EVALUATING THE EFFECTIVENESS OF PROJECT DELIVERY METHODS

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ABSTRACT

Project delivery method refers to the owners’ approach in organizing the project team that will manage the entire design and construction. There are several delivery methods that can be used on construction projects. They can be categorized in three groups: traditional design-bid-build, construction management and design-build. Selecting the appropriate delivery method is a key factor in achieving project objectives and project success. Each project delivery method has its advantages and disadvantages and they deal differently regarding the different owners’ objectives. This paper evaluates the effectiveness of project delivery methods in dealing with the different project objectives. Owners’ objectives can be categorized into 8 groups including cost, time, scope, quality, owner’s organization, funding / cash flow, project characteristics and risk and relationships. Forty construction experts were contacted and filled a questionnaire that evaluates the effectiveness of each method in achieving each of the objectives. Data was then analyzed and summarized to find the effectiveness of each method. A comparison among the different delivery methods is presented in this paper. The results indicate that alternative delivery methods such as design-build and construction management have higher effectiveness in achieving most of the owners’ objectives than the traditional design-bid-build method. However, owners should not choose a project delivery method blindly. Each project is unique and the owner’s objectives change from project to projects. Thus, owners should evaluate their objectives carefully and then study the effectiveness of each method in achieving their specific objectives before deciding on the most appropriate delivery method. This paper provides the foundation for such decision making process.

Key words: Construction Industry, Delivery Methods, Project Management, UAE

1. INTRODUCTION

Selecting the appropriate project delivery method is a key concern to owners and construction professionals. This choice affects project execution, time, cost, quality and safety which are the main objectives of any construction project. The decision is usually made by the owner based on the unique characteristics of the project, owner’s objectives, degree of risk, level of information available or needed at time of construction, level of desired client’s involvement, and interaction between design and construction among other factors. The construction industry today faces tremendous challenges due to increased project complexity, tough competition, increased demand on quality and safety, schedule and budget constraints. Construction projects are temporary endeavours undertaken to create unique facilities.
Owners and contractors are faced with the challenge of completing projects on time, within budget and deliver a quality product in a safe way. The term “delivery method” refers to the owner’s approach to organizing the project team that will manage the entire design and construction process (Gould and Joyce, 2003).

There are numerous project delivery methods that owners use on projects. These include Traditional Design-Bid-Build, Design/Build, Construction Management, Construction Management at Risk, etc. Each method has its advantages and disadvantages. The most common method is the traditional delivery method. In the traditional method, the owner contracts with a consultant for the design portion of the project and then separately contracts with a construction professional (contractor) for project execution. One of the major disadvantages of this method is that construction professionals are brought later in the project after the design is complete meaning that the design is not usually reviewed for constructability before it is finished (Gould, 2002). It is also difficult to fast track projects using the traditional delivery method. This arrangement is the longest in terms of design and construction time (Gould, 2002). In addition, this arrangement results in adversarial relationship between owner, designer and contractors which leads to unnecessary claims and delays. The traditional method often positions the constructor against the architect/ engineer/client, rather than encouraging teamwork toward common targets (Kumaraswamy et al., 2002). One of the alternative delivery methods is Construction Management where the owner contracts with a construction management company to manage the design and construction phases of the project. Another alternative delivery method is the Design-Build (DB), whereby the owner contracts with a single entity to perform both design and construction under one contract (Ling et al., 2004). The new delivery methods offer many advantages to owners such as shorten project duration, reduced cost, and non-adversarial relationships. Thus, owners have to choose a delivery method that enables them to achieve their objectives.

Konchar & Sanvido (1998) compared three project delivery methods in the US in terms of four factors which are unit cost, cost growth, construction speed and schedule growth. Their findings indicated that Design Build was superior to Construction Management at Risk and Design-Bid-Build. Ibbs et al. (2003) compared Design-Build to Design-Bid-Build based on time, cost and productivity. They stated that the timesaving was a definitive advantage of Design-Build while the cost and productivity results were not convincing. Dell’Isola (2002) studied the impact of delivery methods on cost and schedule and compared the advantages and disadvantages of the three delivery methods DBB, DB and CM at Risk. Bai and Hezam (2003) described the advantages and disadvantages of 14 project delivery methods. The factors discussed include contractor early involvement, funding, coordination, design & construction time, price competition, flexibility, single point of responsibility and construction time. Another study (Gransberg et al., 2003) compared the performance of Design-Build and Design-Bid-Build in the US. The study showed that cost growth and time growth are significantly lower for DB than DBB while the cost per square foot was lower but not in all cases. A research by the Construction Industry Institute CII (Anderson, 2003) identified 12 delivery methods and 20 selection factors divided into 3 categories: cost related, schedule related and other factors. The research team also developed a selection model using Excel®. The decision model is based on relative ranking of the different selection factors.
Each project is unique and owners have different objectives. Owners need to decide among many alternative delivery methods using multi objectives. The decision is not a simple one especially with the cognitive bias of decision makers and the tendency to choose the method that they are familiar method. Thus, there is a need for a formal decision making process that allows decision makers to specify their objectives, select the appropriate selection factors and their relative importance, and choose a method based on the effectiveness of that method in achieving the project objectives. This paper presents a comparison among the main delivery methods with regard to their effectiveness in meeting project objectives.

2. RESEARCH METHODOLOGY

The research methodology included two phases. In the first phase, the project delivery methods and the selection factors were identified through an extensive literature review. A questionnaire is then developed. Phase 2 included data collection where 40 questionnaires were completed. On site administration of the questionnaires was used to ensure that accuracy of the data and that the interviewees understand all questions. The data was then analyzed and the effectiveness matrix was developed as an average of all respondents.

The data was collected from 40 projects in the United Arab Emirates including projects in the cities of Abu Dhabi, Dubai and Sharjah. There were 22 public sector and 18 private sector projects. The results indicate that the main delivery method in use is the traditional design-bid-build (60%) especially on public sector projects. The projects included 6 residential, 13 commercial, 6 industrial and 15 infrastructure projects. The contracting parties interviewed were mainly owners (69%) but also included some designers (13%), contractors (13%) and construction management companies (5%). Each respondent was asked to rank the effectiveness of each delivery method in meeting owners’ objectives (section factors). These effectiveness values were averaged for all respondents.

3. PROJECT DELIVERY METHODS

Traditional Delivery Methods
Using the traditional delivery method, design-bid-build, the owner has two contracts: one with the designer for project design and bids preparation and a separate contract with a general contractor for the construction phase. During the construction phase the designer and contractor have working relationship. The multiple DBB is used when the owner wishes to divide the project into packages and contracts with a separate designer and general contractor for each package. The multiple prime contractors method is used when the owner contracts with one consultant for the design phase but then awards the construction contracts to multiple general contractors. The advantages of using this method are cost savings and schedule compression, while the disadvantages are coordination and management difficulties.

Management Based Delivery Methods
The management based delivery methods include the construction management method where the owner hires a construction management company to manage the
design and construction aspects of the project. In this method, the owner has a separate contract with the construction manager, designer, and general contractor. Construction management contracts are particularly attractive to organizations that periodically build complex structures but do not desire to maintain a full-time construction staff (Halpin and Woodhead, 1998). The agency construction management method is used when the owner desires division of the project into packages so the owner will have a contract with the construction manager, the designer, and multiple trade contracts with separate contractors. The Construction Manager at Risk method is used when the owner hires a construction management company to provide both construction management services and general construction of the project. In this case, the owner transfers much of the risk to the CM company. The Engineering-Procurement and Construction Management method is a hybrid of the design-build and the construction management approach. In this case, the owner hires an EP-CM company for the design and procurement of materials and then assist the owner in managing the construction project. This approach has the advantage that the owner retains the contractual relationships with the contractors while passing the responsibility for managing and coordinating to the EPCM contractor (Hartman, 2003). The Program Management method is used to manage multiple related projects. The owner hires a program manager to manage the separate contracts.

**Design – Build Delivery Methods**
The Design-Build delivery method is used when the owner contracts with one company to design and construct the project. The Multiple Design-Build method is used when the owner has separate contracts with several design-build contractors. The Build-Operate-Transfer (BOT) method is similar to the design-build but with financing option. It is used when the owner wants the facility but can not afford to own it (Hartman, 2003). The Bridging method is used when the owner hires a consulting company to assist in selecting and monitoring of the design-build contractor.

**4. PROJECT DELIVERY METHODS EFFECTIVENESS**
The set of selection factors that affect the owners’ decision of the most appropriate delivery method were determined through literature review. For this research, twenty-one selection factors are identified and grouped into 8 categories. The effectiveness of each delivery method in dealing with the different project objectives (selection factors) was calculated as an average from all respondents. The effectiveness values are presented in Table 1.

<table>
<thead>
<tr>
<th>Owners’ Objectives (Selection Factors)</th>
<th>Design-Bid-Build</th>
<th>Construction Management</th>
<th>CM at Risk</th>
<th>Design-Build DB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ensures Shortest Time</td>
<td>0</td>
<td>80</td>
<td>90</td>
<td>93</td>
</tr>
<tr>
<td>2 Stay On Schedule</td>
<td>30</td>
<td>83</td>
<td>88</td>
<td>96</td>
</tr>
</tbody>
</table>
Time & Cost Related Factors

Time related factors are extremely important in deciding the appropriate delivery method. This is particularly true in the UAE where competition is increasing and owners desire that their products completed in a short time. The first factor is ensuring that the construction project is completed with the shortest possible time. The second factor is completing the construction project on schedule but not necessarily the shortest time. Cost related factors are always at the center of decision making. These factors include ensuring that the construction project is completed with the lowest possible time. The second factor is completing the construction project within budget but not necessarily the cheapest. Figure 1 presents the comparison of the effectiveness of each delivery method with regard to time and cost related factors.
Scope, Changes & Quality Related Factors
Scope related factors include the level of scope definition at the time of contract award. Each delivery method requires a different level of scope definition to achieve the desired results. The level and number of changes expected during project execution is another factor affecting the choice of delivery method. The third factor is the flexibility to make changes. Many owners desire that the delivery method should be flexible enough to allow them to make changes as needed. Quality related factors include one factor to measure the project delivery method’s ability to attain the highest overall quality. Although a high quality is always desired by owners, each method achieve this objective indifferent ways. The difference, however, is not as big as other factors. Figure 2 presents the comparison of the effectiveness of each delivery method with regard to scope, changes and quality related factors.

![Figure 2. Scope & Quality Related Factors](image)

Owner’s Organization Related Factors
Owner organization factors deal with the owner’s organization and the level of experience of its staff. These include the level of in-house management experience and the owners’ desire for construction professional input during the early phases of the project. Another factor is the owner’s desire to be involved in the project and to have control over different aspects of the project. The fourth factor deals with the owners desire for single or separate project contracts. If the owner desires a single project contract, the only delivery methods that support this objective is Design-Build or Build-Operate-Transfer. The last factor is the owners’ desire for a single construction contract. Some owners prefer separate construction contracts to benefit from price competition and sometimes faster construction. Figure 3 presents the comparison of the effectiveness of each delivery method with regard to owner’s organization related factors.
Works with No In-House Management Experience

Allows Professional Construction Input

Allows More Owner’s Control

Allows for a Single Project Contract

Allows for a Single Construction Contract

Figure 3. Owner’s Organization Related Factors

Cash Flow, Risk and Relationship Related Factors
The next category is funding and cash flow factors. Some owners do not wish to commit the construction cost of the project in the early phases. Design-Build methods require that early commitment. Phased construction delivery methods allows the owner to spread that commitment. The second factor involves the owners’ desire for early estimating which is important for budgeting and financial planning. The methods that allow early estimating are the ones that involve construction professional input during the early phases. The third factor relates to the need for financing. If the owner desires financing, the Build-Operate-Transfer method provides that option. Other methods of financing are also available but were not studied in this research. The risk and relationships factors include the amount of risk the owner is willing to take and the owners’ desire to minimize adversarial relationships. Almost all respondents agreed that the traditional method is not effective in minimizing adversarial relationships. Figure 4 presents the comparison of the effectiveness of each delivery method with regard to these factors.
Project Characteristics Related Factors
Project characteristics factors relate to the importance of the project to achieving organizational objectives, the project complexity and the familiarity of the owners’ staff with the type of project. Management based and design-build methods are more suited to handle important, complex and unfamiliar projects. Figure 5 presents the comparison of the effectiveness of each delivery method with regard to these factors.

![Figure 5. Project Characteristics Factors](image)

5. CONCLUSIONS
The study results indicate that Design-Build methods are more effective in meeting most project objectives followed by construction management at risk, construction management and lastly the traditional design-bid-build. Design-build is relatively more effective in ensuring the shortest project duration than Construction Management methods. The traditional delivery methods are not effective in ensuring the shortest duration. Construction management method is the most effective in ensuring staying within budget. The results also show that the Design-Bid-Build methods provide the greatest flexibility to incorporate changes during the design and construction of the project. However, this may come at a higher cost. Design-Build is better suited to handle changes and ensuring the highest quality.

The organizations with limited experience required a delivery method that included a construction professional to be present at the early phases. Design-Build methods do not allow a high level of involvement by the owner. Using Alternative delivery methods and minimizing the number of contracting parties help minimizing adversarial relationships. With regards to project characteristics, design-build method is more effective than construction management at risk, construction management and design-bid-build (in that order) in handling essential, complex and unfamiliar projects.

Selecting the appropriate project delivery method is a key decision that has to be made in the early phases of the project. There are many delivery methods that can be used on any project. The decision is usually based on certain factors of importance to the owner. Owners are usually tempted to use the delivery method that they are
familiar with. However, this might be a great mistake since familiar methods are not necessarily effective in all situations. The effectiveness of the delivery methods vary according to the factors. Owners must rank their objectives and choose the method that maximizes the effectiveness in achieving the project objectives.

6. REFERENCES