

Why the Construction Quality of Design-build Projects Is Not Satisfactory?—A Queensland Study

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Abstract

Design-build (DB) system is well-known to be a popular and effective delivery method of construction work worldwide. It has been demonstrated as superior to the traditional delivery system in regards to time and cost performance. However, it suffers a major flaw, in that the performance of project quality cannot be guaranteed. This paper aims to investigate the underlying factors attributing to the poor quality performance of design-build projects in Queensland. Five major factors were first identified through a comprehensive literature review, which relate to (1) project briefing and scope definition, (2) client's role and responsibility, (3) procurement selection, (4) contractor's incentive, and (5) design document quality. A questionnaire survey with 127 DB professionals was conducted to determine how these factors affect various quality criteria, i.e. functional quality, architectural quality, technical quality, workmanship quality, client satisfaction and overall quality. With the architectural quality reduced greatly, the research findings reveal that the DB projects in Queensland have the reduced overall quality compared with traditional projects. The impacts of different factors on the quality performance of DB projects have been closely examined and summarized. The research findings will facilitate project stakeholder's better understanding of the delivery process of the DB system and provide guidelines to improve the quality performance.

Keywords: design-build, quality performance, Queensland

Introduction

Design-build is a contractual arrangement where one single party, namely the design-builder, is responsible for both design and construction. It has been demonstrated as an effective delivery method and gained popularity worldwide. Clients and building owners select DB contracts for a number of reasons including, for example, shortened project duration, early cost establishment, reduced risk, single point of responsibility, and encouragement of construction innovation (Gransberg and Windel, 2008).

Whilst these supporting factors continue to drive the use of design-build system, DB has been criticized as having negative effects on building quality, compared with Design-Bid-Build (DBB) or other traditional systems (Holt *et al.*, 1995; Verwey, 2000). Ratnasabapathy (2006) concluded that the quality of DBB projects far exceeds that of DB. Studies carried out in Singapore (Ling 2004) revealed that aesthetic quality and workmanship quality are reduced under the DB system. This is also supported by Cox *et al.*

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(1999) and Ernzen and Feeney (2003) that the quality performance of DB projects cannot be guaranteed. Moreover, even though some research has found that project quality is improved under DB procurement (Bennett *et al.*, 1996; Konchar and Sanvido, 1998), it has been argued that the quality improvements were not a direct result of the procurement system (Loulakis, 2003).

Through a comprehensive literature review and broad questionnaire survey, this research aims to examine the quality performance of DB projects in the Queensland construction industry and identify the underlying factors attributing to such performance. It is expected that the research findings will facilitate project stakeholder's better understanding of the DB delivery process and provide guidelines to improve the quality performance.

Literature Review

Research targeting the prevalence of quality issues in DB is increasing. Through a comprehensive literature review, five major factors affecting quality performance of DB projects were first identified, which relate to (1) project briefing and scope definition, (2) client's role and responsibility, (3) procurement selection, (4) contractor's incentive, and (5) design documents.

Briefing is a crucial factor in establishing the functional requirements in DB projects (Jergeas, 2006; Lam *et al.*, 2008; Walker and Hampson, 2008). It establishes the project goals and success criteria against which the finished project will be measured. Mo and Ng (1997) conducted a survey on architect's and builder's views on the DB procurement method in Hong Kong. Their results showed that the quality of the client's brief was rated as the most important project success factor for DB projects, which is supported by Doloi (2008). Ratnasabapathy (2006) revealed that "a client/consultant can do little to control the quality of a contractor's work without provision of detailed specifications."

Clients are required to think and act differently in order for DB contracts to succeed (Peterson and Murphree, 2004). The responsibilities of DB clients are critical in ensuring project quality. Xia and Chan (2010) describe client sophistication and contract management abilities as contributing factors to DB project success. Additionally, client's capacity to satisfy their responsibilities particularly with regard to checking and authorising design decisions will affect the project quality. For the inexperienced DB clients, they should employ or engage sufficient resources to prepare briefing documents prior to tender and also ensure that sufficient resources are allocated to consulting with contractors during detailed design and construction. Without good communication throughout this process it is likely the design and subsequent construction will not measure up to the expectation of stakeholders and meet the levels of quality attainable under more traditional delivery methods.

"Even though DB has many advantages it is not appropriate for every owner or every project" (Gransberg *et al.* 2007). The choice of procurement method is probably the most important decision the client makes, after the decision to build (Masterman, 2002) Gransberg and Windel (2008) found that reduced schedule and early cost establishment were the highest ranking reasons owners selected DB whereas contractors perceived cost savings as the highest priority. Some small and simple projects tend to emphasise on lowest-bid selection of DB contractors with little focus on quality. This would imply that certain projects, for which quality is determined in complex architectural details, would not be suitable candidates for DB systems (Songer and Molenaar, 1999).

The incentive of DB contractors to reduce project cost will also affect project quality. Under DB contracts, where early cost establishment and schedule are fixed in advance, the

only variable to increase profit is scope and quality (Gransberg and Molenaar, 2004). After being awarded a DB contract, contractors' incentive may be to lower construction costs to improve profitability (Doloi, 2007). Eriksson and Pesamaa (2007) indicate that many contractors do not provide incentive to add value or increase quality. Baiden *et al.* (2006) found similar results and evidenced that design and construct teams display low levels of integration and do not provide mutually beneficial contributions for all parties.

Quality of design documentation ranked most important to DB project success (Doloi, 2008). The Building Research Establishment in the UK (BRE, 1981) found that errors in buildings had 50% of their origin in the design stage and 40% in the construction stage. Burati *et al.* (1992) found 78% of quality deviations are attributable to design deviations and 9.5% of project cost. It has been largely established that design quality directly impacts project quality. Therefore, in order to increase the quality performance of DB projects, design documents of the highest possible quality should be prepared.

Research Methods

A questionnaire survey was conducted in Queensland to obtain the opinions of DB professionals on the (1) quality performance and benefits of DB projects, and (2) the importance of above mentioned factors affecting the DB quality performance. A preliminary selection of respondents was made based on the experience of respondents. Additionally, the respondents were balanced as far as possible across the participants in client groups, project managers, contractors, and subcontractors representing the key stakeholders involved with the delivery of DB projects.

Before the official data collection, a pilot study was issued to a small sample of respondents from client, project manager, design consultant, contractor and subcontractor groups to test the questionnaire and format of the propositions. A follow up via phone was used to discuss the structuring of the questions and any ambiguities or difficulties in understanding questions, phrasing etc. Based on feedback from the pilot study, several changes were made to the questionnaire in order to increase the likelihood of accurate returns and lead to clearer answers.

Surveys were distributed via both regular mail and email, in an effort to improve response rates. In total 146 questionnaires were sent, 121 were posted, 16 emailed and 9 phone interviews. A follow up phone call was made to approximately 40% of survey recipients to encourage participation.

Operational definitions are important in order to return a quantitative result from any form of data gathering. The primary measure of this study is quality, which has been divided into distinct elements as they apply to buildings:

- Functional Quality
- Architectural Quality
- Technical Quality
- Workmanship Quality
- Owner Satisfaction

Results and Discussion

Of 146 questionnaires, 34 responses were received which represents an overall response rate of 23% which was slightly below expectation. Of the 34 responses, all of them were valid for analysis. A list of the final respondents and their affiliations are shown in Figure 1. The respondents represent a wide spectrum of design and construction professionals and

clients in Queensland, considered to be key stakeholders in the process, providing a balanced view for the study.

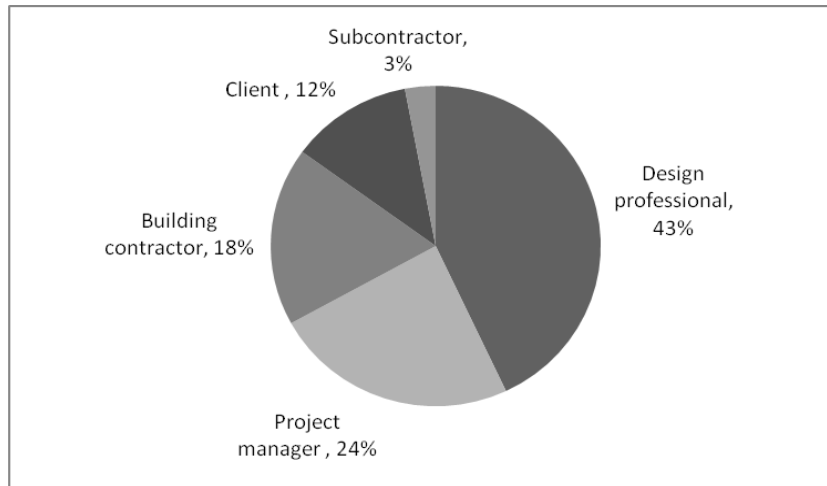


Figure 1. List of the respondents for the Questionnaire Survey

The questionnaires focussed on those with extensive experience in the construction industry. Among the respondents, the majority of them (73.5%) was experienced with 15 years or more and 90% had minimum 11 years experience in their chosen occupation. Additionally, most respondents (76.5%) had significant experience (25+ projects) and all had a minimum of 11. These results were in line with expectation as DB contracts are commonplace in Queensland construction projects.

Levels of Design-build Quality

Respondents were asked to evaluate the level of DB quality compared with traditional delivery methods on a five-point scale, where 1=greatly reduced, 2=reduced, 3=Neutral, 4=improved, and 5=greatly improved. The analysis results of mean values of the DB quality are shown in Table 1.

Table 1 Quality levels of DB projects compared with traditional methods

Quality	Respondents				Overall Mean
	Client	PM	Designer	Contractor	
Functional quality	3.00	2.88	2.40	3.67	2.79
Architectural quality	2.25	2.00	1.53	2.40	1.97
Technical quality	2.5	2.88	2.20	3.83	2.70
Workmanship quality	2.75	2.88	2.40	3.33	2.73
Client satisfaction	3.00	2.88	2.60	3.33	2.85
Overall quality	3.00	2.50	2.27	3.83	2.70

In Table 1, a score lower than 3 points means that quality is negatively affected or reduced. Architectural quality gets the lowest scoring with most respondents believing DB procurement reduced or greatly reduced this outcome. The score of technical quality was

the second lowest with around half the respondents believing it was reduced or greatly reduced under DB conditions. This is thought to be a result of the lack of thorough specification and rare involvement of sub-consultants during the design stage. Functional and workmanship quality also scored lower than 3 points, however a mode of 3 for workmanship suggests this is largely unaffected by procurement type. Following-up interviews suggested that workmanship quality is largely affected by cost pressures rather than the procurement condition.

The overall quality and client satisfaction scored lower than 3 points although the client group scored both these criteria as neutral. Design professionals and project managers scored the “quality” aspects of design-build system lower than that of traditional systems. In particular, design professionals believed the quality of design-build projects was reduced significantly. The contractors however, held different opinions. They believed that project quality in design-build projects is higher than in traditional ones.

In the questionnaire survey, the majority of the respondents (78.8%) reached the agreement that DB method is not the most appropriate choice when quality is the top priority. Especially, the client group which unanimously (100%) agreed that they would not select DB where quality was the top priority. The results of the questionnaire survey echoed the findings in the literature review.

Recognition of Design-build Benefits

Respondents were asked to evaluate whether the theoretical benefits of DB methods were recognised in real practice according to their working experience with DB projects. It is rated on a five-point scale, where 1=strongly disagree, 2=disagree, 3=Neutral, 4=agree, and 5=strongly agree. The analysis results of mean values of the DB quality are shown in Table 2.

Table 2. Benefits of DB projects compared with traditional methods

Benefits of DB system	Respondents				Overall Mean
	Client	PM	Designer	Contractor	
Fewer contractual claims	4.00	2.71	3.07	4.33	3.34
Faster project delivery	3.50	2.63	3.00	3.67	3.09
Lower project cost	3.25	2.50	3.07	3.33	3.03
Providing best value	4.00	2.38	2.27	4.33	2.88
Encouraging innovation	3.00	3.13	1.80	4.33	2.73
Higher levels of integration	2.75	3.25	2.20	3.83	2.82

According to Table 2, the respondents reached a light agreement that DB method provides fewer contractual claims, faster project delivery and lower project cost. However, they did not believe that the DB method would necessarily produce the best value projects, encourage innovation or facilitate project integration. This was strongly echoed by the design professionals who indicated that the lowest cost is driven by the fixed lump-sum tender while the best value is often achieved through review and reconciliations against project briefs, which is seen to be lacking in DB contract.

Factor Importance on Design-build Quality

In order to reveal the impacts of different factors (those identified in the literature review) on the project quality in the DB system, respondents were asked to give ratings to these factors on a five-point scale, where 1=strongly disagree, 2=disagree, 3=Neutral, 4=agree, and 5=strongly agree. The ranked factor importance on design-build quality is presented in Table 3.

Table 3. Factor importance on design-build quality

Benefits of DB system	Respondents				Overall Mean
	Client	PM	Designer	Contractor	
Project briefing and scope	4.75	4.88	4.73	4.00	4.64
Client's role & responsibility	3.25	4.00	4.50	4.17	4.16
Contractor's incentive	4.00	3.88	4.13	3.67	3.97
Design document quality	3.25	3.63	4.07	4.00	3.85
Procurement selection	3.48	3.80	2.32	4.70	3.18

The project brief and scope definition is critical to DB project quality and in particular to architectural and functional quality. This result was expected because architectural and functional quality could only be defined in a detailed, explicit form of brief. A brief of such details could be only provided by the most experienced clients who are aware of the nature of the contracts. Satisfaction is more likely where the brief has been explicit and the contractor's understanding is improved. It is clear that the preparation of a clients brief assists the understanding of the project for the client, consultants, and the bidding contractors. Where the clients' understanding of the project is increased, so is the clarity of expectations which can then be communicated in the form of success criteria. Additionally, the collection and integration of end user requirements into the brief is critically important particularly in DB where the contractor and their design team are required to make decisions which will affect the functionality of the finished product.

Client's role and responsibility have great impact on the quality of the DB procurement route. A mean score of 4.16 indicates most respondents recognised the importance of this factor. In DB projects, even though clients can leave most of the project responsibilities to DB contractors, they are still required to possess certain competences to ensure the success of DB projects (Xia and Chan, 2010). DB clients should, in particular, have clear project scope and objectives, sufficient financial capability and adequate contract management ability. The level of client experience and their involvement in DB projects are important to project success in terms of quality. In this study, there was a lack of acknowledgement by clients on the role of client experience in quality outcomes. The clients were either not aware or misunderstanding the impact of their characteristics and sophistication on the project outcome. Following-up interviews with DB clients revealed that they agreed that it was a contributory factor according to their DB project experiences.

The incentive of DB contractors to cut corners and maintain profitability will compromise the quality of DB projects. As the key stakeholders in DB projects, design-builders play a vital role in the delivery process because they take full responsibility for design and construction, and take control of the project management. A mean score of 3.97 validates Gransberg and Molenaar's (2004) findings where early cost establishment and schedules are fixed in advance under DB contracts, the only variable to increase profit is

scope and quality and is very much in line with expectations. Interestingly, most of the contractor respondents also agreed with this statement. Where the contract conditions provide for this incentive to exist, the quality will almost definitely suffer.

The quality of design documentation also affects the final project quality. Many respondents mentioned that the propensity for design changes and errors is increased under design/build procurement. Quality issues in design documents could be assumed to transpose into quality issues in construction, particularly where short time frames and error checking are reduced. Under the DB contract, the design documentation is influenced heavily by both the design consultant team and the DB contractor. For design consultants, fee competition remains one of the big issues to produce high quality documentation. The respondents from the design group strongly agreed that lower fees by default result in less involvement of experienced staff, and an increase in likelihood of errors and lower quality design. Under DB contract, the contractor is responsible for managing the design process. However, the questionnaire survey results indicate that most of the respondents do not find contractors skilled enough in the design area. As a result, it produces rework for consultants and quality issues in both design and construction. It should be noted that the results, particularly under the study area of Quality levels and benefits of the DB method compared with more traditional systems, highlight a great divide between the Client/PM/Designer group and the Contractors groups. This perhaps indicates the Contractors view that they are delivering buildings which match the scope and quality standards and intent of such DB contracts and that perhaps, the Client/PM/Designer groups expectations of Quality are too high for DB projects where the focus of delivery tends to be towards time and cost factors.

DB is not suitable for all the projects; therefore the procurement selection affects the quality performance of DB projects. The project procurement represents the purchasing steps that owners or their representative must take to gain the service and commodities as required (Beard *et al.*, 2001). The ability for building clients and developers to make the correct procurement choices depend on their understanding of the factors which influence suitability and performance. These factors mainly include project type, client's risk tolerance, financial requirements, contractor availability, and market conditions. Clients should carefully evaluate the suitability of adopting the DB system at the early stage of the project and then clearly define the project scope and expected outcomes in advance of the procurement selection. Otherwise it can be very costly if the procurement decision made by the client at the outset of the DB process is not correct. At the same time, owners should stop short of describing how to get there, for it may preclude the DB team from any significant creativity and innovation.

Conclusions

DB procurement is not a recent development and it has been in use in all project types and industries for some time. This study aimed to evaluate the quality performance of this procurement method in the construction industry of Queensland and to identify and assess the underlying factors that affect the quality performance of DB projects. The overall low response rate of 23 % (34 respondents) despite being a reasonably balanced cross-section from within the groups should be noted as a limitation with this survey particularly when considering the impact of such a study for further research. In the current study, quality has regularly been identified as being reduced under DB method in Queensland. The results of the questionnaire indicate that DB is still considered as having a negative impact on the project quality in terms of architectural quality, functional quality, technical quality,

workmanship quality, and client's satisfaction. Despite the rapid developments of DB contracts and its wider implementation in Queensland construction industry, the client's satisfaction level and overall quality performance of DB projects is considered as lower compared with the traditional delivery method. Only 21.2% of respondents would recommend DB system for projects where quality was of paramount importance. Additionally, even though the respondents reached a light agreement that the DB method provides fewer contractual claims, faster project delivery and lower project cost; they did not believe that DB method would produce best value of project, encourage innovation and facilitate project integration.

The literature review and broad questionnaire survey revealed that the ranked factors affecting the quality of DB projects are (1) project briefing and scope definition, (2) client's role and responsibility, (3) contractor's incentive, (4) design document quality, and (5) procurement selection. The ineffective project briefing and scope definition is the most important factor undermining the quality of DB project. Poor scope definition was seen as the primary driver of low client satisfaction. For client's role and responsibility in DB projects, it is clear that client experience, sophistication and capability would undoubtedly have an impact on project quality. Many respondents mentioned in this study that clients generally do not understand or fully appreciate what is required of them on DB projects.

DB projects are considered by nearly all groups of respondents to provide greater profits to contractors than more traditional forms of procurement. When contractors seek to exploit the incomplete design or sometime vague briefs to improve profitability, the project quality would be usually compromised. The questionnaire survey also found that the quality of design documents in DB projects is reduced because of the increase in both design changes and design errors. As a result, the final quality of DB projects would be compromised. Finally, considering the DB system is not appropriate for all the construction projects, an inappropriate decision making on the project procurement will have a significant effect on the quality outcome for the DB project.

The research findings will facilitate project stakeholder's better understanding of the delivery process of the DB system and provide guidelines to improve the quality performance. However, similar to any other opinion-based research study, this research study suffers from the lack of consideration in terms of subjectivity, bias, and the variability in processing complex information. Further studies should be conducted to capture more responses not only from Queensland but also nationwide in Australia.

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