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Managing the Design Process in Design-Build Projects-The South Florida Experience

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Abstract
Design-Build (DB) approach requires an explicit determination of the roles and responsibilities of the DB team. Over the years studies have been conducted to view the DB approach to construction, of which it has been getting a more favorable response. In comparison of DB versus the traditional design-bid-build (DBB) it has been found to have almost no delays; in addition, has a higher average of speed per square feet of construction per month. For this study, understanding of the management approaches being used nationally, internationally and locally was first developed through existing literature. Building upon the understanding, a questionnaire survey was conducted from South Florida DB companies in an effort to assess how clear the team members are of their roles and responsibilities. The survey was also designed to assess their management approaches and to see how they assess and protect their companies from the possible risks resulting from this particular delivery method. From the analysis of the responses received, it can be asserted that most South Florida survey of DB companies are knowledgeable of the design management approaches being implemented nationally and internationally. Another positive finding is that DB companies working on public and private projects are relatively small to medium size companies, some with their own A/E, some not; their design management approach is established at the onset of projects and continues throughout.

Keywords
Design-Build (DB) approach, design-bid-build (DBB), delivery method, roles and responsibilities

1. Introduction

As established by over abundant literature and endorsed by practice, in a DB project, the owner will enter into a single contract with one entity (usually a D&B contractor) to perform the full service of designing and constructing a facility. Portions or all of the design and construction may be performed by a single D&B entity, or in some cases, all may be sub-constructed to other companies (Konchar & Sanvido, 1998). Cited by Ling and Liu, (2004) that, "in many parts of the world, there appears to be a trend to procure more contracts using the DB procurement system. DB was already in use in the UK in the 1960s. Between 1984 and 1991, DB grew from 5% of the market (by value) to 15% in 1991 (Bound and Morrison, 1993). In the early 1990s, 15% to 20% of building projects in the UK were based on DB Franks, 1990). By mid-1990s, 20% of all construction projects were procured using the DB arrangement

(Holt, 1996). Towards the end of the 1990s, DB took up 23% of the market for new building works (Bennett et.al., 1996)". In the USA, DB started in the early 1900s (Greenfield, 1982). In the 1970s and 1980s, DB was used extensively, especially in major power and industrial projects (Kawaguchi et.al., 1994). In 1991, about 5% of all construction in the USA was based on DB (Setzer, 1991). In the mid-1990s, more than one-third of construction projects used the DB approach (Yates, 19950).

2. Literature Review

The design process can be conceptualized in at least three different ways: 1) as a process of transforming inputs into outputs, 2) as a flow of information through time and space, and 3) as a process for generating value for customers. Case studies and research findings to date indicate that design management in construction is deficient from all three of these points of view. In this paper, a series of experiments aiming at creating clarity and introducing systematic management principles from all three perspectives is described. The results of these experiments suggest that the use of relatively simple, albeit theory-driven, tools can achieve major improvements in the process of construction design. It is argued that only when based on suitable conceptualizations, and informed by empirical data, can effective methods be devised to ameliorate construction design and engineering (Koskela et.al., 2002).

The difficulties in designing complex engineering products do not arise simply from their technical complexity. The managerial complexity, necessary to manage the interactions between the different engineering disciplines, imposes additional challenges on the design process. The managerial complexity of a design is contained by using project management tools and techniques such as DB delivery arrangements (Yassine et.al., 2002).

The use of design-and-build contracting has increased worldwide as a viable alternative to traditional project delivery methods (ASCE, 1992; Songer et.al., 1994; Moore & Dainty, 2001) and many industry-standard forms of contract have a design-and-build version (Pickavance, 2000). Under the method, the client selects a contractor to carry out and be responsible for not only construction but also the design of the works (Ndekugri and Turner, 1994; Chappell & Smith, 1993; Mosey, 1998; DMIA, 2004; Konchar & Sanvido, 1998).

Over the years studies have been conducted to view the DB approach to construction, of which it has been getting a more favorable response. In comparison of DB versus the traditional design-bid-build (DBB) it has been found to have almost no delays; in addition, has a higher average of speed per square feet of construction per month. Other studies have confirmed that DB unit costs were 4 ½ % less than CM-at-risk projects and 6% less than DBB projects. DB projects, measured in terms of square feet of construction per month, were 7% faster than CM-at-risk projects and 12% faster than DBB projects (Levy 2006).

3. Problem Statement

Design-Build (DB) approach requires an explicit determination of the roles and responsibilities of the DB team. This being crucial also in the management of the design process, we have researched management approaches being used nationally, internationally and locally. Locally, we conducted a survey of twenty South Florida DB companies in an effort to assess how clear the team members are of their roles and responsibilities. The survey was also designed to assess their management approaches and to see how they assess and protect their companies from the possible risks resulting from this particular delivery method.

4. Research Methodology

This research effort is consisted of a literature review of the relevant secondary data in the form of few research papers. For this purpose data has been gathered and development of knowledge base for the

exercise was undertaken. However, the study required an extensive Primary data. In order to acquire that, a simple survey exercise was initiated after questionnaire has been developed, to have more responses by targeted audience. The targeted respondents were different contractors operating in the South Florida region, U.S. The results obtained from the survey were then analyzed in order to draw conclusions and propose some recommendations for improvement.

4.1. Data Sources

The following data sources have been used for the study at hand.

4.1.1. Primary source

The general methodology of this study relies largely on the survey questionnaire responses which were collected from Local South Florida DB companies. The questionnaire prepared for the survey was formulated by screening and comprehending the relevant literatures in the area Design-Build delivery methods and design management.

4.1.2. Secondary source

In order to aid the collection of data through primary source it was vital that a thorough literature review is initially conducted to establish a foundation for the study at hand. Prior relevant research and books form the major part of secondary data source. The study involves qualitative analysis of the responses from the survey process.

5. Discussion and Analysis

This study includes a questionnaire survey from several DB firms operating in South Florida region, regarding how they manage the design process in DB projects. A questionnaire was prepared and presented to these firms. There are a total of 20 participants: (07) General Contractors, (04) Construction managers, (06) A/E Firms, (01) Electrical Engineering Firms, (01) Civil Engineering Firms and (01) Mechanical Engineering Firms. Another look at the respondents mix is that, out of twenty; nine (09) were design and construction firms, three (03) were A/E firms who subcontract construction services, four (04) were contractors who subcontract design services and four (04) were joint venture of A/E and Contractor companies. The study is based on both Private and Public DB projects. Out of 20 surveyed firms, sixteen (16) are involved in private projects and four (04) firms are in public DB projects. The survey respondent organizations are involved with. Most of these organizations are involved in residential (12) and commercial construction (12) and at very small level industrial construction (04).

In this section, analysis of various data collected from afore-mentioned sources regarding managing design process in DB firms in the South Florida's construction industry will be illustrated. For ease of interpretation and connectivity, these data have been divided into the following subsets:

1. Project type that best fits the DB method
2. Stage of the project when DB team is being introduced.
3. Design implementation stage
4. Design management
5. Risks during design
6. Role of team member in managing the design process for DB projects

Above mentioned data subsets are illustrated in following sections.

5.1 Project Type that Best Fits the DB Method

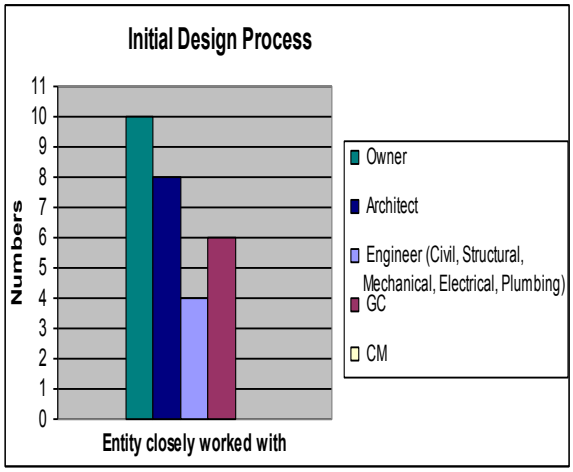
The DB method is preferred in residential, office buildings, and parking garages projects (Table 1).

Table 1: Project Type that Best Fits the DB Method

Category of Projects	Residential	Schools	Offices	Parking Spaces	Specialized Industrial Projects
Percentage Agreement	25	15	26	21	13

5.2 Stage of the Project When DB Team is Being Introduced:

In DB projects during the initial design stage, all entities i.e. Owner, A/E, MEP (Mechanical, Electrical, Plumbing) and structural engineer, and general contractor should work closely and in coordination with each other to make the project successful (Figure 1a). Also it is preferable to introduce the DB team at the time of project initiation and conceptual design (Figure 1b).



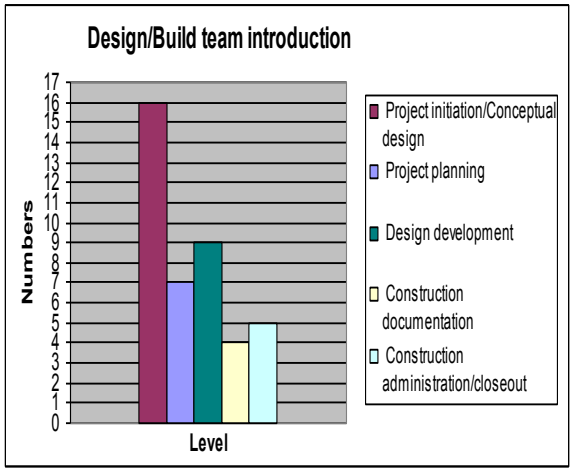


Figure 1 (a): Initial Design Process Involvement **Figure 1 (b): DB Team Introduction**

5.3 Design Implementation Stage

Figure 2 shows that in a DB project the design can be implemented at any stage but it is better to implement the design and design management at the design development stage.

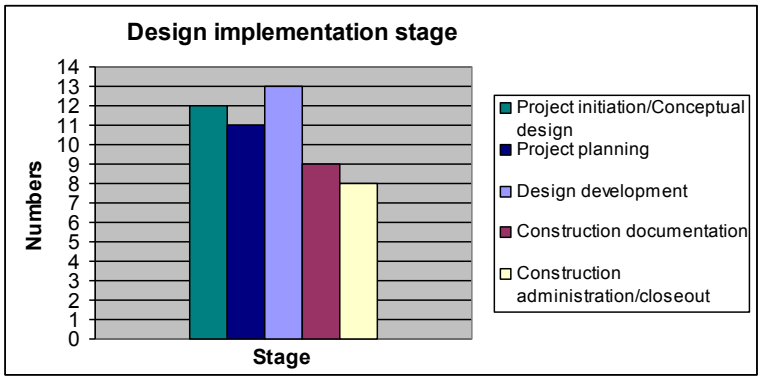


Figure 2: Design Implementation Stage

5.4 Design Management

Summarized in Table 2, Design management should have to be considered during cost estimation and quality control of a project**.** During the scheduling of a project, one may or may not consider the design management. During the design on a particular project in DB, specific clauses in the contract relating to potential design problems should be considered.

Table 2: Factors Considered for Design Management

Statement	Yes (%)	No (%)
Design Management, a factor during cost estimation	76	24
Design Management, a factor during project scheduling	35	65
Design Management, a factor in QC of a project	70	30
Specific Clauses in the contract to address potential design problem	75	25

Regarding specifications, design approach should be based on descriptive and reference standard specifications, and Performance Specifications. It can also be based on Proprietary Specifications; however, it may not be preferred (Figure 3).

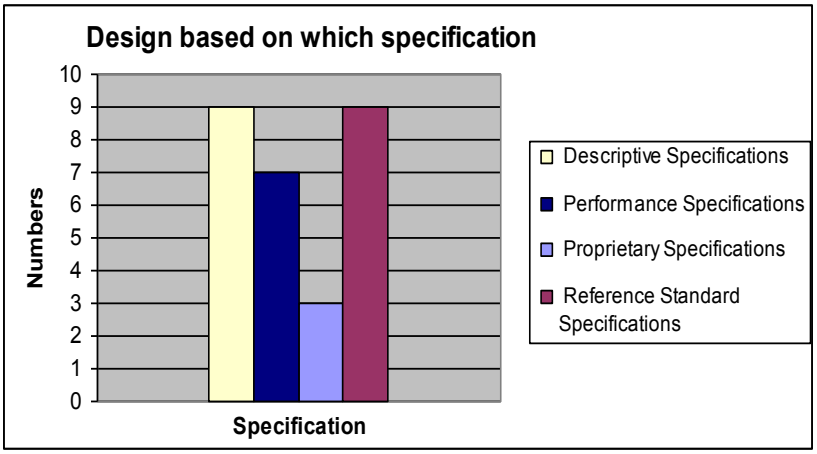


Figure 3: Basis of Design

As depicted in Table 3, owner's involvement level in design process falls between medium and high range. In addition, the importance of following A/E design, product and service specification on a project is very high *(Charts 06 & 07)*. Design quality suffers due to possible speed a project may take (50% agreement; 30% disagreement; 20% indifferent). Speed can be controlled by keeping the changes to a minimum level (100 % agreement).

Table 3: Factors Considered for Design Management

Statement	VL	L	M	H	VH
Owner Level of Involvement in Design	0	0	50	40	10
Importance of following A/E Design product and service specification on a project.	0	24	10	37	29

where VL= Very Low L= low M=Medium H=High VH= Very High

5.5 Risks during Design

Risk for design errors and omissions in DB projects are mostly shared by DB firms only (48%), Owner only (5%) and Both (47%). Design Management Risks prior to planning falls between low and medium range (Table 4). The Owner's will be at risk if one considers final construction cost while using DB delivery method (65% agreement; 30% disagreement; 5% indifferent)

Table 4: Factors Considered for Design Management

Statement	VL	L	M	H	VH
Design Management Risks Prior to Planning	5	0	45	50	0

where VL= Very Low L= low M=Medium H=High VH= Very High

5.6 Role of team member in managing the design process for DB projects

The roles each team member plays in Managing the Design Process of DB Projects has been summarized in Table 5.

Table 5: Role of Team Member

Sr. No	Description	Involvement
	Owner	
1	Provide detailed project descriptions.	34.29%
2	Have design input.	25.71%
3	Acquire materials and equipment required from the start so prospective DB companies can submit proposals to be able to get a close cost and schedule.	8.57%
4	Perform more of the administrative tasks such as review submittals, review proposed changes to documents, visit site periodically.	8.57%
5	May contract an Administrative Professional, another A/E or CM to oversee project	11.43%
6	Be involved in the design management throughout project.	11.43%
	Design Build Team	
1	Provide designs that protect the public's safety and as per codes and regulations.	13.77%
2	Provide designs as per Owner's needs, design requirements, and specifications.	13.77%
3	Provide bidding and/or negotiating documents	7.25%
4	Prepare contract documents	9.42%
5	Prepare conceptual estimates and construction costs	3.62%
6	Check shop drawings	13.04%
7	Process change orders	4.35%
8	Perform field inspections and keep site safe	2.17%
9	Communicates with Owner, CM, or other team members.	11.59%
10	Be the contractor's advocate.	6.52%
11	Control the design management process.	10.87%
12	Issue certificate of completion	3.62%
	Contractor	
1	Gives input to A/E as project is being designed, suggesting best procedures, materials that will save time and benefit the Owner	14.88 %
2	Communicates with Owner, A/E, CM, or other team members.	14.88%
3	Give advice on general site planning, labor and material availability and costs, delivery times	13.22%
4	Offers closely coordinated activities as a result of teaming the design and construction	9.09%
5	Prepares cost estimates	16.53%
6	Prepares construction and procurement schedules	16.53%
7	Participates in value engineering throughout the project	14.88%
	CM, Consultant, Other A/E	
1	May assist in preparation of the project	44.83%
2	Be Owner's advocate, perform the administrative task that are Owner's responsibilities	55.17%

6. Conclusions & Recommendations

Design and design management approaches for the DB method require defined roles and responsibilities (R&R) of its team members. As indicated in this study it is essential that these possible team members, A/E, contractor, Owner, Owner's consultants, end-users, subcontractors, etc. know and follow their roles and responsibilities because these will be intertwined and dependent of the other for the success of the

process. Risks from this method are minimized through effective design and construction management approaches.

From the local South Florida survey of DB companies, it was noted that they are mostly knowledgeable of the design management approaches being implemented nationally and internationally. The survey reveals DB companies working on public and private projects are relatively small to medium size companies, some with their own A/E, some not; their design management approach is established at the onset of projects and continue throughout; they involve the Owner with the project criteria, the design process and as a team member; perform meetings and have efficient communication venues; perform supervision; manage design changes to a minimum, and manage risk.

A DB team that has the best qualifications conforms to its R&R and follows most of these design management approaches. Throughout the design and design management process, the DB team can expect a better outcome of the design quality and delivery of the project in time and within budget. Nevertheless, more research and education for innovative management approaches in this area could be useful to the industry to better the design management process in the DB delivery method.

The roles and responsibilities of the DB team members are determined by the type of Owners, the size and experience of the members of the DB Company, the particular characteristics of the project, type of contract used**,** and the particular provisions that an Owner and DB company agree upon in a contract.

In a small team**,** the responsibilities are simpler. In larger teams roles and responsibilities are spread and may be more complex and specialized. Some apply to all members, such as supervision, while others are particular to the team member. The R&R in general relate to design, design management and construction, changes in time and work**,** and progress payments.

More specific roles and responsibilities deal with compliance of the laws, execution of the contract, warranties, performance and its liabilities, time and its liabilities, disputes and claims, etc. Because there are liabilities if the R&R are not carried out as per the contract, the contract must be carefully examined by all parties before signing to make sure all are in agreement.

The authors propose that standard documents on DB projects such as AIA DB Contract and other Resources be employed while conceptualizing the project and appropriate contractual arrangements be made to establish mutually agreed roles and responsibilities for integral parts of the project such as Change Orders, Project Criteria, Progress Payments, Owner's Consultant, Time, Supervision, Quality, Warranties etc.

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