

Selection Criteria used for the Choice of Procurement System for Major Highway Construction Projects

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Abstract

In the project management process of the realization of major highway projects, the choice of procurement system is central to success as the relevant social environments of public infrastructure projects are numerous and with interdependent interfaces. Since highway projects cannot be considered as repetitive projects, a statistical analysis of performance of highway projects using various procurement systems would not lead to representative results, therefore, the research methodology chosen is dependent on opinions of experts in the field of highway project and contract management.

The procurement systems investigated are Traditional, Traditional Fast Track, Design and Build, Private Public Partnership, Construction Management, Management Contracts and Partnering. An extensive literature review showed significant research into procurement system selection models for buildings projects. Based on this literature review, the most common selection criteria for the most suitable procurement system as documented were chosen and a questionnaire was developed and distributed to experts in highway authorities in Europe and abroad to rate the procurement systems against these criteria.

This paper presents an evaluation of the criteria most commonly employed by contract awarding authorities in the highway industry, both in Greece and abroad, in choosing the most beneficial procurement systems for highway projects.

Keywords

Project procurement systems, Highway projects, Contracts management

1. Introduction

The World Road Association (PIARC) defines procurement as the process whereby an entity purchases works, goods/supplies or services and state that it is common for Road Administrations to consider the procurement of professional or consulting services separately from physical works or contracting services (PIARC, 2003). In the context of this paper the Project Procurement System (PPS) is defined as the overall system chosen for the procurement of a major highway project including any contracts required for its design, construction and supervision of construction.

The procurement process of any major infrastructure project includes the design phase, tender phase and construction phase. In the design phase the Owner determines the need for the realisation of the project, carries out a feasibility study and completes the required designs either through an internal design team or through outsourcing. In the tender phase the project budget and tender documents are prepared by the

Owner based on the definitive design and a construction tender procedure is carried out according to the relevant legislation and the chosen PPS. Finally, during the construction phase the project is constructed according to the construction contractual documents and construction supervision is achieved on behalf of the Owner in-house or by outsourcing to a Construction Manager (CM) and is completed when the project is handed over to the Owner. In addition, the Owner maintains the project throughout its design life (either with in-house resources or out-sourcing). The major participants in the above procedure are the Owner, also known as the Client, the Design Consultant, Contractor and Construction Manager (CM). The project procurement system (PPS) chosen defines the number and types of contracts drawn up between the major participants. The number and quality of contractual relationships between the major participants are crucial in terms of time, cost and quality achievement of the resulting project.

This paper attempts to draw conclusions from a survey between highway procurement experts of the rating of each examined PPS against a series of selection criteria, as a first step towards the development of a simple model that can be employed by highway agencies around the world when faced with the choice of project procurement system most compatible with the specific project characteristics, the Owner's needs and the market situation.

2. Selection Criteria Employed for the Choice of Project Procurement Systems

An extensive literature review of the systems in use during the past 20 years was carried out. It must be noted that the vast majority of relevant published papers refer to practice in the US Departments of Transport, Australia and Hong Kong. With regards to proposed models for choice of procurement system, most refer to building projects. Following this review the author concluded on the procurement systems to be investigated are Traditional, Traditional Fast Track, Design and Build, Private Public Partnership (BOT, turnkey etc.) Construction Management, Management Contracts and Partnering. A short description of each PPS is included in Table 1.

Highway projects cannot be considered as repetitive projects. As a result a statistical analysis of the performance of various projects using various procurement systems would not lead to representative results, therefore a methodology dependent on opinions of experts in the field of highway project and contract management was chosen. It was therefore necessary to choose evaluation criteria most relevant when making the choice of the most appropriate Project Procurement System and to develop a relevant questionnaire in order to obtain expert opinions. An initial questionnaire survey was circulated to 20 relevant highway procurement experts in order to evaluate each PPS against the chosen selection criteria

The choice of evaluation criteria was made based on the results of an extensive literature review into the most commonly employed evaluation criteria. The criteria employed in making this choice can be globally separated into criteria relating to the project characteristics, the clients needs, market attributes and contractor needs. Those criteria that were most frequently used in similar studies relating mostly to building projects were chosen to be included in this survey for road projects.

In Tables 2 and 3; the results of the literature review regarding evaluation criteria relating to Project Characteristics and Client's Requirements are summarized and the criteria chosen are denoted in bold and correspond generally to those most frequently employed. In addition, criteria relating to Market Attributes such as availability of experienced contractors and familiarity of procurement system were also included in the survey. The selection criteria that were included in the survey against which each PPS was rated on a scale of 1 to 10 are shown in Table 4 along with an explanation of each rating scale.

Table 1: Project Procurement Systems

Project Procurement System	Short Description
Traditional	Detailed designs are completed before tender of a construction contract. In this case the client contracts with a designer and separately with a contractor and supervises construction with in house staff.
Traditional Fast Track	Designs are partially completed before tender and completed in parallel with construction. In this case the client contracts with a designer and separately with a contractor and supervises construction with in house staff.
Design and Build	Preliminary designs may or may not be completed before tender for one contractor responsible for both completing the detailed design and construction of the project. Supervision of construction may again be carried out by the client directly.
Private Public Partnership contract (BOT, turnkey etc.)	In this case the client contracts with one entity that finances, designs, constructs, operates and maintains a project for a fixed period, at the end of which the project is transferred free of charge to the government (client).
Construction Management	The owner (client) contracts separately with a designer, a contractor and a construction manager. The designer is responsible to complete the design. The construction manager supervises the construction of the project by the contractor on behalf of the client.
Management contracts	The owner (client) contracts separately with a designer and a construction manager. The construction manager supervises the construction work carried out by his sub-contractor.
Partnering	The owner (client) contracts with designers and contractors or design/builders that have proven to have adopted the partnering philosophy by which designer, contractor and owner work towards a common goal by reducing incidents of disputes in order to avoid litigations. Such a relationship can also be unofficial. In any case, common procedures are set up for project delivery regardless of the contractual relationship between parties.

Table 2: Selection Criteria Related to Project Characteristics as Found in the Literature

Selection Criteria (times found in literature)	Source
Flexibility (13)	Love <i>et.al.</i> 1998, Alhazmi and McCaffer 2000, Chan <i>et al.</i> 2001, Cheung <i>et al.</i> 2001, Bennet and Flanagan 1983, Hewitt 1985, HMSO 1985, Skitmore and Marsden 1988, Ng <i>et al.</i> 2002, NEDO 1985, Singh 1990, Masterman and Duff 1994, Luu 2003.
Complexity (13)	Love <i>et.al.</i> 1998, Chan <i>et al.</i> 2001, Alhazmi and McCaffer 2000, Cheung <i>et al.</i> 2001, Bennet and Flanagan 1983, HMSO 1985, Skitmore and Marsden 1988, Franks 1990, Ng <i>et al.</i> 2002, NEDO 1985, Singh 1990, Masterman and Duff 1994, Luu 2003.
Design and construction integration	Alhazmi and McCaffer 2000
Project funding method	Alhazmi and McCaffer 2000
Degree of clearness of required	Chan <i>et.al.</i> 2001
Project size	Chan <i>et.al.</i> 2001
Other criteria mentioned:	
Type, Cost, Time constraints, Payment method	Alhazmi and McCaffer 2000

Table 3: Selection Criteria Related to Client Requirements as Found in the Literature

Criteria	Source
Speed (10)	Love <i>et.al.</i> 1998, Cheung <i>et al.</i> 2001, Bennet and Flanagan 1983, HMSO 1985, Skitmore and Marsden 1988, NEDO 1985, Singh 1990, Kumaraswamy and Dissanayaka 2001, Ng <i>et.al.</i> 2002, Luu <i>et.al.</i> 2003.
Certainty of time (8)	Love <i>et.al.</i> 1998, Alhazmi and McCaffer 2000, Chan <i>et al.</i> 2001, Kumaraswamy and Dissanayaka 2001, Singh 1990, Masterman and Duff 1994, Luu <i>et.al.</i> 2003, Ng <i>et.al.</i> 2002.
Certainty of cost (13)	Love <i>et.al.</i> 1998, Alhazmi and McCaffer 2000, Chan <i>et al.</i> 2001, Kumaraswamy and Dissanayaka 2001, Cheung <i>et al.</i> 2001, HMSO 1985, Skitmore and Marsden 1988, NEDO 1985, Singh 1990 Masterman and Duff 1994, Luu <i>et.al.</i> 2003, Ng <i>et.al.</i> 2002, Bennet and Flanagan 1983.
Risk allocation/avoidance (10)	Love <i>et.al.</i> 1998, Chan <i>et.al.</i> 2001, Cheung <i>et.al.</i> 2001, Bennet and Flanagan 1983, HMSO 1985, Skitmore and Marsden 1988, NEDO 1985, Singh 1990, Luu 2003, Ng <i>et al.</i> 2002.
Quality (12)	Love <i>et.al.</i> 1998, Alhazmi and McCaffer 2000, Chan <i>et al.</i> 2001, Kumaraswamy and Dissanayaka 2001, Cheung <i>et.al.</i> 2001, Bennet and Flanagan 1983, HMSO 1985, Skitmore and Marsden 1988, NEDO 1985, Singh 1990, Luu <i>et.al.</i> 2003, Ng <i>et.al.</i> 2002,
Responsibility/accountability (11)	Love <i>et.al.</i> 1998, Chan <i>et.al.</i> 2001, Bennet and Flanagan 1983, Hewitt 1985, Masterman and Gameson 1994, HMSO 1985, Skitmore and Marsden 1988, NEDO 1985, Singh 1990, Luu <i>et.al.</i> 2003, Ng <i>et.al.</i> 2002.
Price competition (13)	Love <i>et.al.</i> 1998, Chan <i>et al.</i> 2001, Cheung <i>et.al.</i> 2001, Bennet and Flanagan 1983, Masterman and Gameson 1994, HMSO 1985, Skitmore and Marsden 1988, Franks 1990, NEDO 1985, Singh 1990, Masterman and Duff 1994, Luu <i>et.al.</i> 2003, Ng <i>et al.</i> 2002..
Minimization of disputes and arbitration (6)	Love <i>et.al.</i> 1998, Kumaraswamy and Dissanayaka 2001, HMSO 1985, Skitmore and Marsden 1988, Singh 1990, Masterman and Duff 1994.
Degree of client's involvement, Time available for project completion	Chan <i>et.al.</i> 2001
Other criteria mentioned:	
Certainty, Innovative input from consultants	Hewitt 1985
Certainty of payment intervals	Love <i>et.al.</i> 1998
Lower capital and life cycle costs and Effective and efficient communication and decision making	Kumaraswamy and Dissanayaka 2001

Table 4: Explanation of Rating Scale for each Selection Criteria used in Survey

Criteria	Each PPS was rated as 10 (in a scale of 1 to 10)
Project Characteristics	
Flexibility	it can accommodate changes in design and construction after commencement of contract.
Complexity	it can accommodate advanced construction requirements.
Project funding	it attracts significant private investment
Integration	it allows interaction between design and construction phases
Design completion at tender	it does not require complete designs at tender.
Size	it is considered ideal for major motorway projects
Speed	it minimizes significantly the overall pre-construction and construction duration.
Client's Requirements	
Certainty of time	it guarantees time of construction completion at outset
Certainty of cost	it enhances certainty of cost at start of project
Risk allocation/avoidance	it shifts most of the risk away from the client
Quality standards	it allows certainty of high quality through tight supervision
Point of responsibility	it reduces client bureaucracy due to few points of responsibility
Price competition	it guarantees value for money through price competition
Minimization of disputes	it minimizes the occurrences of disputes
Client's involvement	it allows significant client involvement
Market Attributes	
Availability of competent contractors and design firms	the construction market has an adequate number of contractors experienced in the specific PPS
Familiarity of procurement system	it was considered as a familiar one in the respondents construction industry

3. Survey results

The average rating and corresponding standard deviation for each PPS against each criterion was calculated and the results are summarized in table 5 and are shown graphically in Figures 1-7. Where the standard deviation less than 2 it is assumed that the results of this initial survey provide fairly safe conclusions.

Traditional project procurement system results:

The survey results show that this PPS receives high ratings (7+) on criteria relating to price competition, quality, client involvement, existence of competent contractors and familiarity of system. The ratings of these criteria have generally a low standard deviation (under 2) except for the price competition as it seems that there is greater disagreement on whether the traditional procurement system actually achieves the best price for the contractor.

Traditional Fast Track project procurement system results:

The respondents agree that this PPS allows a high degree of client involvement and is suitable in most cases as this is a familiar system in the construction industry world wide with adequate number of contracting firms experienced in this system. It also seems to be a general consensus that this system produces high quality projects as it allows tight supervision. In addition, there is significant agreement that this system does not attract private funding and does not require design completeness at tender. It is also considered a procurement system that does not significantly affect risk avoidance or minimizes disputes.

Design and Build (D&B) project procurement system results:

The clearest results of this survey regarding the D&B PPS is that this system does not require design completion at tender and allows extensive integration of the design and build phases producing high quality projects as the construction industry had competent contractors in this procurement system.

Private-Public Partnership project procurement system results:

The survey results clearly show that this PPS is ideal for attracting private funds to major highway projects, does not require design completion at tender, reduces client bureaucracy due to few points of responsibility while shifting most of the risk away from the client thus minimizing disputes and required client involvement.

Construction Management project procurement system results:

There seems to be good agreement between the respondents that this Procurement System is convenient for major highway projects assuring high construction quality and that this is a fairly familiar system in the construction industry. On the other hand the respondents believe that this system is not ideal to attract private funding and that average design completeness is required at tender.

Management Contracts project procurement system results:

Even though none of the respondents have direct experience in this procurement system, they agree that this is an unfamiliar procurement system in their construction industries; it will not significantly reduce the overall pre-construction and construction duration and requires a fair amount of design completeness at tender.

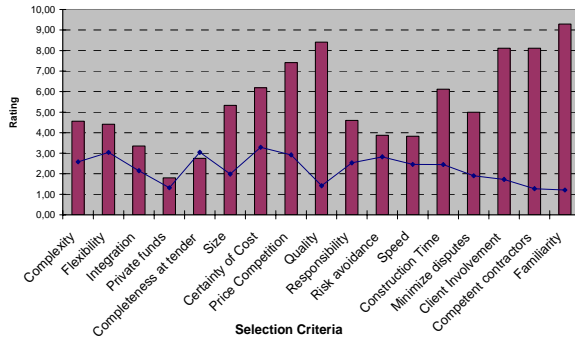


Figure 1: Evaluation Criteria against Traditional PPS

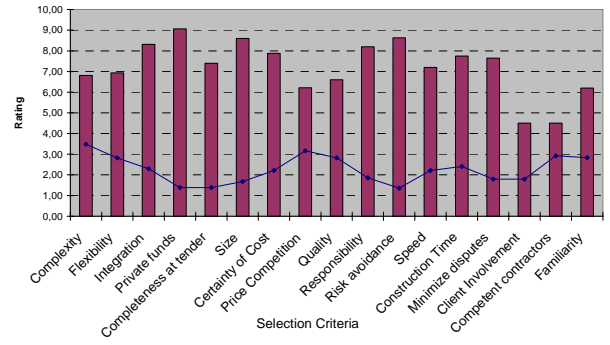


Figure 4: Evaluation Criteria against Public-Private Partnering PPS

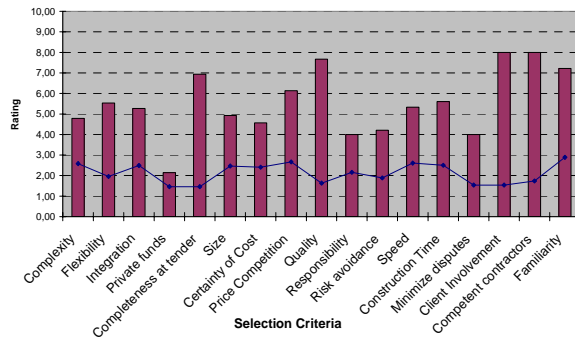


Figure 2: Evaluation Criteria against Traditional Fast Track PPS

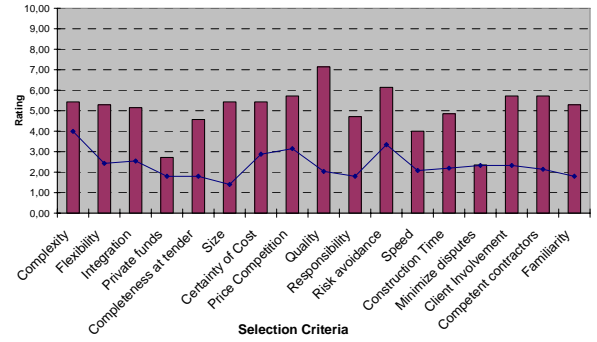


Figure 5: Evaluation Criteria against Construction Management PPS

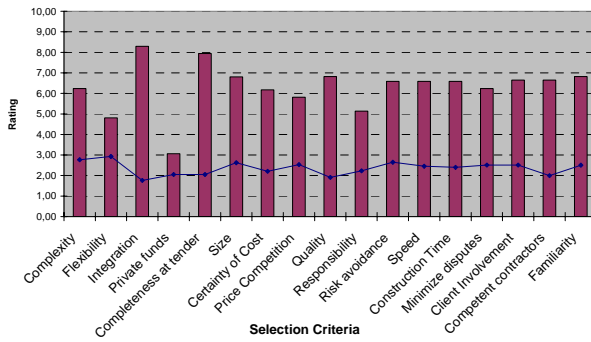


Figure 3: Evaluation Criteria against Design and Build PPS

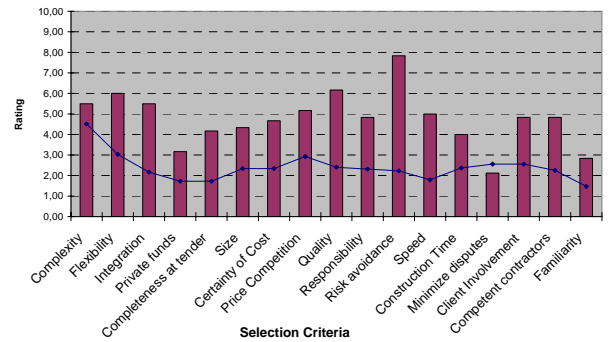


Figure 6: Evaluation Criteria against Management Contract PPS

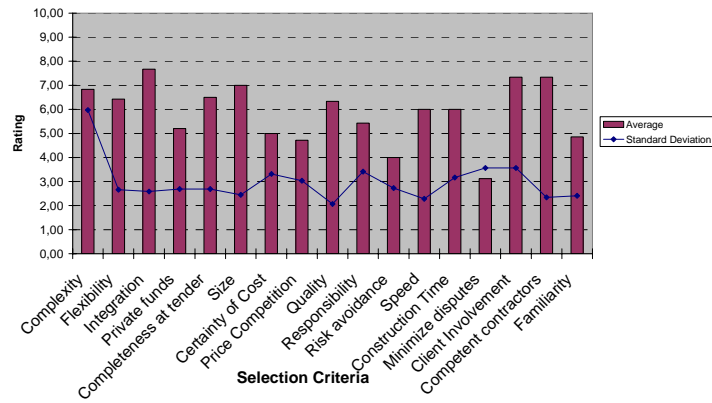


Figure 7: Evaluation Criteria against Partnering PPS

Table 5: Average and Standard Deviation of Ratings of Project Procurement System against each Selection Criteria

Project Procurement System	Traditional		Traditional Fast Track		Design and Build		Private Public Partnership		Construct-ion Management		Manage-ment contracts		Partnering	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Complexity	4,56	2,58	4,79	2,59	6,24	2,77	6,81	3,48	5,43	3,99	5,50	4,51	6,83	5,97
Flexibility	4,41	3,04	5,53	1,96	4,81	2,93	6,93	2,81	5,29	2,43	6,00	3,03	6,43	2,66
Integration	3,35	2,15	5,27	2,49	8,29	1,76	8,31	2,30	5,14	2,54	5,50	2,17	7,67	2,58
Private funds	1,80	1,32	2,14	1,46	3,07	2,05	9,06	1,39	2,71	1,80	3,17	1,72	5,20	2,68
Completeness at tender	2,75	3,04	6,93	1,46	7,94	2,05	7,40	1,39	4,57	1,80	4,17	1,72	6,50	2,68
Size	5,33	1,99	4,92	2,47	6,80	2,62	8,60	1,68	5,43	1,40	4,33	2,34	7,00	2,45
Certainty of Cost	6,19	3,29	4,57	2,41	6,18	2,20	7,88	2,21	5,43	2,88	4,67	2,34	5,00	3,32
Price Competition	7,41	2,92	6,13	2,67	5,81	2,54	6,21	3,17	5,71	3,15	5,17	2,93	4,71	3,03
Quality	8,41	1,42	7,67	1,63	6,82	1,91	6,60	2,82	7,14	2,04	6,17	2,40	6,33	2,07
Responsibility	4,60	2,53	4,00	2,16	5,13	2,23	8,20	1,86	4,71	1,80	4,83	2,32	5,43	3,41
Risk avoidance	3,88	2,83	4,21	1,89	6,59	2,65	8,63	1,36	6,14	3,34	7,83	2,23	4,00	2,73
Speed	3,82	2,46	5,33	2,61	6,59	2,45	7,20	2,21	4,00	2,08	5,00	1,79	6,00	2,28
Construction Time	6,12	2,45	5,60	2,50	6,59	2,40	7,75	2,41	4,86	2,19	4,00	2,37	6,00	3,16
Minimize disputes	5,00	1,90	4,00	1,54	6,24	2,51	7,65	1,79	2,35	2,33	2,12	2,55	3,12	3,56
Client Involvement	8,12	1,73	8,00	1,54	6,65	2,51	4,50	1,79	5,71	2,33	4,83	2,55	7,33	3,56
Competent contractors	8,12	1,27	8,00	1,74	6,65	2,00	4,50	2,92	5,71	2,14	4,83	2,25	7,33	2,34
Familiarity	9,29	1,21	7,21	2,89	6,82	2,51	6,20	2,83	5,29	1,80	2,83	1,47	4,86	2,41

Partnering Procurement System

Regarding this fairly innovative procurement system there seems to be no significant agreement on the rating of this system against any of the selection criteria. This is an expected result considering that only 2 of the respondents have had direct experience in this procurement system.

4. Conclusions

Following an extensive literature survey and an initial questionnaire survey to 20 experts in the field of highway project procurement systems in Australia, USA, Greece, and other European Countries, it can be deduced that the PPS that are being examined are the most relevant systems in use and the selection criteria employed to make a choice between these systems are the most representative. It is the object of future research work to develop a simple to implement project procurement model for major highway projects.

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