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Determining the optimal proportion of design in design-build request for proposals (RFPs)

Bo Xia[1], Keith Molenaar[2], Albert Chan[3], Martin Skitmore[4], Jian Zuo[5]

[1] Lecturer, School of Civil Engineering and Built Environment, Queensland University of Technology, Garden Point Campus, 2 George Street, Brisbane QLD 4000, Australia.
Email: paul.xia@qut.edu.au

[2] Professor, Department of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder, Campus Box 428, ECOT 643
Email: keith.molenaar@colorado.edu

[3] Professor, Department of Building and Real Estate, Hong Kong Polytechnic University, Hung Hum, Kowloon, Hong Kong, China.
Email: bsachan@polyu.edu.au

[4] Professor, School of Civil Engineering and Built Environment, Queensland University of Technology, Garden Point Campus, 2 George Street, Brisbane QLD 4000, Australia.
Email: rm.skitmore@qut.edu.au

[5] Senior Lecturer, School of Natural and Built Environments, University of South Australia, City East Campus, GPO Box 2471 Adelaide SA 5001, Australia
Email: Jian.Zuo@unisa.edu.au

ABSTRACT

The design-build (DB) system is a popular and effective delivery method of construction projects worldwide. After owners decide to procure their projects through the DB system, they may wish to determine the optimal proportion of design to be provided in the DB request for proposals (RFPs), which serve as solicitations for design-builders and describe the scope of work. However, this presents difficulties to DB owners and there is little, if any, systematic research in this area.

This paper reports on an empirical study in the USA entailing both an online questionnaire survey and Delphi survey to identify and evaluate the factors influencing owners' decisions in determining the proportion of design to include in DB RFPs. Eleven factors are identified, i.e. (1) clarity of project scope; (2) applicability of performance specifications; (3) desire for design innovation; (4) site constraints; (5) availability of competent design-builders; (6) project control requirements; (7) user group involvement level; (8) third party requirements; (9) owner experience with DB; (10) project complexity; and (11) schedule constraints. A statistically significant agreement on the eleven factors was also obtained from the (mainly non-owner) Delphi experts. Although some of the experts hold different opinions on how these factors affect the proportion of design, these findings furnish various stakeholders with a better understanding of the delivery process of DB projects and the appropriate provision of project information in DB RFPs. As the result is mainly industry opinion concerning the optimal proportion of design, in addition and for completeness, future studies should be conducted to obtain a big picture of the optimal proportion of design by means of seeking owners' inputs.

Key words: design and build, proportion of design, request for proposals, Delphi method

INTRODUCTION

Design-build (DB) is a construction delivery method where one entity or consortium is contractually responsible for both design and construction (Songer and Molenaar, 1997). It is effective and has gained considerable popularity in recent years worldwide (Konchar

and Sanvido, 1998, Haque et al., 2001; Hale et al., 2009). With DB projects, even though owners can leave most of the delivery responsibilities to a design-builder in a single contract, they still need to sufficiently articulate their requirements for project performance and expectations for the completed facility (Janssens, 1991; ASCE Committee of Specifications, 2008) and provide a base for tendering and project procurement (Harris and McCaffer 1995). It is imperative to involve the completion of some design work for inclusion in the request for proposals (RFPs).

According to the American Association of State Highway and Transportation Officials (2005, 2008), the degree of conceptual or preliminary design completion prior to appointing a DB contractor can influence the degree of success of DB contracting. Clearly, too little information imposes too many uncertainties on potential contractors and reduces the chances of obtaining satisfactory design solutions in the tenders. On the other hand, providing too detailed design solutions in the RFPs may limit the potential for contractor innovation in addition to burdening owners with extra design fees (Gransberg et al. 2008). An important decision for DB owners, therefore, is to decide on an appropriate amount of DB project information to provide to a design-builder (Beard et al. 2001) and particularly when some design work is needed (USA Federal Highway Administration 2006).

However, determining an appropriate proportion of design in DB RFPs is not an easy task and presents difficulties to many owners, especially those with less experience (Janssens, 1991). Different organizations provide different guidelines. For example, the

Design-build Institute of America (DBIA) suggests that owners should provide no design work in DB RFPs, while the American Council of Engineering Companies indicates the completion of 35% of design work to be appropriate prior to engaging design-builders (Chen, 2004). This only adds to the confusion for many DB owners.

The objectives of the study described in this paper were therefore, firstly, to identify the appropriate proportion of design work to be included in DB RFPs. Secondly and more importantly, considering a single proportion of design for all circumstances is unlikely to be appropriate, the work aimed to identify the contingent factors involved in determining the proportion of design and the extent to which they affect the associated decision-making process.

BACKGROUND

A typical DB RFP consists of instructions to proposers, contractual documents, technical provisions and attachments (Migliaccio et al. 2009). Gransberg et al. (2008) recommend that the specifications, design criteria and standards should be clearly stated in the RFP so that DB team has a better understanding of the required level of design, which is critical for clarifying the scope of work. On the one hand, non-client stakeholders should thoroughly analyze the RFP issued by client in order to have a better understanding of: (1) what motivates the client to choose the DB approach and (2) the success criteria defined by the client (del Puerto et al. 2008). del Puerto et al.'s (2008) study found that design approach is considered to be relatively less important than qualifications and price for a

successful response to DB RFPs. Upon analyzing 75 RFPs from various agencies in the United States, Gransberg and Windel (2008) supported this by concluding that clients rely heavily on the DB team's qualifications for the design quality of DB projects.

On the other hand, for DB owners, selecting an appropriate proportion of design involves deciding on when to hand over projects to contractors. When there is less design information in RFPs, there are increased opportunities for interaction between the design-builders and clients, and the design-builders have more control of the projects. Indeed, a reduced level of design completion helps to encourage innovation from the DB team and to improve efficiencies in integrating design and construction, and consequently to achieve better value (Molenaar et al. 1999). The level of design completion is also a key consideration during procurement method selection, e.g. qualifications-based, best value or low bid (EI Wardani et al. 2006). When more information is issued by owners (or their design consultants), some opportunities for alternative solutions may be foreclosed, and the process becomes more aligned with traditional design-bid-build (Beard et al., 2001). Owners, therefore, need to closely examine the situational factors of each project and balance the tradeoffs involved when deciding the proportions of design.

Given the importance and difficulty in deciding the proportion of design, organizations in different countries offer some suggestions to guide the owners' choice, help reduce project risk and ensure the successful completion of DB projects. These are as summarized in Table 1 and indicate quite a wide range of figures to be involved. The reasons for these differences are manifold, including different conditions of DB markets

and different levels of interest in DB projects. Moreover, considering the unique situational conditions of each DB project, it is unlikely that a single proportion of design will be appropriate for all DB project settings.

Please insert Table <1> here

Janssens (1991) categorized the variables influencing the proportion of design work into those relating to *design*, *cost*, *time* and *other circumstances* as the appropriate proportion of design work should affect all these variables for every single project.

The American Society of Civil Engineers developed "*Preparing Requests for Proposals and Specifications for Design-Build Projects*" in 2008. This guideline clearly specifies that "the RFP must contain the information necessary for the DB proposing entity to prepare a proposal that addresses the needs of the owner without the need for significant owner involvement during the project" (ASCE, 2008, p.15). Owner's requirements should be summarized in the conceptual design and subsequently incorporated into the RFP. Design detail should be accommodated by establishing the unit price in the RFP.

According to the U. S. Federal Highway Administration (2006), the amount of pre-RFP design work needed depends on the nature and complexity of the project, the needs of prospective teams to understand the requirements of the owners, the potential risks of the proposed project, and the comfort level of design-builders in developing the scope of the project (see also Migliaccio et al. 2009). The American Association of State Highway

and Transportation Officials (2008) points out that when deciding on the appropriate level of design, the agency should consider the following characteristics: clarity of project goals and scope, nature and complexity of the project, the agency's ability to convey the scope through performance criteria, and the comfort level of the contracting agency with outsourcing the design.

Xia and Chan (2012) examined the effects of different proportions of design on the responsibilities and risks involved for DB stakeholders. Their study found that, in order to determine the appropriate proportion of design in DB RFPs, owners have to take various factors into consideration, including the availability of competent design-builders, the DB experience of owners, complexity of DB projects, project control requirements, need for early commencement and short duration, reduced responsibilities, and clearness of project definition. However, these results are limited to the Chinese construction market and may differ from other countries.

RESEARCH METHODS

The methods employed in the research comprise an open-ended online questionnaire survey with DB owners followed by a two-round Delphi study with DB construction professionals practicing in the USA. For the online questionnaire survey, DB owners recalled the different levels of proportions of design in DB RFPs they have encountered, and the factors affecting the decisions involved. After consolidating these factors, a two-

round Delphi study prioritized the factors and evaluated their effect on client decision-making.

An online questionnaire survey provided the initial data collection method. This is an approach frequently used in construction management research and increasingly involves the use of the Internet, which is relatively inexpensive and takes less time in addition to reducing the time needed for data analysis by collecting data into a central database (Mangione, 1995; Sharp et al., 2007). As an initial step in the online questionnaire development, a pilot survey was conducted with six professionals through email contacts to refine the questionnaire and ensure the questions do not lead to biased answers or misunderstandings. After the pilot survey, 235 email invitations were sent to owners attending the DBIA 2007 and 2008 annual conferences inviting their participation in the survey.

Respondents answered the following open-ended questions in the online questionnaire survey:

I(a): What has been the MINIMUM proportion of design contained in a design-build RFP that you have encountered (%)?

I(b): What were the factors that determine the Minimum level of proportion of design?

II (a): What has been the MAXIMUM proportion of design contained in a design-build RFP that you have encountered (%)?

II (b): What were the factors that determine the Maximum level of proportion of design?

III(a): What do you think is the OPTIMAL proportion of design that should be included in a design-build RFP (%)?

III(b): What do you think are the important variables/factors that determine the optimal proportion of design in a design-build RFP? Please list a minimum of three such factors

Ultimately, 20 owners completed the online survey. Although the number of the respondents is comparatively small (with 9% response rate), it is acceptable for the exploratory nature of the research at this stage (mainly to identify the factors that determine the optimal proportion of design in DB projects) and the complexity of the topic. In addition, the statistical analysis conducted in the online questionnaire survey is descriptive, e.g. frequencies to present the distribution of design proportions in different situations. Among the 20 respondents, 16 had more than 5 years DB experience, with 4 having 10-20 years and 3 over 20 years experience.

After collecting the survey data, the underlying factors were identified through content analysis. Content analysis helps determine the major facets of a set of data, by simply counting the number of times an activity happens, or a topic is depicted (Fellows and Liu, 2008).

A two-round Delphi study then prioritized the identified factors and explored how they affect client decision making. The Delphi method extracts the maximum amount of unbiased information from a panel of experts (Chan *et al.*, 2001). Even if the collective

judgments of experts are subjective opinions, Delphi is more reliable than individual statements and therefore more objective in its outcomes (Masini 1993). The method typically involves the selection of suitable experts, development of appropriate questions and analysis of the answers (Cabaniss, 2002; Outhred, 2001). The original Delphi procedures have three features: (1) anonymous responses; (2) iteration and controlled feedback; and (3) statistical group responses (Adnan and Morledge, 2003). The features minimize the biasing effects of dominant individuals, irrelevant communications, and group pressure toward conformity.

The Delphi method used in this research comprised two rounds with DB experts in the construction industry. All the experts are members of DBIA Designated Design Build Professional™, who have demonstrated their in-depth understanding and knowledge of DB project delivery through education, experience and examination (DBIA, 2009). A total of 615 members of DBIA Designated Design Build Professional™ were identified from the professional DBIA database online and were invited through email contact to attend the on-line Delphi research study. In Round 1 of the study, 82 expert respondents provided (1) ratings of the level of importance of each factor based on a five-point Likert scale, and (2) opinions on how the factors affect the proportion of design. As is standard practice with the Delphi method, in Round 2 of the study, 34 expert respondents reconsidered their decisions in the light of the consolidated results from Round 1.

The majority of Delphi studies use 15-20 respondents (Ludwig, 1997). Moreover, with a homogeneous group of experts, good results occur even with a panel as small as 10-15

individuals (Ziglio, 1996). Therefore, the opinions solicited from the 34 designated DB professionals in Round 2 are more than adequate to provide reliable results.

ANALYSIS OF THE ONLINE QUESTIONNAIRE SURVEY

As shown in Figure 1, public owner agencies provided the most responses, with respondents from both public and private owner agencies accounting for 75% of the total. As anticipated due to the nature of the study and the background of the targeted respondents, those from other organizations all have the experience in acting as owners' consultants.

Please insert Fig <1> here

According to the responses, the minimum proportion of design the owners have encountered ranges from 0% to 50%. The average proportion is 11% and the median proportion of design is 10%. The major reasons for providing a minimum or less proportion of design in DB RFPs include the simplicity of the project, the comprehensiveness of performance specifications or project criteria that clearly define the project, the urgency of projects, and the owner's preference. Figure 2 provides the distribution of the minimum proportion of design.

Please insert Figure <2> here

The maximum proportion of design they have encountered ranges from 0% to 95%, with 44% and 40% average and median proportion of design respectively. Many owners provide a higher degree of proportion of design in RFPs mainly because they lack a clear understanding of the project requirements at the early stages of a project. As a result, they hope to exercise firm control of the projects, and intend to avoid undesirable risks. In the DB system, owners should normally provide no more than 50% of the design in order to leave enough room for innovative input from contractors. However, in some real life projects owners still provide too much design, even as much as 95% in a DB contract, as reported by one respondent in the online questionnaire survey. In this case, the project delivery process resembles the traditional design-bid-build more than the design-build approach. Figure 3 provides the distribution of the maximum proportion of design.

Please insert Figure <3> here

The optimal proportion of design proposed by the respondents ranges from 0% to 80% (Figure 4). Most of the respondents (80%) commented the optimal proportion of design should be no more than 30%. Twenty percent of the respondents suggested that the optimal proportion of design should be less than 10%, and only 10% of the respondents viewed the proportion of design should be more than 50%.

Please insert Figure <4> here

A content analysis on the data collected identified and consolidated the factors that affect the determination of proportion of design. Weber (1990) stated that content analysis helps classify textual material, reducing it to more relevant, manageable bits of data. All the factors listed in the Minimum, Maximum, and Optimal situations were documented and analyzed. Similar main points and ideas were then assembled and different main themes finally crystallized from the analyzed factors. After the analysis, 17 identified main factors were categorized. Table 2 shows the 17 consolidated key factors and their frequency.

Please insert Table <2> here

THE TWO ROUNDS DELPHI STUDY

Selection of the Expert Panel

One of the most important considerations in carrying out a Delphi study is the identification and selection of potential members to constitute the panel of experts (Ludwig, 2001; Stone and Busby, 1996), as the validity of the study depends on this process.

In this Delphi study, all the experts were members of DBIA Designated Design Build Professional™, who have demonstrated through education, experience and examination their in-depth understanding and knowledge of the DB project delivery process (DBIA,

2009). The Professional DBIA Certification recognizes professionals in the industry who possess a qualified and quantified level of expertise in DB project delivery. This level of expert experience and knowledge helped to increase the validity of the research.

Round 1 Delphi Study

In the first round, the panel was requested to assess the importance of each factor based on a 5-point Likert scale (from 1=not important to 5=extremely important), and giving opinions on how the factors affect owners' decisions. Additionally, experts were encouraged to recommend new factors in addition to scoring the existing factors. Invitation letters were sent to all the 615 DBIA Designated Design Build Professional™ people. Finally, 82 experts completed the first round in early October 2009, and no new factors emerged. Tables 3 and 4 summarize the background details.

Please insert Table <3> here

Please insert Table <4> here

As the Tables indicate, the selected experts represent a wide spectrum of professionals in the USA and provide a balanced view for the study. In addition, nearly all the experts (95%) have more than five-years working experience with DB projects and have been involved in more than five DB projects. This working experience, together with the various professional positions and organizations involved, ensures the validity of the Delphi study.

The 82 completed questionnaires were statistically analyzed, and the factors listed in descending order based on their mean scores (shown in Table 5). According to Friedman's analysis of variance ($p<.05$), the importance levels of the factors are significantly different from each other. A mean score of 3.0 was adopted as the cut-off point and only the factors with mean scores over 3.0 (i.e., 'IMPORTANT') were re-evaluated in the next round. This led to the exclusion of type of project, requirement for design changes, requirement of price competition, and size of project.

Please insert Table <5> here

Kendall's Coefficient of Concordance (W) was used to measure the degree of agreement between the panel members on the ordered list of the 17 factors. This indicates the degree of agreement by mean ranks by taking into account the variations between the rankings (Doke and Swanson, 1995; Schmidt et al., 2001). With a coefficient of 0.174 (Table 5), this is statistically significant ($p=0.000$). The null hypothesis that the respondent's ratings within the group are unrelated to each other was therefore rejected.

In Round 1, all the experts also showed opinions on how each factor affects the proportion of design. Table 5 provides the results. For example, 98% of the experts considered the factor of clarity of project scope to be negatively related to the proportion of design, which means that if the clarity of project scope increases (with other factors remaining unchanged), the owner should provide less proportion of design. Only 2% of the experts proposed more design work in RFPs. According to the analysis, the majority of experts significantly agree on the relationship between the proportion of design and

shortlisted factors, namely, clarity of project scope, applicability of performance specifications, desire for design innovation, involvement of user group, owner experience, need for project control, and schedule constraints.

There was no agreement, however, on the factors of project complexity, need for price accuracy, site constraints, and early price certainty. Especially for the factor of early price certainty, 35% of the experts observed that it relates to clarity of project scope instead of proportion of design. Even with no design provided, design-builders can still obtain early cost estimates based on a clear scope definition. Finally, even though its mean score is higher than 3.0, early price certainty was excluded from the factor list for Round 2.

In order to assess the agreement among the experts regarding the importance of the factors and their effects on the determination of proportion of design, they received all the results from Round 1 for their reference in the next round. After the Round 1, 12 factors, with mean scores higher than 3.0, were included in the second Delphic round for the experts' re-evaluation.

Round 2 Delphi Study

In Round 2, the experts (1) re-rated the factors, and (2) re-considered their opinions on how these factors affect the proportion of design in the light of the consolidated results obtained in Round 1. The experts who completed the Round 1 survey received the Round 2 questionnaires by email in late December 2009, resulting in 34 returns.

Most experts reconsidered their ratings provided in the previous round and made adjustments to their original ratings. However, the top three factors - clarity of project scope, applicability of performance specifications, and desire for design innovation - remained unchanged. Table 6 shows the rankings for all factors in descending order. The increased value of Kendall's Coefficient of Concordance (W=0.184) indicates that the agreement among the panel experts has improved.

Please insert Table <6> here

Except for the factors of project complexity and requirement for proposal price accuracy, the majority of experts reached agreement on the relationships between the factors and the proportion of design. For example, all the experts agreed that owners should provide less design themselves when they require more design innovation from design-builders. There was no agreement, however, on how project complexity and need for price accuracy might affect the proportion of design. This applied particularly to project complexity, where the numbers of experts holding different opinions are almost the same. Further analysis of the experts' opinions is required to ascertain exactly how the factors may influence the proportion of design.

DISCUSSION

The Delphi method, by its nature, serves as a self-validating mechanism as experts are given chance to re-assess their decisions with reference to the consolidated opinions of

other experts (Yeung et al. 2009). The Delphi method extracts the maximum amount of unbiased information from the experts (Masini, 1993; Chan *et al.*, 2001). Although the study suffers from subjectivity, bias, imprecise definition, and human inability to process complex information, the results nevertheless provide perspectives for a better understanding of the relationships between project conditions and the proportion of design in DB RFPs.

The clarity of project scope is the most important influencing factor. All the respondents agreed that when the clarity of project scope increases, owners can provide less design information and allow design-builders more flexibility and options. Developing a clear scope for DB projects involves understanding the requirements and objectives of completed projects in both function and performance terms (Gransberg et al., 2006). Proper scope definition has proven to be a primary determinant of project success in the traditional delivery method, and it is even more important in DB projects (Songer and Molenaar, 1997). Many research studies indicate that if the owner is very clear about the project's goals, scope, and expected outcome, then the owner will benefit from the DB system (Mo and Ng, 1997; Molenaar and Songer, 1998; Leung, 1999; Pearson and Skues 1999; Chan et al., 2001). Otherwise, it can be very costly if the information provided by the owner to the contractor at the outset of the DB process is incorrect (Mogaibel, 1999).

For the factors of applicability of performance specifications, desire for design innovation, and schedule constraints, almost all the experts reached agreement on their relationship with the proportion of design. In contrast with traditional specifications, which give

preferred design solutions to define how a project is to be delivered, performance specifications describe the functional requirements/performance of the final project without stating the methods needed to achieve the required results. When owners apply performance specifications rather than prescriptive specifications, they can provide less design work to enable design-builders to choose the best solutions. Similarly, if owners desire design innovation from design-builders, they should provide less design work in RFPs, otherwise the ability of design-builders to be innovative would be constrained and the possibility of obtaining an improved and more reliable project limited. For schedule constraints, if the DB project has an urgent or compressed schedule, owners should provide a smaller proportion of design in order to reach out immediately to design-builders and give design-builders more flexibility in selecting the means and design to meet the schedule constraints.

Design-builders and owners are the key stakeholders in DB projects and contribute greatly to project success (Lam et al., 2008). The availability of competent design-builders and owners experience in DB also plays an important role in the determination of the proportion of design. Ninety seven percent of experts agreed that if owners are experienced in DB projects or owners can find competent design-builders to deliver their projects, they could provide a reduced proportion of design and focus on performance aspects, leaving most of project responsibilities and design work to the design-builders. In addition, a greater number of competent design-builders usually correlates with the maturity of the DB market. The experience and competitiveness of design-builders enables them to be more capable of delivering projects from a less restrictive RFP.

For site constraints, the majority of experts (70%) suggested that when these increase, less design should be provided in order to leave more latitude for design-builders to exercise creativity and innovation to devise necessary solutions. On the contrary, the remaining 30% of the experts suggest that owners should provide more design, primarily because it is owners who have a greater understanding of the site and can delineate all the impacts that design-builders may encounter. Even though experts hold different opinions on the determination of the proportion of design, most agree that when site constraints increase, owners should provide more scope definition or more information concerning the constraints and share their understanding and knowledge with design-builders. With a clearer delineation of site constraints, owners can provide less or even no design work and let the successful design-builders find the best solutions.

The requirement of project control is the only factor that the majority of experts (77%) positively relate to the proportion of design in RFPs. By providing more proportion of design, owners are increasingly assured that their requirements will be exactly met. However, by providing more proportion of design, owners (or design consultants) are again in the position of warranting the completeness of design to the design-builders (Beard et al., 2001). As a result, owners accept the design risk and may not derive the best of the DB system. Furthermore, some experts point out that, in order to retain control of their projects, owners should increase the performance requirements or choose better contract terms instead of providing more design work.

For the factor of user group involvement, if user groups are involved in the development of the project definition, less design is required in the RFP as the requirements of user groups are reflected in the RFP performance specifications. If user group involvement does not start until the design-builder has been appointed, it is still more preferable to provide less design information in order to allow design-builders more flexiblity in communicating with user groups and identifying suitable solutions. However, as many respondents commented, if user groups have specific needs or desires, a prescriptive design is more likely to be needed.

The experts did not agree on the relationship with project complexity. Nearly one half (52%) suggest that, when complexity level increases, owners should provide less design primarily because it is better to allow design-builders have more control and flexibility to address the complex issues involved. The other half (48%), on the contrary, suggest that owners should provide more design to reduce project uncertainty and risks, especially when owners or their consultants are the experts for a specific type of facility. In the construction field, project complexity affects project outcomes in various ways, and its importance in the project management process has been widely acknowledged (Baccarini, 1996; Doyle and Hughes, 2000; Austin et al., 2002; Chan et al., 2004). Considering the difference in opinions of the experts in this study, further research work is required for an improved understanding of the relationship between project complexity and proportion of design.

For the need for price accuracy, 60% experts suggested that owners should provide less proportion of design, primarily because this allows design-builders to have more control of alternative designs and final cost estimation. The remaining experts suggest the opposite, primarily because the more specific information is available in RPFs, the better is the chance of getting a more accurate cost proposal. Although not agreed on this aspect, many experts thought that price accuracy is more related to clarity of project scope than the proportion of design. This is because design-builders can have accurate cost estimates based on a clear project definition even with no design information provided. As suggested by the respondents, the requirement of proposal price accuracy was not a factor to be considered.

CONCLUSIONS

Over the past decade, the DB system has been widely used and gained much popularity in the construction industry. The determination of the proportion of design in DB requests for proposals is important to the success of DB projects but also poses difficulties for many owners. The primary objective of this paper is to determine the identity and influence of the factors affecting the proportion of design that an owner should include in a DB RFP. Eleven factors are identified, and the findings indicate that a client should comprehensively evaluate project conditions (clarity of scope, applicability of performance specifications, complexity level and site and schedule constraints), availability of competent design-builders, requirements of third parties, and their DB experience and project requirements (project control and desire for design innovation) in

order to determine the appropriate proportion of design in RFPs. These findings furnish stakeholders in general and clients in particular, with perspectives to understand how different circumstances affect the delivery process of DB projects. These findings also deepen the current body of knowledge and serve to accelerate the development of the field.

However, it is worth noting that the experts do not agree on the relationship of some factors (such as project complexity) with the proportion of design. Some of the factors identified in this study may interact with others, e.g. project complexity may affect the clarity of the project scope. However, there is no causal relationship between these two factors and they are separate project conditions. A project with a high level of complexity could have a clear project scope. Therefore, it is imperative to balance the effects of various factors (as some factors help to optimize design proportions) and to determine the optimal design proportion. Future research opportunity exists to establish a multiple criteria/attributes decision making model to assist the owners to cope with this challenge.

Limitation of this study exists due to the fact that experts may have their own definition and consequently subjective interpretation of the proportion of design in DB projects. Furthermore, considering the Delphi experts were all the members of DBIA Designated Design Build Professional™ and only 7% owner representatives, the research findings only reflect industry opinion on the optimal proportion of design. While the input from the design and construction professionals who form the DB team is clearly valuable, their opinion may substantially differ from clients' opinion due to different motivations.

Further studies should seek a significant amount of owner input in order to generalize these findings.

In identifying and evaluating the factors affecting owners' decisions on the determination of the proportion of design to include in DB RFPs, the Delphi method serves as a self-validating mechanism and provides a valuable framework for eliciting expert knowledge. This is especially true when there are very few studies available in the field. The Delphi study provided both insights and structure to assess the different factors. Given that the experts did not reach agreement on all the factors, it is desirable to conduct further studies. These should include empirical research based on quantitative evidence and case studies in order to better understand how the factors may affect the proportion of design in RFPs. Further research should establish a framework for determining the appropriate proportion of design in the light of the findings in this study.

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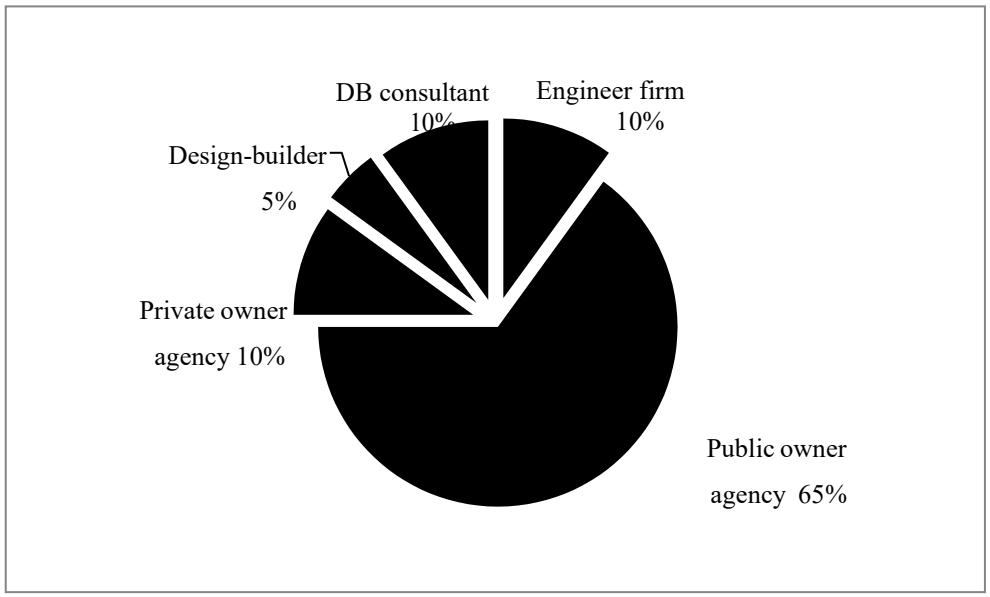

Figure 1 Percentage of participants by organization type

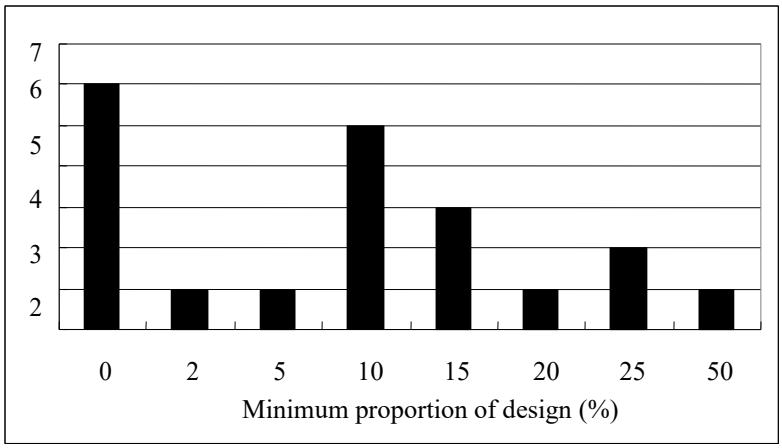

Figure 2 Distribution of minimum proportion of design in DB RFPs

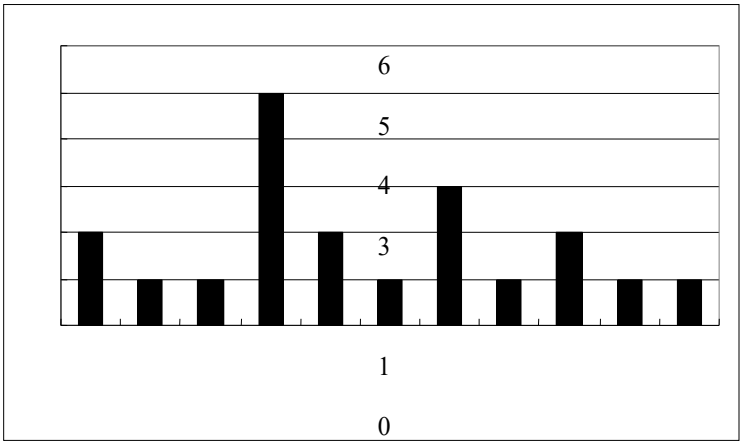

Figure 3 Distribution of maximum proportion of design in DB RFPs

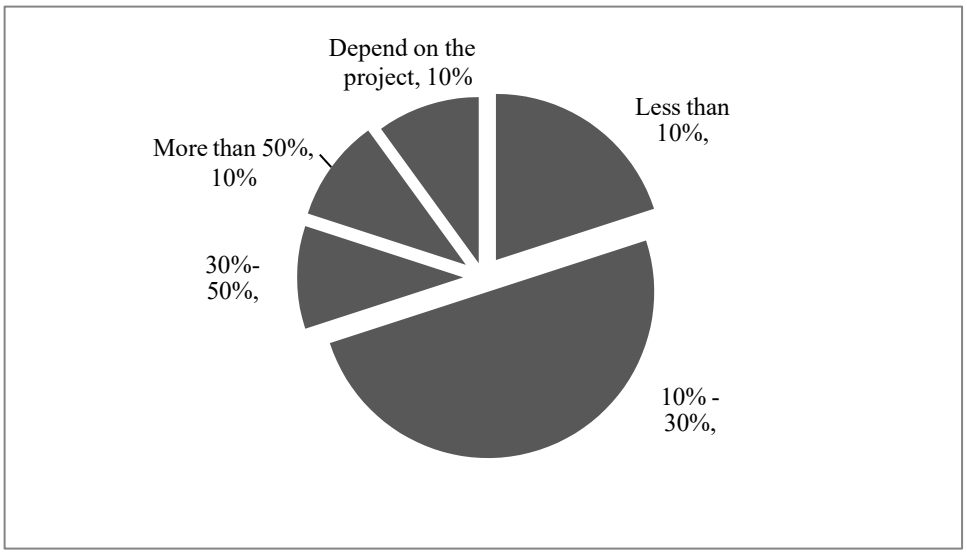

Figure 4 Distribution of optimal proportion of design in DB RFPs

Table 1 Proportion of design in DB proposed by different organizations

Countries	Department	Owner's proportion of design in DB RFPs（%）
*Singapore	Housing Development Board	None
	Public Works Department	20
*U. K.	Highways Agency	20-30
*Japan	Residence Trade Union	30
U. S.	Design-build Institute of America	None
	Federal Highway Administration	No more than 30
	Massachusetts Highway Department	25
	North Carolina Department of Transportation	25
	U.S. Army Reserve	5
	Naval Facilities Engineering Command	15-35
	Department of Veterans Affairs	Schematic level or design development level (15-50)
	American Council of Engineering Companies	35

* Source: Chen (2004)

1 Table 2 Consolidated factors and expert frequency

No.	Factors	Expert frequency
1	Clarity of project scope	80%
2	Applicability of performance specifications	60%
3	Requirement of owner project control	35%
4	Availability of competent design-builders	25%
5	Schedule constraints	20%
6	Project complexity	20%
7	Owner experience with DB	20%
8	Type of project	15%
9	Desire for design innovation	15%
10	Site constraints	15%
11	Requirement from third parties	10%
12	Requirement of proposal price accuracy	10%
13	Requirement of price competition	10%
14	Involvement level of user group	5%
15	Requirement of early price certainty	5%
16	Size of project	5%
17	Requirement for design changes	5%

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1 Table 3 Summary of the experts' working experience

DB experience		DB project number involved		DB project value involved	
1-5 years	5%	1-5	5%	Less than 50m	6%
5-10 years	26%	5-10	20%	50-100m	11%
10-20 years	33%	10-20	22.5%	100-500m	41.5%
More than 20 years	37%	20-50	31.3%	500m-1b	15.9%
		More than 50	21.2%	More than1b	25.6%

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1 Table 4 Summary of the experts' professional positions and working organizations

Type of organizations		Professional positions	
DB firm	28%	Architect	7%
General contractor	30%	Engineer	10%
Architecture firm	4%	DB manager	28%
Engineering firm	10%	Construction manager	33%
Specialty contractor	2%	Acquisition professional	5%
Consultant firm	16%	Independent consultant	4%
Owner agency	10%	Owner representative	6%
		Others	7%

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1 Table 5 Results of Round 1 of the Delphi questionnaire survey

Factors	median	average	Relationships	
			Positive	Negative
1. Clarity of project scope/requirements	4	4.02	2%	98%
2. Applicability of performance specifications	4	4.00	8%	92%
3. Desire for design innovation	4	3.81	4%	96%
4. Availability of competent design-builders	4	3.71	14%	86%
5. Involvement level of user group	4	3.38	32%	68%
6. Project complexity	4	3.32	45%	55%
7. Requirement of proposal price accuracy	3	3.29	49%	51%
8. Site constraints	3	3.28	44%	56%
9. Owner experience with DB	3	3.26	10%	90%
10. Requirement of owner project control	3	3.22	62%	38%
11. Schedule constraints	3	3.22	16%	84%
12. Requirement of early price certainty	3	3.21	48%	52%
13. Requirement from third parties	3	3.18	--	--
14. Type of project	3	2.99	--	--
15. Requirement for design changes	3	2.96	28%	72%
16. Requirement of price competition	3	2.59	32%	68%
17. Size of project	2	2.28	34%	66%
Friedman's chi-square=155.861, p=.000				
Kendall's Coefficient of Concordance (W) = .174, p=.000, N=56 (Excluding the partially completed entries)				

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1 Table 6 Results of the Round 2 of the Delphi questionnaire survey

Factors	median	average	Relationships	
			Positive	Negative
1. Clarity of project scope/requirements	4.5	4.21	0%	100%
2. Applicability of performance specifications	4	4.18	3%	97%
3. Desire for design innovation	4	4.14	0%	100%
4. Site constraints	4	3.79	30%	70%
5. Availability of competent design-builders	4	3.64	3%	97%
6. Requirement of owner project control	3	3.57	77%	23%
7. Involvement level of user group	3	3.43	34%	66%
8. Requirement from third parties	3	3.36	--	--
9. Owner experience with DB	3	3.32	3%	97%
10. Project complexity	3	3.25	48%	52%
11. Schedule constraints	3	3.21	3%	97%
12. Requirement of proposal price accuracy	3	3.18	40%	60%
Friedman's chi-square=56.634, p=.000				
Kendall's Coefficient of Concordance (W)=.184, p=.000, N=28 (Excluding the partially completed entries)				

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