design also; financing, operation and maintenance for a certain period of time may be integral parts of the contract. This change is driven by the clients' quest to focus on their core business – securing adequate infrastructure – and by the clients' and the contractors' aim to increase their benefits. At the same time, the number of alternative project delivery methods is increasing making it more difficult for the client to select an appropriate method. As a result, decisions to use any of the alternative project delivery methods are often subjective. There is an evident lack of consolidated knowledge about the specific merits of these alternative routes.

To assist strategic decision making on the best project delivery methods for future project delivery, the research concentrated on gathering data on the performance of different road project delivery methods. Data was gathered on the performance of the traditional Design-Bid-Build (DBB) and the Design-Build (DB), Construction Management (CM) and Design-Build-Maintain (DBM and its variants DBOM, DBFO, BOOT, etc.) project delivery systems in road construction in Finland, UK, Australia, New Zealand and USA. The main source of information were semi-structured interviews of the main market actors (clients, contractors, designers, consultants and researchers). Additionally an extensive literature review was done to supplement and verify the data provided by the interviewees. The data was then used as the basis for the actual performance analysis presented in the second report 'The Current and Future Performance of Road Project Delivery Methods'.

It seems that the problems experienced with DBB have led to increased use of DB and DBM in the countries of interest. These project delivery methods help deliver projects in time and to budget while also reducing other experienced problems (adversarial relationships, etc.). However, there seem to be some problems even with DB (reduced quality, etc.) and DBM (reduced client flexibility, etc.) . Solutions to these problems are sought by largely similar actions taken or planned in the different countries. Alliancing also seems to provide an interesting alternative for complex and large projects. Use of CM in road construction is marginal.

Keywords
road procurement, project delivery, design, construction, maintenance, Design-Bid-Build, construction management, Design-Build, Design-Build-Maintain, Design-Build-Finance-Operate, Build-Own-Operate-Transfer, alliance, costs, performance, innovation

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Commissioned by
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Internationally road authorities are becoming more of asset managers which enables use of more integrated service packages. In addition to construction and technical design also; financing, operation and maintenance for a certain period of time may be integral parts of contracts. Generally broader service packages, performance- based contracting and large-scale competition are believed to enable the optimisation of the process and product as a whole, as well as to facilitate the development of the market. However, decisions to use any of the alternative project delivery methods are often subjective due to a lack of consolidated knowledge about specific merits of these alternative routes.

To assist strategic decisions on the best project delivery methods for the future project delivery, this report concentrated on gathering data on the performance of the traditional Design-Bid-Build (DBB) and the Design-Build (DB), Construction Management (CM) and Design-Build-Maintain (DBM and its variants DBOM, DBFO, BOOT, etc.) project delivery systems in road construction in Finland, UK, Australia, New Zealand and USA. The main source of information were semi-structured interviews of the main market actors (clients, contractors, designers, consultants and researchers). Additionally an extensive literature review was done to supplement and verify the data presented by the interviewees.

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