PERFORMANCE OF DESIGN-BUILD PROJECTS IN TERMS OF COST, QUALITY AND TIME: VIEWS OF CLIENTS, ARCHITECTS AND CONTRACTORS IN SINGAPORE

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INTRODUCTION

There is a growing trend towards the use of the design-build (DB) procurement system in Singapore, which may be reflect the inherent advantages of DB. However, DB should not be viewed as a panacea for all the flaws of the traditional design-bid-build method. Moore and Dainty (2001) found that DB teams are not integrated because individuals continue to work as disparate individuals based on professional divisions, hierarchical relationships and non-interoperability of project participants' cultures. Katsanis and Davidson (1998) found that the DB procurement system requires owners to be highly sophisticated. In addition, making DB contractors solely responsible does not solve the fragmentation of the industry but merely transfers the problems from owners to contractors. It is therefore necessary to determine the performance levels of DB projects in terms of their time, cost and quality, so that when this procurement method is used the parties enter into the contract with full knowledge of what DB can and cannot achieve.

The objective of this paper is to determine the performance of DB projects from the Singapore clients', architects' and contractors' points of views, and to compare these views. In particular, performance is discussed based on projects' time, cost and quality performance. The importance of this study is that with the project performance known, better procurement decisions can be made to give clients value for money. The comparison of views reveals how different participants in the construction industry regard DB arrangements. Biased views are identified and steps can then be taken to change the mindsets of people who are prejudiced towards the DB arrangement.

LITERATURE REVIEW

In DB projects, contractors are responsible for the design as well as construction of a project. When the contractor provides all the design, based on the owner's brief, and subsequently undertakes construction, this is known as 'pure DB' (Janssens, 1991; Turner, 1995). This arrangement is also known as the 'traditional DB form' (Akintoye, 1994; Bennett et al., 1996), 'true DB' (Caunce, 1995) and 'complete DB' (Turner, 1995). It also includes package deal and turnkey arrangements. This traditional DB form accounts for 20% of all DB work in the UK (Bennett et al., 1996).

The main hybrids of DB are 'develop and construct' and 'novated DB'. In develop and construct, the owner signs a contract with its architects and engineers to produce the preliminary design (Chan, 2000). After the contract is awarded the contractor selects and appoints its own consultants to develop the design. They are responsible for ensuring structural sufficiency, method of construction and other special requirements. In this arrangement the owner's consultants are responsible for the documents they prepare and contractors are responsible for technical efficacy, price and schedule (CIOB, 1988).

Novated DB is also known as 'consultant-switch' (Pain and Bennett, 1988: 312). Novated DB has two distinct stages, the pre-novation stage which is similar to the design-bid-build system, and post novation stage. In the pre-novation stage the consultants engaged by the owner may develop 30% to 80% of the design (Chan and Lam, 1995). At the post novation stage contractors must employ these same consultants who had carried out the preliminary design under the owner.

Several studies on DB project performance have been undertaken. In the UK, owners have above average satisfaction with DB projects in terms of cost, time and quality performance (Ndekugri and Turner, 1994). In a later study it was shown that DB projects have greater time and cost certainty, better value for money and are 50% more

likely to finish on time and be delivered on the agreed budget compared to design-bid-build projects (Bennett et al.,1996). In a USA study, Konchar and Sanvido (1998) found that quality, cost and time performance of DB projects are generally better than those of design-bid-build projects.

Chan et al. (2001) suggested that the overall success of DB projects should be based on the projects' quality, time and cost performance. Following this idea the sections below review the specific performance of DB projects in terms of quality, time and cost.

Quality

Walker (1995) noted that in the majority of cases it is not the procurement route that gives poor quality but the quality of the client's brief — whether DB is able to deliver a quality project, depends to a great extent on the quality and clarity of the client's brief (Akintoye, 1994). Murray (1995) agrees, stating that if the final version of the brief does not sensitively and comprehensively reflect and fulfil client aspirations, then the end result will be a dissatisfied client and certainly an unsatisfactory building.

Hashim (1996) believes that the DB client's brief must be clear and comprehensive and contain not only the aesthetic, technical and performance criteria for the project, but also, equally importantly, his primary and secondary objectives in terms of functional quality, time and cost.

The concept of quality is very subjective and can be divided into four separate aspects (Pain and Bennett,1988): functional quality, architectural quality, technical quality and workmanship quality.

Functional quality

Pain and Bennett's (1988) study to assess the functional quality of various types of construction works revealed that projects procured under DB met their objectives generally better than the conventional approach would have been expected to do. Napier and Freiburg's (1990) study showed that functional quality of DB projects, which can be represented by conformance to client's expectations, was above average expectations and overall owner satisfaction was also above average.

Architectural quality

There is a school of thought, the "garden shed" school, that considers DB suitable only for very simple structures such as garden sheds (Ndekugri and Turner, 1994), and "the method seem[s] appropriate only for cheap and cheerful buildings" (Walker, 1995). Ndekugri and Church (1996) also noted that aesthetics is seldom considered in the evaluation of tenders for DB projects with costs as main priority. A survey of architects by Akintoye and Fitzgerald (1995) also showed that aesthetic quality is generally sacrificed in DB.

However, Pain and Bennett (1988) interviewed contractors, clients and independent architects and found that majority of the respondents felt that projects under DB arrangements have similar aesthetic quality as compared to those procured using the traditional methods. A few respondents even felt that DB projects gave better aesthetic quality.

Technical quality

Pain and Bennett (1988) found that majority of the respondents thought that DB produced buildings of similar technical quality in terms of materials, components, fittings and finishes as compared to the traditional approach. In fact, in certain situations, the results were thought to be even better. This is partly due to the establishment of a single point of responsibility resulting in an immediate reduction in the number of interfaces with whom the client comes in contact (Murray, 1995). With contractors' early involvement, the DB method not only improves communication but also provides the opportunity to overlap the design and construction phases and to incorporate the concept of buildability into the design (Rowlinson, 1987).

Workmanship quality

In Pain and Bennett's (1988) study it was established that the workmanship quality of DB projects is generally the same as the traditional method would have produced. In absolute terms, many of the respondents felt that workmanship quality was satisfactory.

One of the reasons could be that of single point of responsibility as mentioned before whereby the contractor is solely responsible for design, workmanship and materials. Another reason is that DB projects are more buildable. Rowlinson (1987) feels that the quality of construction is improved in DB as the architect is expected to seek buildable solutions, thereby enhancing ease of

construction. The involvement of contractors in the planning and design stages reduces construction problems during the execution stage and they are thus able to propose highly buildable design and construction systems with which they are familiar (Ling, 1995).

Time

An attractive feature of DB projects as compared to those using the traditional procurement method is that of shorter time duration. Timely completion is also of vital importance in the success of the project.

Shorter project duration

In a survey by Songer and Molenaar (1996) to assess public and private sector attitudes towards DB and to gain an insight into owner design-build selection factors, it was concluded that shortening the duration of construction was the most important reason why owners choose the DB arrangement. The majority of the architect respondents in Ndekugri and Turner's (1994) survey agreed that DB is generally faster than the traditional arrangement. In a Hong Kong hospital project, DB was chosen specifically because the client had a tight schedule (Chan, 2000).

In a survey carried out in the USA which compared different project delivery systems, DB projects were found to be at least 12% faster than the traditional design-bid-build projects and 7% faster than construction management projects (Konchar and Sanvido, 1998).

There are several reasons for these shorter times. Time saving in the overall project duration is possible by overlapping the design and construction process (Akintoye and Fitzgerald, 1995) as the DB arrangement permits the contractor to commence construction before the complete set of design is completed. Furthermore, Ndekugri and Turner (1994) attributed the shorter duration to contractor's superior knowledge of the state of the industry in terms of lead times of key items of materials and components, and so arrange his/her affairs to minimise delay in their procurement. Ling (1995) further commented that the DB contractor, being responsible for both design and construction, can recommend the use of highly buildable designs coupled with construction systems familiar to the contractor, resulting in time-savings.

Completion on time

Pain and Bennett (1988) found that half of the DB projects finished on time, with one finishing six weeks early. In a survey of UK contractor's views, Akintoye (1994) found that 54% of the contractors felt that DB projects could finish on time. A survey by Molenaar et al. (1999) of USA public sector owners found that schedule performance was excellent under DB arrangements — 77% of the DB projects were within 2% or better of the schedule established when the builder was hired. This was extremely impressive considering that 73% of DB contractors are hired with 25% or less of the design completed.

Cost

Previous studies are not in complete agreement on DB projects' performance relating to cost, with some saying that DB projects are cheaper, others saying they are more expensive or the same as design-bid-build projects.

A survey by Songer and Molenaar (1996) revealed that reduction in cost is the second most important reason for clients to select DB. In another survey by Akintoye and Fitzgerald (1995), the results indicated that 53% of the architects claimed that DB could achieve savings in construction cost of between 1% and 15%. This survey revealed very similar results compared to a previous one on contractors (Akintoye, 1994), where 62% of the contractors believed that up to 20% of costs can be saved by using DB. DB contractors are expected to involve experienced sub-contractors and suppliers to help architects produce designs which economise on materials used and adopt methods that they are experienced in. On the other hand Ernzen and Schexnayder (2000) found that DB projects are more risky, and the average profit margin is 3.5% greater than that for non-DB work.

Pain and Bennett (1988) concluded from their case studies that the cost of DB projects may be the same as traditional design-bid-build projects. Turner (1995), in a comparison of performance between different procurement methods, suggested that there was no evidence to indicate any differences in the prices tendered under either DB or traditional methods.

Rowlinson (1987) commented that a lot of resources are committed to prepare a DB

tender and the risks of not being awarded the contract are usually high. Ling (1995) highlighted that tender costs could be as much as 10 times more than those under the traditional arrangement. Following that, Ndekugri and Church (1996) stated that the cost of abortive tenders would ultimately be borne by owners of future projects and society at large. In view of such wastage of resources, the Code of Procedure for Selective Tendering for DB (NJCC, 1985) recommends there be a maximum of four tenderers as a way of minimising the high costs of abortive DB tendering.

Several studies in the UK have also shown that DB projects are more likely to be delivered to budget (Chappell, 1991; Akintoye and Fitzgerald, 1995). In a survey of 50 owners in the UK, 40% said that DB is useful when a guaranteed price is crucial for the project (Chevin, 1993). Bennett et al.'s (1996) study, also in the UK, showed that 60% of owners feel that it is important to have a guaranteed maximum price, which can be achieved if the owner's requirements are detailed. Molenaar et al.'s (1999) study in the USA on DB project performance revealed that cost performance was excellent with 59% of the DB projects within 2% of the budget established when the DB contractor was hired.

The review above shows that DB is generally advantageous and performs well in the USA and the UK, however before Singapore adopts DB with greater intensity, it is necessary to study how DB projects perform in Singapore.

METHODOLOGY

In order to seek Singapore contractors', architects' and clients' opinions and perceptions of DB, a questionnaire was formulated based on the issues uncovered in the literature review. In the questionnaire the first set of statements relates to quality of DB projects, the second set of statements pertains to the time performance of DB projects while the third set was designed to determine what respondents felt about the cost aspect of DB projects. Respondents were asked to state their level of agreement or disagreement with the issues raised on a five-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. Respondents were also asked demographic questions in the second part of the questionnaire.

After the questionnaires were prepared, copies were sent out to contractors, clients and architects who are based in Singapore. Each questionnaire was accompanied by a cover letter indicating the objectives of the research and attached with a self-addressed and stamped envelope. The responses were returned within a month of mailing.

Survey forms were sent to 100 randomly selected architects listed in the Singapore Institute of Architects' Member Directory. Another 100 questionnaires were sent to clients — this comprised: all the 40 public sector clients listed in the Singapore Government Telephone Directory, and 60 randomly selected private clients listed in the Singapore Real Estate Developers Association directory. Only large contractors were surveyed because it was felt that they would have the resources to undertake DB projects. There are 155 large building and civil engineering contractors (paid up capital above US$1 million each) registered with the Building and Construction Authority (BCA) and all of them were selected for this study.

Random sampling of architects and private sector clients was done because it would have been too time consuming and expensive to survey the whole population. Random sampling was done by using a table of random numbers to pick the required number of samples. In hindsight it would have been more appropriate to increase the sample sizes for these two groups because the response rates were low. Because of the manageable population sizes all public sector clients and large contractors were surveyed.

RESULTS

Usable responses were received from 40 contractors, 15 architects and 15 clients. This represented response rates of 26%, 15% and 15%, which is considered to be adequate for a study of this nature.

Responses from one public sector architect and 14 private architects were received with 93% of the architect respondents having practised in the construction industry for more than 10 years. The architects have been involved in public sector DB projects, private sector 'pure' DB projects and novated DB projects. A small number have

also undertaken develop and construct projects.

There were nine and six usable responses from private and public sector clients respectively — 93% of the client respondents have practised in the construction industry for more than 10 years and have been involved in public and private sectors DB projects.

Of the 40 building and civil engineering contractors 33 (83%) had practised in the construction industry for more than 10 years — 90% of the respondents had handled DB projects in the past.

The demographic characteristics of the respondents indicate that they are very experienced people in the construction industry. A large majority of them also have experience in DB projects, therefore their views on DB should be noteworthy.

Mean ratings for all the statements relating to DB performance were calculated for each of the categories of respondents (see Table 1). These mean ratings are merely those of the sample. It is therefore necessary to find out whether the population would agree with these DB performance attributes, using Student's t-test. This statistical test is adequate for this type of evaluation because it can deal with situations in which the sample size is not large (n=15 for architects and clients) and a standard normal distribution may not exist (Newbold, 1991).

For each performance attribute, the null hypothesis that the attribute did not receive agreement amongst the population and the alternative hypothesis that the attribute was agreeable are set out below. To test the null hypothesis H_o: $\mu \leq \mu_o$ against the alternative hypothesis H_1: $\mu > \mu_o$, where μ is the population mean. μ_o is the critical rating above which the attribute was considered agreeable by the population. In this study, μ_o was fixed at 3 because, by the definition given in the rating scale, ratings above 3 (i.e. 4 and 5) represented 'agree' and 'strongly agree'. The significance level was set at 0.05. When the calculated significance ("sig." in Table 1), $p < 0.05$, it can be concluded that the population agrees with the statement at a 95% confidence interval.

The results of the statistical tests (see Table 1) show that contractors agree with 23 of the 30 DB performance attributes. Clients agree with 18 of these statements, while architects agree to only 17 of these statements. In many instances the three groups of respondents did not have the same level of agreement relating to a performance attribute of DB.

DISCUSSION

The discussion in this section is based on the statistical results in Table 1.

Quality performance

Table 1 shows that contractors and clients felt that DB projects perform well in terms of functional (H1), architectural (H2) and technical quality (H3). Clients and contractors did not agree that contractor-led DB projects concentrate on costs and buildability at the expense of aesthetics (H9) and quality (H10). This is consistent with UK and USA studies. In the UK, Bennett et al.'s (1996) study revealed that DB performs consistently better in meeting quality standards in complex or innovative buildings rather than simple and standard traditional buildings. Moreover, DB projects deliver more consistent aesthetic quality than traditionally procured buildings, and score marginally higher in terms of aesthetic quality. Konchar and Sanvido's (1998) USA study showed that quality of DB projects is higher than design-bid-build projects.

Clients and architects do not agree that workmanship quality (H4) of DB projects are good, and that DB procurement maximises overall client satisfaction (H7). Neither do they agree that DB projects are aesthetically pleasing (H5). However, they felt that architect-led DB would ensure quality and aesthetics of projects (H11). Contractors disagreed with this, as it may mean that the arrangement is not much different from design-bid-build, which carries with it inherent disadvantages such as low buildability and fragmentation of design and construction.

All the respondents felt that the administrative burden of DB projects are not lower than traditional design-bid-build projects (H6). They also felt that when the schematic design is developed to an advanced stage before tendering, quality of DB project will be good (H8). Clients may determine the cost of quality of the DB projects using the methodology developed by Hall and Tomkins (2001).

Table 1: Statistical results of architects, clients and contractors' ratings

No.	DB performance statements	Architect			Client			Contractor		
		Mean	t value	Sig.	Mean	t value	Sig.	Mean	t value	Sig.
H1	Functional quality of DB projects satisfies client's requirement.	3.333	1.160	0.133	3.733	4.036	0.001	4.050	8.483	0.000
H2	Architectural quality of DB projects meets client's expectation.	3.000	0.000	0.500	3.467	1.825	0.045	3.875	7.306	0.000
H3	Technical quality of DB projects satisfies client's requirements.	3.200	0.823	0.212	3.867	5.245	0.000	4.100	11.000	0.000
H4	Workmanship quality of DB projects is good.	3.133	0.564	0.291	3.200	0.899	0.192	3.825	8.204	0.000
H5	DB projects are aesthetically pleasing.	2.800	-0.676	0.745	3.267	1.293	0.109	3.675	4.970	0.000
H6	Administrative burden in DB projects is lower.	2.867	-0.397	0.349	3.467	1.606	0.066	3.000	0.000	0.500
H7	Usage of DB procurement maximises overall client's satisfaction.	3.067	0.211	0.418	3.400	1.572	0.069	3.725	5.619	0.000
H8	When schematic design is developed to an advanced stage before tendering, quality of DB project is good.	3.600	2.358	0.017	3.667	3.162	0.004	3.725	5.619	0.000
H9	Contractor-led DB projects concentrate on costs and buildability at the expense of aesthetics.	3.800	3.055	0.005	3.333	1.099	0.150	2.675	-1.801	0.961
H10	Contractor-led DB projects concentrate on costs and buildability at the expense of quality.	3.800	3.055	0.005	3.333	1.099	0.150	2.300	-3.749	1.000
H11	Architect-led DB projects would ensure quality and aesthetics of projects.	3.733	2.048	0.030	3.533	2.086	0.028	3.100	0.561	0.289
H12	Usage of DB reduces physical construction time.	3.533	1.835	0.044	4.067	4.298	0.001	4.075	7.654	0.000
H13	Overlap of design and construction phases in DB reduces overall project time.	3.533	2.477	0.014	4.267	6.971	0.000	4.275	9.521	0.000
H14	Response time to design changes is faster in DB projects.	3.400	1.702	0.055	3.600	2.806	0.007	4.375	12.338	0.000
H15	Early involvement of contractor in DB allows his expertise in buildability to be incorporated for time and cost savings.	3.600	3.154	0.004	4.600	12.220	0.000	4.575	15.662	0.000
H16	Contractor's knowledge of lead times of key items and components allow materials and equipment to be procured faster in DB projects.	3.733	3.556	0.002	4.200	8.290	0.000	4.125	9.394	0.000
H17	High degree of consultation, co-operation and good information flow ensures that design discrepancies are resolved faster in DB projects.	3.533	2.779	0.008	4.000	4.583	0.000	4.275	10.743	0.000
H18	Usage of innovative construction methods reduces construction time in DB projects.	3.400	1.871	0.041	3.733	4.036	0.001	4.175	9.945	0.000
H19	DB contractors are willing to start physical construction works with limited design information.	3.333	1.435	0.087	3.333	1.234	0.119	3.700	4.462	0.000
H20	The overall pre-contract period is shortened in DB as compared to the traditional design-bid-build method.	3.600	2.806	0.007	3.467	1.284	0.110	3.700	4.857	0.000
H21	In DB projects, detailed working drawings are not necessary as design can be developed as construction is going on.	2.867	-0.381	0.646	3.133	0.459	0.327	3.375	1.922	0.031
H22	Risk of costs exceeding budget is minimal in DB projects.	2.867	-0.397	0.651	3.267	1.000	0.167	3.550	4.113	0.000
H23	DB contractors make use of value engineering to reduce costs without reducing quality.	3.467	2.168	0.024	3.800	4.000	0.001	4.050	9.297	0.000
H24	DB contractors make use of value engineering to increase quality without increasing costs.	3.467	2.168	0.024	3.800	4.000	0.001	3.900	8.473	0.000
H25	Contractors tend to reduce professional fees in DB projects.	4.067	4.000	0.001	3.400	1.702	0.056	3.150	1.183	0.122
H26	DB contractors pursue cheaper design solutions all the time.	4.067	5.172	0.000	3.600	2.201	0.023	3.125	0.842	0.203
H27	DB contractors use standardised components.	3.867	4.516	0.000	3.467	2.432	0.015	3.475	3.427	0.001
H28	Usage of DB procurement route provides clients with early knowledge of the maximum project cost.	3.600	3.154	0.004	3.733	3.214	0.003	3.775	5.894	0.000
H29	DB contractual arrangement leads to fewer disputes and claims.	3.267	0.939	0.182	3.600	2.553	0.012	3.775	5.176	0.000
H30	There is a reduction in the usage of architect and engineers' services by DB contractors.	2.933	-0.222	0.587	3.000	0.000	0.500	2.850	-1.183	0.122

Time performance

With regard to time performance, Table 1 results show that all the three groups of respondents agree that the usage of DB reduces overall project development time (H13) and physical construction time (H12). This is consistent with Bennett et al.'s (1996) UK study which showed that DB projects are 12% faster in construction speed compared to design-bid-build projects, with total delivery (design and construction) speed being 30% faster. It is also consistent with Konchar and Sanvido's (1998) finding that delivery speed and construction speed of DB projects in USA are faster than design-bid-build projects. Tam (2000) also reported that construction time has been shortened because of the use of DB in a Hong Kong project.

The associated reasons for the lesser time to complete the project, which are agreed by the three groups of respondents are:

- contractors' early involvement allows them to incorporate buildability (H15)
- contractors' knowledge of lead times of key items and components allow materials and equipment to be procured faster (H16)
- high degree of consultation, co-operation and good information flow ensures that design discrepancies are resolved faster (H17)
- use of innovative construction methods (H18).

The findings are consistent with Chan et al.'s (2001) Hong Kong study, which established that contractors' competencies contribute to good time performance. Clients and contractors agreed on the issue of a reduction in response time because of the use of DB(H14) — it is understandable that architects disagreed with this, as they would not want to admit that they have not responded quickly enough to design changes.

Another issue affecting time performance is the completeness of drawings before the commencement of construction. Contractors agreed that they are willing to start physical construction work with limited design information (H19). In addition, detailed working drawings are not necessary as design can be developed as construction is ongoing (H21). This can be achieved by applying concurrent engineering principles (Anumba and Evbuomwan, 1997), and dynamic tracking and control methodology (Pena-Mora and Li, 2001). It should be noted that some clients prefer to have construction drawings for site supervision and control, and in DB projects, this may not be readily available (Tam, 2000).

Clients indicated that the overall pre-contract period involving preparing of client's brief, tender documentation, and tendering process, evaluation and award, is lengthened for DB projects compared to traditional projects (H20). This is in agreement with previous studies that found that careful preparation of client's brief is one of the success factors for DB projects (Akintoye, 1994). To ensure careful preparation, time and effort need to be expanded, and this would lead to longer pre-contract period.

Cost performance

Table 1 shows that all the three groups of respondents felt that costs of DB projects may be lower (H23). This is in concordance with Konchar and Sanvido's (1998) finding that unit cost of DB projects are lower than those on design-bid-build projects. This is because DB contractors would have conducted value engineering to make their offers more competitive and can propose design solutions that reduce cost without reducing quality, or increase quality without increasing cost (H24). In addition, contractors would use standardised components (H27). Clients and architects felt that the cost of DB projects may be lower because contractors pursue cheaper design solutions all the time (H26) — as expected, contractors deny this.

Clients, architects and contractors agreed that the use of DB procurement system allows clients to have early knowledge of the maximum project cost (H28). Bennett et al.'s (1996) study also showed that DB projects are more likely to be completed on budget, or within 5% of the budget; 75% of DB projects were completed within 5% of the budget, compared to 63% of traditional projects. Tam (2000) found that DB is advantageous because the client can obtain a firm price for the project at the outset.

Clients and architects felt that the risk of costs exceeding budget in DB projects is not minimal (H22). This contradicts Konchar and Sanvido's (1998) finding that cost growth for DB projects is only 2.17%, while that of design-bid-build projects is 4.83%.

Clients and contractors also agreed that DB contractual arrangements lead to fewer disputes and claims (H29). The absence of variations enables DB projects to have higher cost certainty and they are also able to proceed without the disruptions and claims associated with variations (Bennett et al., 1996).

With regard to professional fees, architects felt that contractors tend to reduce professional fees in DB projects (H25), but contractors denied this. Notwithstanding this, all the different groups of respondents felt that the services or architects and engineers are still very important in DB projects (H30).

This study has several limitations. The responses gathered from architects and clients constitute a relatively small sample and a bigger sample would therefore give a more accurate indication of opinions. Secondly, investigating the opinions of clients, architects and contractors is still not sufficient to draw conclusions on the performance of DB projects in Singapore — a possible future study could entail the use of a more rigorous method to measure the performance of DB projects.

CONCLUSION

The findings suggest that while contractors rated the performance of DB projects highly in terms of quality, architects seem to give the thumbs down on DB projects' performance with regard to quality. Clients appear to have a more balanced view, as they indicated that functional, architectural and technical quality are acceptable. Workmanship quality, however, still needs improvement.

The finding that 'when schematic design is developed to an advanced stage before tendering, quality of DB project will good' indicates that the construction industry in Singapore may not be ready for pure DB as yet, but may instead be more comfortable with the develop and construct form.

The findings also show that all clients, architect and contractors generally agree that DB projects can be completed in a shorter time. The main reason for this is contractors' early involvement in the project, giving them the opportunity to contribute to the design upstream of the construction process. However, the shorter development time is offset to some extent by the longer time taken by clients in the pre-contract stage.

Clients, architects and contractors also agreed that DB projects cost less than traditional projects because of the use of value engineering and standardised components. Even though fees payable by contractors to architects and engineers may be lower, the extent of their services is not reduced. This should reassure clients that DB projects may not be less professionally designed than traditional projects.

The responses of these three major parties in a DB project are encouraging, reflecting that DB, in general, performs well. These findings indicate that DB has the potential to grow and its future seems bright. With more people recognizing its inherent benefits, the usage of DB may increase in the near future.

It can be concluded from the findings that architects did not feel that DB projects have good quality, time and cost performance. As clients view DB projects' performance favourably perhaps it is time for architects to be more receptive towards DB.

For contractors, being in the leadership position in DB projects entails many responsibilities, for both design and construction. Contractors should take full advantage of the opportunity presented by DB to exercise their management abilities and to push the construction industry to achieve better performance.

It is recommended that clients consider carefully the procurement method to be adopted, instead of adopting traditional design-bid-build as a matter of course. With the many advantages of DB identified in this paper, clients are urged to seriously consider DB as a viable procurement system.

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