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Design–build: How to Increase its Usage, and its Impact on Architects and Contractors in Singapore

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ABSTRACT

The purpose of this paper is to explore the ways to increase the usage of design-build (DB). The scope covers how project managers (local and foreign) can play a role in increasing DB usage in Singapore. It is found that owners would adopt DB if their requirements can be properly met. This is achieved by having clear and comprehensive bid documents, having sketch designs prepared by client appointed consultants, and engaging experienced DB contractors. Clients also need to engage project managers and consultant quantity surveyors to manage the DB projects, but the liability for design rests on DB contractors. Clients want DB contractors to provide warranty for fitness for purpose. The conclusion is that clients welcome the use of DB if some concrete steps are taken to make it meet their needs better. This study also concludes that consulting and contracting companies welcome DB, as this procurement method does not have a significantly negative impact on them.

Keywords: procurement management, design-build, architects, owners, contractors, Singapore.

INTRODUCTION

Several studies have been conducted to compare design-build (DB) with a number of different types of procurement routes available for clients to choose from. In the USA, Konchar and Sanvido (1998) compared the performance of projects using DB, traditional design-bid-build (DBB) and construction management routes. They found that DB projects perform better than design-bid-build projects in all the three aspects: schedule, cost and quality. In the UK, Bennett et al. (1996) also discovered that DB projects' performance is not worse than design-bid-build projects. In Singapore, Ling and Leong (2002) investigated the perceptions of clients, architects

and contractors on DB procurement system. Clients and contractors supported DB because they perceived DB projects have high functional, architectural and technical quality, shorter in project time, and lower project costs.

The objectives of this paper are: to investigate the possible ways to make DB more suitable for owners' use; and to explore the impact of DB on architects and contractors. DB is explored because its current level of usage in Singapore is low; only an average of 15% of projects were based on DB between 2002 and 2004 (Building and Construction Authority, 2005). It is important to increase DB's usage since studies have shown that DB projects perform better than traditional design-bid-build projects in terms of time, cost and quality (Konchar and Sanvido, 1998). DB is an important procurement system for the Singapore construction industry as DB projects perform significantly better than design-bid-build projects in terms of higher project delivery speed, lower operations and maintenance costs, and low clients' administrative burden (Ling and Kerh, 2004). The relative low usage of DB in Singapore, despite its demonstrated superior performance indicates that some alterations may need to be undertaken before clients adopt this procurement method. Tookey et al. (2001) found that clients make changes to conventional procurement systems to obtain the best outcome. The second objective is important to find out if DB has a negative impact on construction industry participants such as architects and contractors, which may have caused DB's low usage. These negative impacts therefore need to be identified, and ways found to overcome them, if necessary. The study singled out architects and contractors for investigation because the status of these two actors is radically changed in DB system compared to design-bid-build. There is a change in leadership in DB; the architect is now responsible to the contractor for the design he has produced and answers to the contractor.

The study of DB encompasses a wide scope. For example, it is possible to study the strengths and weaknesses of each type of procurement system, by comparing the performance of the projects using different systems (Ling and Kerh, 2004). Ling (2004a, 2004b) had investigated critical success factors affecting DB and DBB projects. Another study had been conducted on how to predict the performance of DB and DBB projects (Ling et al., 2004). The scope of the paper is confined to increasing usage of DB and perceptions of architects and contractors in Singapore for reasons given earlier.

This paper is important because owners' concerns in DB are identified. The findings can be used to fine-tune the DB procurement system to suit owners' needs better, and thereby encouraging increased usage. The impact of DB on architects and contractors is also uncovered.

After the introduction, a brief literature review is given. This is followed by the research methodology and results of surveying owners, architects and contractors. The discussion is divided into three parts; how to increase DB usage, and its impact on architects and contractors. This paper ends with limitations of the study and a conclusion.

LITERATURE REVIEW

Many studies have shown that despite its advantages, there is no widespread usage of DB. In the UK, for example, DB usage is predicted to stagnate at 23% of the market for new building works (Bennett et al., 1996). In the USA, DB accounted for about 24% of the US\$286 billion of non-residential construction output in the USA (Tarricone, 1996). In Singapore, as previously mentioned, only 15% of building projects were based on DB (Building and Construction Authority, 2005). This may be because some changes are needed to make DB more suitable for use. In this study, changes are operationalised using the theory of construction process re-engineering (CPR), whereby radical improvements are founded on incremental change (Love and Li, 1998). Common themes of re-engineering include: examining current work operations to combine multiple components, possibly jobs or functions into one; undoing standards created by division of labour and replacing these with models which cater specifically to each case; and aiming for inter-enterprise harmony and synergy based on

aptitude and mutual benefit (Betts et al., 1997). Using CPR, several initiatives that may bring about higher usage of DB are identified. The first aim of this paper is to gauge the extent to which Singapore's clients and contractors felt that the suggested solutions would bring about improvement in DB projects. The possible solutions to make DB projects more suitable for usage are now reviewed.

OWNER'S LEVEL OF CONSTRUCTION SOPHISTICATION

Even though DB contractors have single point of responsibility, owners still have many duties and responsibilities. These include conducting feasibility studies, obtaining planning approvals, preparing bid documents and Request for Proposals (RFPs) (Ndekugri and Turner, 1994), establishing the budget, conducting value engineering, selecting contractors to bid (Kluenker, 1996), evaluating bids, and checking contractors' proposals. Owners also need to administer the contract such as making progress payments and inspections, responding to contractors, and ensuring schedules are followed (Kluenker, 1996). They should manage design changes, claims and defects, undertake quality control (National Joint Consultative Committee (NJCC), 1985) and ensure that their own requirements are met (Akintoye and Fitzgerald, 1995). As owners using the DB procurement system are not expected to engage a team of design consultants, the many duties of the owners described above do point to the need for owners to be knowledgeable in construction matters if they want to procure projects through the DB route.

Studies have shown that DB is not suitable for owners who do not possess any knowledge of the workings of the construction industry (Ndekugri and Turner, 1994). Katsanis and Davidson (1998) suggested that owners need to have a high degree of sophistication, be knowledgeable and have a detailed awareness of their own requirements when procuring projects through the DB route. The fieldwork would investigate whether only owners who are familiar with construction process should use DB contractual arrangement.

PROJECT SIZE

Ling et al.'s (2001) study showed that DB is suitable for projects of any size. However, there are studies that showed that DB should be used only for large projects (Songer *et al.*, 1996). In

view of the different opinions encountered, the fieldwork investigated if DB should be used only for large projects.

ORGANIZATIONAL STRUCTURE

DB is a procurement system in which the contractor provides all the design based on the owner's brief, and subsequently undertakes construction. This is known as 'pure DB' (Janssens, 1991). However, clients are known to heavily amend procurement routes to the point that they do not follow an orthodox type of structure (Tookey, et al., 2001). In DB, hybrid forms have surfaced to combine the advantages of several different contractual arrangements while retaining some of the advantages of pure DB. These include 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. After the contract is awarded, the contractor selects and appoints its own consultants to develop the design and working drawings. 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 (Janssens, 1991).

Novated DB has two distinct stages, the pre-novation stage which is similar to the design-bid-build system, and post novation stage, which is akin to a pure DB arrangement (Chan and Lam, 1995). 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. In the fieldwork, owners' preference for which organizational structure for DB was investigated.

BIDDING ISSUES

A RFP document may contain the owner's brief, which communicates his/her requirements to DB bidders. There is no agreement on how comprehensive the brief should be (Murray, 1995). It may vary from a general statement of needs to a detailed schedule of requirements incorporating drawings and specifications

(Ndekugri and Turner, 1994). However, it should contain information such as owners' requirements, project objectives (Osborne, 1996), project constraints (Ndekugri and Turner, 1994), physical design needs, and the intended specific use of the building (Marshall and Morledge, 1988). In the fieldwork, the importance of a comprehensive brief was investigated.

Bidding cost for DB contracts is more than twice that of traditional procurement routes (Latham, 1994). It is considered one of the most unfair aspects of DB because contractors and their designers need to be willing to underwrite the substantial cost of preliminary design and engineering to prepare the overall estimate and bid price, which is not recoverable if they are not successful in the bid (Kawaguchi *et al.*, 1994). The consequences of high bidding costs are: ultimately, owners must pay for these costs on future projects (Greenfield, 1982); and more competent contractors may decline to bid if there are too many bidders (Ndekugri and Church, 1996). This will then deprive owners of the opportunity to secure good quality proposals (Osborne, 1996) and also discourage competition (Dreger, 1993).

There are several possible solutions to the problem of high bidding cost. These include reimbursing bidders for front-end costs, limiting the number of bidders (NJCC, 1985; Latham, 1994) and refraining from asking bidders to provide too many details. The fieldwork investigated whether owners should reimburse bidding costs to obtain better design proposals.

SELECTION OF CONTRACTORS

For DB projects to be successful, owners should select DB contractors carefully (NJCC, 1985). The main criteria to be used include the contractor's track record, ability to provide competitive price, attitude and interest in the project, financial status, past experience, and reputation. In DB, it is usual not to invite open bids in order to control the quality of bidders. Bidding is generally preceded by a prequalification exercise where interested bidders submit their job references and curriculum vitae. There are many criteria for prequalifying contractors for DB projects. These include relevant experience and a good record in DB projects (Janssens, 1991). After the initial screening, only suitable contractors are invited to submit proposals and bid for the next project.

Owners may also consider selecting contractors and design consultants who form joint ventures to undertake DB projects. The advantage is that because of profit sharing, consultants will produce a design that is as efficient as possible (Hodgson and Bayfield, 1996). The disadvantages of design consultants joint-venturing with contractors are that each entity loses its individual identity, and there is a reduction in profit coupled with increased risk to the organization (Yates, 1995). However, it is arguable whether there is actually a reduction in profit because the synergy provided by the firms ensures that performance is enhanced. The fieldwork investigated selection of contractors based on previous DB experience, importance of prequalification; and formation of joint ventures between builders and designers.

QUALITY CONTROL

Some owners are not willing to use DB because they feel that DB projects have lower quality than design-bid-build projects, aesthetics is compromised and maintenance issues are not considered by DB contractors (Ling et al., 2000). DB lacks independent checks and balances compared to the traditional form (Dreger, 1993). To increase DB usage, more quality control practices may be needed.

In meeting the owner's requirements on the construction project, the contractor's behavior is normally to provide service at the minimal acceptable level to maximize profit (Kluenker, 1996). To achieve high quality of constructed facility, the RFP should state the minimum quality levels to be achieved. A good constructed product may also be procured if contractors provide a guarantee for fitness for purpose. This is an absolute obligation to produce a constructed facility which does not contain faults (Marshall and Morledge, 1988). This is a higher duty than exercising reasonable skill and care because contractors may still be liable even if there is no fault or negligence on their part. This requirement would not be unduly unfair to DB contractors because they have control over the whole development process and are thus in a position to guarantee the performance of their buildings (Bennett *et al.*, 1996).

To safeguard their interests further, owners with no in-house project management team should engage independent project managers and

consultant quantity surveyors to monitor the work of contractors and their consultants and administer the contracts. However, the independent consultants add cost to the project and erode the advantage of the single point responsibility afforded to owners in DB projects. In a survey of contractors in Singapore, 58% felt that the presence of owner-engaged supervisors in DB projects slows down their work (Ling et al., 2000). The fieldwork investigated ways to control quality of DB projects.

IMPACT OF DB ON ARCHITECTS

In DB, the role of architects is different from design-bid-build arrangement. Cecil (1983) commented that DB implies major changes in roles, relationships and responsibilities for no one more radically than the architect. In DB projects, the contractor becomes the paymaster of the architect. The architect's traditional role in a construction contract in which he is empowered to administer, is absent in the DB situation.

Friedlander (1998) pointed out that the contractor-led DB projects have often been criticized by architects for their mediocre design, believing that the design often overvalues considerations of costs and constructability at the expense of aesthetics and other traditionally important design criteria. A study by Akintoye and Fitzgerald (1995) to determine what role architects expect themselves to play in DB contracts concluded that architects do not wish to give up responsibility for contract administration. They further found that architects resent DB because of loss of professionalism, reduction in professional fees, job dissatisfaction, erosion of professional roles and responsibilities, and lack of sufficient time to produce good design solutions. Their study also concluded that architects generally felt that the quality of product and design innovation is sacrificed.

The roles that architects play in DB projects are different from design-bid-build projects. Architects may need to relinquish control in DB projects. They may also encounter problems with project owners and DB contractors. Architects need to adapt to the loss of their leadership position in DB projects. In the fieldwork, the impact of DB on architects was investigated.

IMPACT OF DB ON CONTRACTORS

DB contractors are responsible for producing a proper design in response to the brief, supplying good quality materials and workmanship, and meeting residual liabilities until extinguished at law due to the passage of time (Gardiner and Simmons, 1995). DB contractors assume total responsibility to guarantee price, completion time and quality (Cecil, 1983). The DB contractor's single point responsibility allows effective and detailed planning from inception to completion of the project (Osborne, 1996). Better co-ordination and decision-making lead to time reduction (Akintoye, 1994). Contractors are able to control the type of materials and method of construction without needing to add a large contingency to cover themselves for unforeseen situations. DB allows flexibility in contractors' operations so that they can innovate and adapt to new technology (Yates, 1995). Contractors have more control over design and construction (Dreger, 1993). Therefore, contractors should have more job satisfaction in DB projects, compared to traditional design-bid-build projects. In the fieldwork, the impact of DB on contractors was investigated.

METHODOLOGY

With knowledge of the project owners' needs and requirements from the literature review, 14 possible solutions to improve DB were formulated. These solutions were designed after interviews with three experts in the construction industry. These are a project manager, an architect and a construction manager, all with more than 10 years of experience and have handled more than five DB projects each. Owners' views on the applicability of these solutions were sought in the fieldwork using a structured questionnaire. They were asked to state their level of agreement with the solutions suggested on a 5-point scale (1= totally disagree; 5= strongly agree). This is to ensure that future projects could include the suggested solution so as to make DB procurement more suitable for owners and contractors.

The impact of DB on architects and contractors was also investigated in the fieldwork. Views of architects and contractors were obtained using two different structured questionnaires. Statements in the questionnaire sought to find out how architects and contractors felt about DB and its impact on them, on a 5-point scale.

Besides the structured questions, respondents were also asked demographic questions in the second part of the questionnaire. The survey package comprised a questionnaire, a cover letter indicating the objectives of the research and a self-addressed and stamped envelope.

The population frames for this study comprised architects, project owners and contractors who operate in Singapore. 150 survey forms were sent to randomly selected architects who practice in the public and private sectors. Another 150 questionnaires were sent to randomly selected public sector clients and property developers representing private sector owners. Questionnaires were sent to all 155 registered large building and civil engineering contractors (paid up capital above US\$1 million each). Only large contractors were surveyed because it was felt that they would have the resources to undertake DB projects. After the survey and data analysis, the results were discussed with the same three experts.

RESULTS

40, 30 and 25 usable responses were received from contractors, architects and owners respectively. This represented response rates of 26%, 20% and 17%, which are considered to be adequate for a study of this nature. 20 responses were from private architects and 10 from public sector architects. 91% of the architect respondents have practised in the construction industry for more than 10 years. 70% of the architects have also been involved in DB projects.

There were 15 and 10 usable responses from private and public sector owners respectively. 92% of the owner respondents have practised in the construction industry for more than 10 years. 80% have procured projects using DB system. Of the 40 responses received from building and civil engineering contractors, 83% of the respondents have practised in the construction industry for more than 10 years. 90% of the respondents have handled DB projects in the past.

The demographic characteristics of the respondents indicate that they are very experienced construction industry players. A large majority of them also have experience in

DB projects. Therefore, their views on DB would be noteworthy. Mean ratings for all the statements were calculated for each of the categories of respondents (see Tables 1 to 3). Statistical t-test of the mean was carried out to check whether the population would agree to these statements or otherwise. For each statement, the null hypothesis that the statement 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 $H_0: \mu \leq \mu_0$ against the alternative hypothesis $H_1: \mu > \mu_0$, where μ is the population mean. μ_0 is the critical rating above which the attribute was considered agreeable by the population. In this study, μ_0 was fixed at 3 because by 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.

An analysis of the 14 statements that may help to improve DB procurement system shows that owners agree with nine of them (see Table 1). When comparing owners and contractors' responses, the Analysis of Variance (ANOVA) shows that they did not rate in the same manner in eight instances. An analysis of the 13 statements relating to the impact of DB on architects shows that architects agree with none of them (see Table 2). An analysis of the 14 statements relating to the impact of DB on contractors shows that contractors agree with five statements (see Table 3).

No	Suggested solutions to improve DB projects	Mean (Owners)	t-value	Sig.	Mean (Con-tractor)	F-value	Sig.
1	Owners' construction sophistication						
1.1	Only owners who are familiar with construction process should use DB contractual arrangement	2.933	-0.222	0.587	2.925	0.001	0.981
2	Project size						
2.1	DB should be used for large projects (eg. above US\$25 million)	4.000	3.623	0.002*	2.825	4.373	0.041#
3	Organizational structure						
3.1	Owners should opt for 'pure DB' organizational structure	3.071	0.366	0.360	3.700	4.862	0.032#
3.2	Owners should opt for 'develop and construct' organizational structure	3.786	3.015	0.005*	2.825	5.082	0.006#
3.3	Owners should opt for 'novated DB' organizational structure	3.071	0.366	0.360	2.450	7.005	0.009#
4	Bidding issues						
4.1	Owner's brief to DB contractors should be very clear and comprehensive	4.467	5.358	0.000*	4.250	0.729	0.397
4.2	Owners should reimburse bidding costs to obtain better design proposals	3.000	0.000	0.500	3.675	6.461	0.014#
5	Selection of contractors						
5.1	Only contractors with previous DB experience should be awarded DB contracts	4.000	3.623	0.002*	2.850	8.449	0.005#
5.2	There should be a pre-qualification of DB teams	3.933	3.108	0.004*	3.650	0.748	0.391
5.3	Contractors and design consultants should form joint ventures to undertake DB projects	3.000	0.000	0.500	3.250	0.444	0.508
6	Quality control						
6.1	Owners should engage project managers to manage the design and construction of the DB project	4.000	3.623	0.002*	3.400	4.373	0.041#
6.2	Owners should engage consultant quantity surveyors to administer DB contracts	3.600	2.073	0.029*	2.775	8.449	0.005#
6.3	DB contracts should state the minimum quality levels to be achieved	3.786	3.015	0.005*	3.225	3.913	0.053
6.4	DB contractors should bear design liability and provide warranty for fitness for purpose	4.133	3.900	0.001*	3.600	3.084	0.085

* Clients agree with the suggestion at 5% significance level. # Clients and contractors did not rate in the similar manner.

Table 1: Survey results on solutions to make DB projects more suitable

No.	Impact of DB on architects	Mean (architect)	t- value	1-tail Sig.
1	There is a loss of job satisfaction for architects in DB projects	2.933	-0.174	0.568
2	Architects are unable to give independent professional advice in DB projects	3.200	0.526	0.303
3	Relationship between owners and architects is remote in DB projects	3.067	0.202	0.471
4	Owners for DB projects still believe that architects are answerable to them, as in traditional projects	3.067	0.235	0.409
5	DB contractors are acting as an “uneducated” barrier between owners and architects	2.867	-0.459	0.674
6	Architects are reluctant to provide adequate service due to lack of incentive in DB projects	3.067	0.174	0.432
7	DB contractors generally do not adopt architects’ recommendations	3.133	0.367	0.359
8	DB contractors curtail architects’ powers	3.467	1.333	0.102
9	DB contractors do not understand their management role	3.200	0.587	0.283
10	DB contractors are not familiar with the relevant building regulations	2.867	-0.381	0.355
11	There is a lack of architect’s involvement during construction stage of DB projects	2.867	-0.397	0.651
12	There is insufficient time for designing and interpreting owner’s requirements in DB projects	3.200	0.526	0.303
13	Proper development of design and detailing rarely occur in DB projects	3.000	0.000	0.500

Table 2: Survey results on impact of DB on architects

No.	Impact of DB on architects	Mean (contractor)	t- value	1-tail Sig.
1.	Contractor-engaged architects provide cost effective designs	3.925	5.867	0.000*
2	Contractors should monitor the overall quality of DB projects	4.075	8.897	0.000*
3	Owners should engage project managers to examine DB contractor's proposal and verify contractor's solution on site	3.150	0.947	0.175
4	There is more job satisfaction for contractors in DB projects compared to traditional projects	4.100	9.348	0.000*
5	There is insufficient time for designing and interpreting owner's requirements in DB projects	2.725	-1.602	0.942
6	DB contractors generally do not adopt architects' recommendations	2.125	-7.656	1.000
7	DB contractors curtail architects' powers	2.650	-2.058	0.977
8	Proper development of design and detailing rarely occur in DB projects	2.175	-6.418	1.000
9	Owners lose control over the design of DB projects	1.975	-8.101	1.000
10	DB contractors want to execute the works to meet minimum requirements at the lowest possible cost	3.225	1.270	0.106
11	Bidding costs of DB projects are much higher than traditional design-bid-build projects	3.400	1.688	0.049*
12	Bid award decisions for DB projects are not as fair as traditional design-bid-build projects	2.725	-1.638	0.946
13	Profit margins for DB projects are higher than traditional projects	2.900	-0.644	0.739
14	DB projects pose more risks to contractors than traditional design-bid-build projects	3.750	4.713	0.000*

* Contractors agree with the statement, at 5% level of significance.

Table 3: Survey results on impact of DB on contractors

DISCUSSION

The discussion in this section is based on the statistical results in Tables 1 to 3.

OWNERS ARE NOT REQUIRED TO HAVE CONSTRUCTION KNOWLEDGE

The survey results show that owners did not agree that they should have construction sophistication before embarking on DB and contractors also agreed with them (see Table 1). This finding departs from previous studies that suggested that only owners who are familiar with the construction process should use DB contractual arrangement (Ndekugri and Turner, 1994; Friedlander, 1998). The conclusion is that owners who are not familiar with the construction process do not want to be precluded from DB procurement system. This group of owners

makes up a large percentage of clients and project initiators who require built facilities but are not in construction or real estate business. They therefore may not have the necessary experience and expertise in construction operations. The implication of this finding is that project managers can help these owners manage the DB projects.

PROJECTS MUST BE LARGE

The results of this study show that owners felt that DB is only effective if projects are sufficiently large (see Table 1). This does not concur with Ling et al.'s (2001) finding that DB can be used for projects of any size. ANOVA showed that contractors disagreed that projects should be sufficiently large. Contractors may have rated this way because precluding DB from medium and small projects would reduce the market share of DB. The implication of this finding is

that project managers should offer the DB procurement system to owners only if projects are sufficiently large, for example, above US\$25 million. Project managers also benefit because fees, which usually commensurate with the size of project, would be higher.

DB PROJECT OWNERS SHOULD PROVIDE SOME SKETCH DESIGN

The survey results show that owners are not comfortable with 'novated DB' and 'pure DB' organizational forms. Instead, they felt that DB would be more widely used if 'develop and construct' were used, in which owner-appointed consultants undertake the sketch design, and DB contractors are tasked with preparing working drawings and construction. The three experts who were interviewed felt that it is unreasonable to force DB contractors to accept owner-appointed consultants in 'novated DB' arrangement. 'Pure DB' did not find favor with owners because it is difficult to specify all requirements in writing. It would be clearer if owners could provide sketch design for contractors to work on, thus, the preference for 'develop and construct' arrangement.

The findings provide support to Tookey et al.'s (2001) hypothesis that in future, procurement systems will be an amalgam of various facets from distinct procurement systems. This study also provides empirical support to Murray's (1995) suggestion that hybrid DB arises because pure DB is not responding to and fulfilling owners' expectations. The implication of this finding for project managers is that they should have some architectural design capability, as owners would like some design to be done, before engaging contractors to develop the design further before undertaking the construction work. It is not unexpected that contractors prefer 'pure' DB. They dislike hybrids of DB as these are unnecessary hindrances to the single point of responsibility.

BID DOCUMENTS MUST BE COMPREHENSIVE

The results show that owners should make sure that their RFPs, containing the owner's requirements, are very clear and comprehensive. This finding is in agreement with previous studies on the importance of comprehensive briefs (Ndekugri and Turner, 1995). A complete brief is the only way owners could have a constructed facility that meets their requirements. Therefore, project managers

could help owners prepare detailed RFPs, as owners who do not possess construction knowledge may not be competent.

As the cost for bidding for a DB project is substantial, another suggestion to improve DB is to ask owners to reimburse DB contractors for the cost incurred in submitting proposals (Latham, 1994). As this means that owners will incur additional cost, it is hardly surprising that they disagreed with it, though it is very welcomed by contractors. The implication of this finding is that project managers should not suggest that bidders be reimbursed, as it would discourage owners from using DB procurement system.

CONTRACTORS SHOULD HAVE DB EXPERIENCE

The results show that owners only want to engage contractors who have previous DB experience. As expected, contractors disagree with this, as it puts them in a catch-22 situation; how can they gain experience in DB if they are not allowed to participate in DB projects without prior DB experience. The implication of this finding is that foreign DB contractors would find it easy to secure DB jobs in Singapore, as many Singapore-based contractors still do not have DB experience. Indigenous contractors can work as subcontractors first, or form joint ventures with DB contractors, so that they can accumulate DB experience.

Owners and contractors felt that DB would be more widely used if there is pre-qualification of DB teams. This would allow owners to study the background of the teams before inviting them to submit proposals and bid for the projects. The implication of this finding is that a project manager who helps the owner manage a DB project should screen potential contractors through a formal pre-qualification exercise first, prior to actual invitation to bid. Owners and contractors disagreed with the suggestion that contractors and design consultants should form joint ventures to undertake DB projects. This finding departs from Hodgson and Bayfield's (1996) earlier study which found that companies should form joint ventures to undertake DB projects. The implication of this finding is that owners prefer design consultants to be subcontractors to DB contractors, instead of being a joint venture partner. This means that design firms that are interested in DB projects must be prepared to work as subcontractors under main contractors. This is consistent with

DB principle of single point of responsibility, where owners prefer a team leader, instead of allocating responsibilities between contractors and design consultants.

QUALITY CONTROL

Owners agreed that they should engage project managers to monitor design and construction carried out by DB contractors because left on their own, some contractors may seek to maximize their profits at the expense of quality. This is because single point responsibility may also lead to a reduction in quality because of fewer in-built checks and balances (Nahapiet and Nahapiet, 1985). However, contractors did not rate this in the same way as owners, as the introduction of other parties may dilute the single point of responsibility bestowed on contractors in DB projects, and slow down their progress (*Ling et al.*, 2000). Project managers could help to draft bid documents, which are generally difficult to prepare. In addition, writing functional and performance specifications for DB, which includes describing required quality, is inherently very difficult.

Owners felt that they would procure more projects using the DB route if they could employ very experienced consultant quantity surveyors to administer DB contracts. As is already known, DB contractors are responsible for, among other things, technical quality, functional quality and workmanship quality. However, owners still need someone to handle the contractual issues, payments and change orders. Therefore, the services of a consultant quantity surveyor would be welcome. It is not surprising that contractors disagree with the engagement of consultant quantity surveyors. This is consistent with the earlier finding about owners engaging project managers, because contractors may feel that these owner-appointed consultants hinder their work unnecessarily (*Ling et al.*, 2000). The implication of this finding is that project managers' role in DB is not diminished.

To further guarantee the quality of DB projects, owners and contractors felt that it is important that DB contracts state the minimum quality levels to be achieved, such as the technical quality, functional quality, workmanship quality and architectural quality (*Pain and Bennett*, 1988). Owners and contractors also agreed that DB contractors should bear design liability and provide warranty for fitness for purpose. This follows from the single point of responsibility that

DB contractors are conferred with. The implication is that contractors should insure themselves adequately for this high level of duty in DB projects.

ARCHITECTS DO NOT ABHOR DB

The survey results show that architects do not see DB in a negative light, as was previously thought. Table 2 shows that architects rejected all the perceived negative impacts of DB. Architects felt that there is no loss of job satisfaction for them in DB projects. It is untrue that they are unable to give independent professional advice in DB projects. Architects also felt that their relationships with owners are not remote in DB projects. Owners for DB projects are aware that contractors have single point of responsibility, and do not ask architects to be answerable to them, as in traditional projects.

As regards architects' relationship with contractors, again, the former do not cast contractors in a bad light. They did not think that DB contractors are acting as an "uneducated" barrier between them and owners. They are not reluctant to provide an adequate level of service as there is no lack of incentive in DB projects. It is not true that DB contractors generally do not adopt the architects' recommendations, or that DB contractors curtail their powers. Architects confirm that DB contractors do understand their management role. DB contractors are also familiar with the relevant building regulations. Architects do not see their roles diminished in DB projects. They felt that they are adequately involved during construction stage of DB projects. While it is known that owner who choose DB route generally want their projects to be completed faster, architects felt that they do have sufficient time to design and interpret owners' requirements in DB projects. The respondent architects also confirmed that there is proper development of design and detailing in DB projects.

The above finding indicates that architects in Singapore are not totally opposed to DB procurement system. This is a departure from previous findings (example *Akintoye and Fitzgerald*, 1995). This means that the perception that architects oppose DB is untrue. The implication of this finding is that architects are receptive towards DB, thus giving DB a higher chance of wider usage in Singapore.

CONTRACTORS WELCOME DB

The results on the impact of DB on contractors are shown in Table 3. The results show that contractors felt that they do receive cost effective designs from architects engaged by them. They acknowledged that they should monitor the overall quality of DB projects. Bid award decisions for DB projects are generally as fair as traditional design-bid-build projects. Bidding costs and risks of DB projects are much higher than traditional design-bid-build projects. However, profit margins for DB projects are not higher than traditional projects.

Contractors did not feel that there is insufficient time for designing and interpreting owner's requirements in DB projects. They felt that there is proper development of design and detailing in DB projects. They also said that they do adopt the architects' recommendations, and would not curtail the architect's powers. DB contractors said that owners do not lose control over the design of DB projects. They do not agree that owners should engage project managers to examine their proposals and verify their solutions on site. They deny that they would execute the works to meet minimum requirements at the lowest possible cost.

Overall, contractors felt that there is more job satisfaction in DB projects compared to traditional projects. The findings indicate that contractors welcome DB, as it puts them in charge of projects, instead of constantly taking instructions from architects and engineers, and merely constructing according to drawings and specifications.

LIMITATIONS OF THE STUDY

This study has several limitations. The responses gathered from contractors, architects and owners constitute a relatively small sample and a bigger sample would therefore give a more accurate indication of opinions. However, this is partially overcome by discussing the results with three experts who have extensive experience in DB. The next limitation is the fieldwork being conducted in Singapore and hence may not be representative of owners, contractors and architects' views in other countries. However, the practical use of this study is that foreign construction industry practitioners who want to undertake work in Singapore can understand the DB market better. This study also identified work opportunities for project managers, architects and contractors. As Singapore practices free

trade, the work opportunities would apply to both local and foreign construction industry practitioners.

CONCLUSION

The literature review has shown that DB projects perform well in terms of schedule, cost and quality. However, the percentage of projects that are procured using DB is still low. This study has found several ways to increase the usage of DB in the construction industry. More projects will be procured through DB, even if project owners are not familiar with construction, if they can be assured that the constructed facility will be of good quality. This can be achieved by owner-engaged project managers managing design and construction matters, and administering the contracts. RFPs should state the minimum quality levels to be achieved and state owners' requirements clearly and comprehensively. In addition, DB contractors should bear design liability and provide warranty for fitness for purpose. They should be short listed, and only those who already have prior DB experience should be allowed to submit proposals.

DB usage can be increased if the 'develop and construct' organizational format is used, instead of 'pure DB'. Even though pure DB allocated responsibilities very clearly, owners are worried that the end product may not meet their requirements. Projects should be sufficiently large for it to be procured using DB, as small projects are not worth the effort of asking every bidder to assemble a design team.

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