Design-Bid-Build Vs Design – Build Projects: Performance Assessment of Commercial Projects In Sri Lanka

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Abstract: Success or failure of any project is greatly influenced by the performance of cost, time and quality aspects of a project. The performance of each project may differ with the type of procurement system used. Therefore, performance of projects under each delivery system should be considered in making the decision to select suitable procurement system. In Sri Lanka, Design-Bid- Build (DBB) and Design-Build (DB) are the most commonly used systems and DBB is the dominant among others. This paper aims to assess the performance of DBB and DB projects in Sri Lanka. Altogether 18 performance indicators in terms of cost, time and quality were used to evaluate the performance of 60 commercial projects procured through DBB and DB systems. Means of each performance indicator were analyzed using 'Analysis of Variance' (Anova) to find out the major differences between the performance of both DBB and DB systems. In addition, few case studies were carried out in the view of interpreting the results of performance. It was found that the DB projects perform better in certain measures such as cost growth, time (schedule growth), and quality (performance specification) and the DBB projects perform better in certain other measures such as interior space, architectural finishes, and client's involvement. The results indicate that DB projects show best performance in terms of cost and time, at the same time quality is achieved in DBB projects. In addition, this study concludes that performance of a project is not only depended on the selection of appropriate procurement system, but also influenced by the capability of the contractor as well as the quality of all inputs including proper design and management. The synthesis of the outcome of this study reveals that there is a need to look beyond the selection of appropriate procurement system to attain the outstanding project performance.

Keywords: Construction Industry, Design-Bid-Build, Design-Build, Performance Assessment, Performance Indicators

1. Introduction

The construction industry is project-based with an ultimate goal to deliver a good quality product which can be either producing a new building or refurbishing existing buildings to its variety of clients. Performance measurement in construction has predominantly focused on project performance in the form of time, cost and quality (Ward *et al*., 1991; Love and Holt, 2000; Kagioglou *et al*., 2001). Performance in construction is generally determined through the success or failure of the projects. When assessing the success or failure of construction projects, a common approach is to evaluate the performance on the extent to which client objectives like cost, time and quality were achieved (Ward *et al.*, 1991). Cost, time and quality are seen as the traditional indicators of performance. Ward *et al*. (1991) also suggest that 'looking back on the conduct of a project, what sticks in the mind is often not so much financial success or early completion, but memories of other people involved and abiding

impressions of harmony, goodwill and trust or, conversely, of arguments, distrust and conflict'. The client's willingness to pursue a given procurement route to achieve a future project is likely to be strongly influenced by these factors. Therefore, it is clear that the traditional measures of the performance of construction projects are not sufficient to assess their 'true' performance.

With the development of new technologies and innovative systems, several procurement systems have been developed in the construction industry over the past decades. Among those, Design-Build (DB) and Design-Bid-Build (DBB) are the most common project delivery systems used in many countries. Countries like, USA, UK, Australia and Singapore, most commonly use traditional Design-Bid-Build and Design-and-Build systems (Ling and Kerh, 2004). Any project can be considered as successful when the project is delivered at the time, at the appropriate cost with the expected quality standards and provides the client with a high level of satisfaction (Skitmore and Marsden, 1998). Masterman (1992) has found that one of the principal reasons for the construction industry's poor performance is the inappropriateness of the procurement system that has been chosen. Therefore, selection of suitable procurement system is crucial to the success of any kind of project in construction. Performance of a construction project may differ with the type of procurement system used. Selection of any of the delivery systems to use may depend on how well the project could perform under each system.

The current review of procurement systems used in construction industry of Sri Lanka reveals that the traditional DBB and DB are the most commonly used systems and the traditional Measure and Pay is the dominant system among other systems. Majority of public projects are consistently procured through this method due to the influence of government. Further, many private sector clients also use this method as it is very familiar to them. Most of the experienced clients rely on professional advice for the selection process. Therefore, assessing the performance of the projects in each system could be valuable to the clients to achieve their ultimate goals. In this context, the aim of this study is to empirically assess and compare the performance of commercial projects procured through DBB and DB delivery systems.

2.   Review Of DBB And DB Systems

A project delivery system has been defined as the set of "relationships, roles and responsibilities of project team members and the sequence of activities required" for the deployment of a capital project (Sanvido and Konchar, 1998). There are a number of standard routes or processes available, particularly with respect to the design, construction and management aspects, which need early consideration when procuring construction. Each route places different demands, risk allocation and responsibilities on everyone involved and different cash flow profiles on the client. Given the fact that project objectives vary on a project-to-project basis, no one project delivery system is sufficient to address them (Construction Industry Institute, 2001).

The DB and DBB systems are commonly used procurement paths in most countries and they differ in several important ways. Therefore, it will be informative to specify what constitutes each procurement system in order to promote a more complete understanding of how to measure the impacts of the procurement system on project performance.

DB project delivery system is one where the client makes contract with a single entity to perform both design and construction under a single DB contract. Contractually, DB offers the client a single point of responsibility for both design and construction services. The design and construction, either partly or fully, may be performed by a single DB contractor or may be subcontracted to other contractors. In DB, designers work under contractors as one team and therefore, there is an absence of adversarial relationship between contractors and consultants which is found commonly in DBB projects.

Further, advantages of DB system includes, transfer of risk to contractor (but not usually all risks), competition in design, maximum overlap of design and construction, availability of construction expertise for design, early commitment to maximum price and less construction information required from the client.

The specific features of DBB system are the rigid separation of design and the construction process and lack of integration across this boundary (Cox and Townsend, 1998). In this system, client appoints an independent team of consultants on a fee basis, who completely designs the project and prepares tender documentation upon which competitive bids are obtained from the contractors. The successful tenderer enters into a direct agreement with the client and carries out the work in accordance with the design and specifications under the supervision of the consultants. These systems offer minimal input of contractors to the design process (Rowlinson, 1999).

The DBB method has survived for so many years because it has several advantages. These include familiarity to participants of the construction process, tested, refined and widely understood contractual relationships, and clear lines of authority, responsibility and liability In addition, owners have complete control over the design because consultants are directly engaged by them. However, DBB contains some limitations which include vertical fragmentation, slow take-up of innovation, low productivity, and a lack of single point responsibility (Ling and Kerh, 2004).

Since each procurement system posses several advantages and disadvantages, assessing the performance will help the client and/or consultants to choose an appropriate procurement system for his/her project.

3. Methodology

The aim of this study is to evaluate and compare the project performance in DB and DBB projects. Altogether 18 indicators were used to evaluate the performance of DB and DBB projects in terms of cost, time and quality. Two sets of questionnaires were designed to achieve the objectives. One set of questionnaire was targeted to collect the specific project related details from DB and DBB projects. These questionnaires were distributed among consultants and contractors. Details of DBB projects were collected from consultants and DB projects were collected from contractors. The second set of questionnaire was aimed to identify and rank the performance indicators based on quality. Further, interviews were conducted among respondents to identify the reasons for the significant differences in the performance of DB and DBB projects.

The sample for this study was limited to commercial projects which mostly include offices and shopping complexes, exceeding 10 million rupees in value and completed within 3 to 5

years. All together 72 projects were selected to the survey. But responses were received from 60 projects: 30 DBB projects and 30 DB projects and the response rate was 83%. Two sets of questionnaires were distributed for each project. The following Table 1 shows the profile of the projects in terms of type, contract sum, gross floor area and type of tendering.

Table 1: Profile of the projects' sample

Profile of projects	DBB		DB	
	Number	%	Number	%
Type of the Building				
Offices & Banks	19	63	18	60
Shopping & Market complex	8	27	10	33
Hotels	3	10	2	7
Contract sum				
Rs. 10 million - Rs.50 million	18	60	22	73
Rs. 50 million - Rs. 100 million	6	20	4	13
Rs.100 million - Rs.150 million	3	10	3	10
Rs.150 million - Rs.200 million	3	10	1	3
Gross Floor Area (m^2)				
Less than 1000 m^2	7	23	12	40
Between 1000 m^2 - 5000 m^2	17	57	15	50
Between 5000 m^2 - 10000 m^2	4	13	2	7
Above 10000 m^2	2	7	1	3
Types of Tendering				
Open tendering	18	60	6	20
Selective tendering	8	27	19	63
Negotiate tendering	4	13	5	17
Total of projects	**30**	**100**	**30**	**100**

Once the completed questionnaires were received, they were checked for accuracy. Mainly the following two analyses were carried out;
1. Calculation of the mean scores of DB and DBB projects
2. Comparing these means using 'Analysis of Variance' (Anova)

The Anova was used to compare performance based on cost, time and quality and to identify the significant differences between the performance of DBB and DB projects. The level of significance was set at 0.05. The test hypotheses were set out as follows;

Null hypothesis Ho: $\mu_1 = \mu_2$; Alternative hypothesis H$_1$: $\mu_1 \neq \mu_2$

Where μ_1 denotes DBB mean and μ_2 denotes DB mean.

Acceptance of Ho means that the type of the procurement has no significant influence on the project performance. Acceptance of H$_1$ means that there is significant difference between the performance of DBB and DB projects for a specific performance indicator.

4. Results And Discussion

From the data collected through survey, means of 18 performance indicators for DBB and DB projects were calculated. Anova (Analysis of Variance) was carried out to determine the significant differences between the means at 95% confidence level. Table 2 presents the summary of data analysis and the outcome of the survey.

Table 2: Overall comparison of performance between DBB and DB projects

Code	Performance Indicators	DBB Mean	DB Mean	ANOVA F- value	Sig.
	COST				
PI1	Unit cost (Rs/m2)	21,979.72	25,379.78	2.75	0.103
PI2	Cost growth (%)	15.60	7.67	6.73	**0.012***
	TIME				
PI3	Construction speed (m2 / month)	224.80	243.25	0.06	0.801
PI4	Delivery speed (m2 / month)	170.30	206.00	0.91	0.344
PI5	Schedule growth (%)	37.90	13.22	9.95	**0.003***
	QUALITY				
PI6	Commissioning.	3.467	3.600	0.68	0.412
PI7	Quality of inputs	3.533	3.333	2.46	0.122
PI8	Efficiency of communication	3.356	3.485	0.05	0.830
PI9	Performance specification followed by the contractor	3.366	3.766	7.59	**0.008***
PI10	Performance of mechanical & electrical system	3.400	3.266	0.44	0.509
PI11	Performance of interior space	3.900	3.566	4.82	**0.032***
PI12	Performance of building elements	3.830	3.653	2.73	0.104
PI13	Quality of architectural finishes	3.533	3.166	10.05	**0.002***
PI14	Protection given to finish work	3.666	3.267	4.88	**0.031***
PI15	Aesthetic aspects of the building	3.800	3.500	0.400	0.527
PI16	Client's involvement in process	3.766	3.366	4.59	**0.039***
PI17	Defects and problems	3.333	3.399	0.16	0.693
PI18	**Overall Client's satisfaction**	**3.500**	**3.466**	**0.04**	**0.838**

* Significant difference at 95% confidence level.

4. 1 Assessment of overall performance

From the data analysis, it was found that at a significance level of 0.05, the results show that there are some significant differences in the performance between the means of DBB and DB projects. The significant difference was found in appraising the cost growth, schedule growth and other five indicators in terms of quality. The significant differences in terms of quality related indicators includes performance specification followed by contractor, performance of interior space, quality of architectural finishes, protection to finish work and client's involvement. The following section discusses the assessment of performance to which significant differences were found in terms of cost, time and quality.

4.2 Assessment based on cost

The cost growth for DBB projects is significantly higher than DB projects (F= 6.73, p = 0.012). Cost growth means the increase of total project cost based on the initial contract sum. This may due to several reasons in commercial projects. The main reason for the significant difference is the very high degree of variation in DBB projects, thus increases the project cost. Since the flexibility for design changes are possible during construction stage in DBB projects, the variations are initiated by the clients as well as designers. The variations affect the total cost and delivery speed of the DBB projects. Sometimes, claims may affect the cost growth. From the survey, it was found that the claims based on cost (including price escalation) and time, are comparatively high in DBB projects. Liquidated damages for extended time period play a significant role in increasing the total cost of the DBB projects in Sri Lanka. On the other hand, the tendency for the flexibility for design changes is very less in DB projects, thus the degree of variation is very low compared to DBB projects. Perhaps, bonus claims subsist in some DB projects. Therefore, cost growth is less in DB projects.

4.3 Assessment based on time

The schedule growth for DBB projects is significantly higher than DB projects (F= 9.95, p = 0.003). Schedule growth means the increase of total time duration of the project based on the planned time. The mean values of the schedule growth for DBB and DB projects are 38% and 13% respectively.

The total time required to complete the DB projects is shorter than the DBB projects. This is because of the following major reasons;
- Possibility of integrating design and construction
- The rate is fixed and additional cost (overheads, financial charges, etc) are borne by the DB contractor, thus risk is high to the contractor
- Degree of contractor's involvement in design and construction is significantly high
- Single point of responsibility and the integration of subcontractors with design and construction
- Liquidated damage is very high in DB projects

All the above mentioned factors influence the schedule growth of DB projects thus lower the schedule growth. In addition, majority of the commercial clients require the project to be completed as quickly as possible. Some clients are prepared to pay extra costs in order to achieve earlier occupation, since the additional cost could be recovered by earlier revenue from the investment. This may be another reason for the low schedule growth in DB projects. Further, majority of respondents agreed that the use of DB project procurement system can account for up to 20% reduction in overall project time compared to traditional DBB system.

4.4 Assessment based on quality

Assessment of performance in terms of quality proves that quality of DBB projects are significantly higher than that of DB projects in certain indicators such as specification

followed by the contractor (f = 7.59, p = 0.0.008), interior space, (f = 4.82, p = 0.032), architectural finishes (f =10.05, p = 0.002), protection given to finish work (f =4.88, p = 0.031) and client's involvement (f =4.59, p = 0.039).

The quality of building depends upon a whole range of inputs from the soundness of the design, a correct choice of performance specification, efficient workmanship, adequate supervision, and the capability of the builder. Management inputs and co-ordination of work packages are also very important to obtain a quality product, in terms of services as well as overall installation. Virtually completed design prior to the commencement of work on site is likely to be beneficial in improving the qualitative aspects of the project rather than the more ad-hoc design approach with inconsistency. A client/consultant can do only little to control the quality of the contractor's work without detailed working drawings and specifications. In DBB project delivery system, all the required drawings and specification should be completed before the commencement of works at site. In addition, large number of standard forms and high quality functional standards enable to ensure the better quality of projects for DBB than DB.

In Sri Lanka, it was found that most of the factory buildings are procured through DB system, due to high delivery speed and the aesthetics aspect is not a major requirement for factory buildings. Most of the clients interviewed agreed that the DB system is best suited to projects, such as office buildings, factories and parking garages. A study carried out in UK has concluded that DB performs better in meeting quality standards in complex or innovative buildings rather than simple and standard traditional buildings. On the other hand in Singapore, it was found that clients and contractors disagreed that aesthetics quality is compromised in DB projects. Similar to the expectations, there was significant difference found in aesthetics quality in the Sri Lankan context. The results show that DBB projects have better performance for interior space and architectural finishes than DB projects. This is due to the engagement of specialized design consultant and degree of client's involvement from the inception stage of the project. Furthermore, in DBB projects, contractors perform the works in accordance with the specification primed by the design consultant and protection given to finished works shows good performance. This is due to the efficient supervision given by the consultants from inception to completion of the project.

5. Conclusions

The aim of this study was to fulfill a need for an assessment of performance in DBB and DB commercial projects based on the project data in order to find out the consequence of procurement system on project performance. At the macro level, it was found that DB projects perform significantly better than DBB projects in some areas such as cost growth, time (schedule growth), and quality (performance specification) and at the same time DBB projects perform better in some other areas such as interior space, finishes, and client involvement. With respect to the benefits, DB delivery system shows best performance both in cost & time and at the same time, performance in quality is achieved in DBB delivery system. Efficient supervision by the consultants enables to achieve the quality level expected by the client. Although the quality level of DB projects is not up to the level of DBB projects, the required quality level can be achieved by selecting the DB contractor based on cost and capability. Further, it can be stated that the performance of a project is not only depended on selection of appropriate procurement system, but also influenced by the capability of the contractor as well as the quality of all inputs including proper design and management. Therefore, it can be stated that the excellent performance of a project is determined by the

selection of suitable project delivery system, right consultant and capable contractor. This may lead to successfully achieve the client objectives in terms of cost, time, quality and other major requirements. The synthesis of the outcome of this study reveals that there is a need to look beyond the procurement system to attain the outstanding project performance.

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