

# Significance of Selection Criteria for Project Delivery Methods in Sustainable Construction

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**Abstract**—Sustainable construction has been gaining a lot of attention recently due to its positive impact on the environment and natural resources. A crucial decision that affects the success of sustainable construction projects is the selection of project delivery methods. Current available literature focuses on the selection criteria for project delivery methods in traditional construction projects with little research towards the selection criteria that deserve the most attention in sustainable construction projects. This research sets out to identify the most significant criteria for selection of project delivery methods in sustainable construction. Literature review was conducted to extract a list of the most cited selection criteria, twenty were shortlisted and used to create a questionnaire survey that was then distributed among construction professionals within the United Arab Emirates (UAE) to gather their perceptions on the significance of each of these criteria. 110 questionnaires were returned and used for analysis. The Relative Importance Index was calculated in order to rank the criteria. The five most significant criteria were: contractor's capability and experience, capitalize on well-defined scope, control cost growth, reduce risks and control time growth.

**Keywords**—sustainable construction, selection criteria, project delivery methods

## I. INTRODUCTION

One of the most crucial decisions in project management that affect project success in terms of cost, schedule and quality is the choice of project delivery method (PDM) [1]. PDM assigns the tasks to each key participant in the best way to utilize the benefits of the various players in the projects [2]. Among the delivery methods available in practice is the traditional Design-Bid-Build (DBB) where two contracts are issued by the owner, one for the consultant and one for the contractor [3]. Design build (DB) is also another PDM which consists of a single entity that issues one contract for both the consultant and contractor [4]. While in Construction Manager at Risk (CMR), the construction manager is involved early in the design phase to act as both a contractor and a project coordinator [5].

The literature review is rich in providing numerous studies on the selection of project delivery methods around the world. For instance, Qiang *et al.* [6] identified a total

of 25 factors that govern the process of PDM selection and categorized them into 3 groups which were: internal project conditions, external project conditions and project performance objectives. Similarly, Touran *et al.* [7] summarized 24 selection criteria of project delivery methods, grouped into 5 categories which were: project level, agency level, public policy and life-cycle as well as other issues.

Although this field of research has witnessed tremendous effort. There is still a gap in determining the selection criteria that deserve the most attention in today's construction world where there is a huge emphasis on sustainable construction projects. In fact, the shift towards sustainable construction came as a response plan to reduce the negative environmental impacts that construction activities contribute towards. This is due to the fact that sustainable construction mainly depends on natural resources and minimize the destruction of natural habitats, thereby protecting the ecosystem [8].

Therefore, the main aim of this research is to evaluate the selection criteria associated with projects delivery methods in sustainable construction projects with evidence from construction professionals in the UAE. The UAE was chosen as the country has witnessed a boom in the construction industry with tremendous efforts being put in place to promote sustainable construction. In order to achieve this aim, the following objectives must be met:

1. Identify the key selection criteria for project delivery methods in sustainable construction projects
2. Measure the relative importance and rank each of the identified selection criteria

## II. MATERIAL AND METHODS

The identification of the selection criteria of project delivery methods in sustainable construction was done through extensive literature review. A list of 20 selection criteria was developed. This was then used to structure a questionnaire to get the perceptions of construction experts in the UAE. The first section in the survey consisted of general information such as the average size of the projects, the role of the respondents, and their years of experience. While the second section of the survey was aimed to collect the respondent's perception on the significance of

each selection criterion on a Likert scale of 1-5 where 1 indicated very low significance and 5 indicated very high significance. 110 responses were collected out of a total 250 surveys distributed. 12% of the respondents had more than 20 years of experience, also 57% of the respondents worked in international companies while 53% worked in local companies. Moreover, 42% of the respondents were contractors while 39% were consultants. The relative importance index was then calculated using Eq. (1) [9].

$$RII = \frac{\sum_{i=1}^5 w_i x_i}{\sum_{i=1}^5 x_i} \quad (1)$$

where;

- w<sub>i</sub> is the weight assigned to the i<sup>th</sup> response;
- w<sub>i</sub>=1,2,3,4,5 for i=1,2,3,4,5 respectively
- x<sub>i</sub> is the frequency of the i<sup>th</sup> response
- i is the response category index=1,2,3,4,5 for very low, low, average, high and very high significance respectively.

### III. SELECTION CRITERIA FOR PDMS

The PDM selection criteria is divided into five groups: cost, time, scope, owner and contractor characteristics as well as project characteristics. The cost groups consist of five criteria: control cost growth, ensure lowest cost, facilitate early cost estimates, reduce risks, minimize expenditure rate. While the time group consists of 3 criteria: control time growth, ensure shortest time, promote early procurement of material and equipment. Moreover, the scope group consists of four criteria: capitalize on well-defined scope, efficiently utilize poorly defined scope, ease change incorporation and capitalize on expected low levels of change orders. Additionally, the owner and characteristics group have 4 criteria: owner’s willingness to take risks, owner’s available human resources, owner’s willingness to be involved, as well contractor’s capability and experience. Lastly, the project’s characteristics group consist of four criteria: capitalize on project confidentiality, capitalize on familiar project conditions, efficiently co-ordinate project complexity, capitalize on project’s quality performance. Table I Summarizes the selection criteria of PDMs.

TABLE I. SELECTION CRITERIA OF PDMS

| Group | Selection Criteria                                  | Sources       |
|-------|---|---------------|
| Cost  | Control cost growth                                 | [10,11,12,13] |
|       | Ensure lowest cost                                  | [1,10,11,14]  |
|       | Facilitate early cost estimates                     | [1,10,12]     |
|       | Reduce risks  | [10,12,15,16] |
|       | Minimize expenditure rate                           | [1,10,12,17]  |
| Time  | Control time growth                                 | [10,12,13,18] |
|       | Ensure shortest time                                | [1,10,12,14]  |
|       | Promote early procurement of material and equipment | [10,12]       |
| Scope | Capitalize on well-defined scope                    | [10,12,19,20] |
|       | Efficiently utilize poorly defined scope            | [10,12]       |
|       | Ease change incorporation                           | [10,12,19,20] |
|       | Capitalize on expected low levels of change orders  | [10,12,21]    |

|                           |   |               |
|---------------------------|---|---------------|
| Owner and contractor      | Owner’s willingness to take risks           | [19,22,23]    |
|                           | Owner’s available human resources           | [22,24]       |
|                           | Owner’s willingness to be involved          | [19,23]       |
|                           | Contractor’s capability and experience      | [19,22,24]    |
| Project’s characteristics | Capitalize on project confidentiality       | [10,12,25]    |
|                           | Capitalize on familiar project conditions   | [10,12]       |
|                           | Efficiently co-ordinate project complexity  | [10,12,19,20] |
|                           | Capitalize on Project’s quality performance | [25,26]       |

### IV. RESULTS

Based on the results of the survey, the relative importance index was calculated for each criterion. The criteria were then ranked according to their RII. The results are presented in Table II.

TABLE II. RII AND RANK OF SELECTION CRITERIA

| Criteria  | RII  | Rank |
|---|------|------|
| Contractor’s Capability and Experience              | 4.25 | 1    |
| Capitalize on Well-Defined Scope                    | 4.15 | 2    |
| Control Cost Growth                                 | 4.11 | 3    |
| Reduce Risks  | 4.05 | 4    |
| Control Time Growth                                 | 4.04 | 5    |
| Promote Early Procurement of Material and Equipment | 4.04 | 6    |
| Capitalize on Project’s Quality Performance         | 4.03 | 7    |
| Efficiently Co-ordinate Project Complexity          | 3.99 | 8    |
| Facilitate Early Cost Estimates                     | 3.94 | 9    |
| Ensure Shortest Time                                | 3.88 | 10   |
| Capitalize on Familiar Project Conditions           | 3.84 | 11   |
| Ensure Lowest Cost                                  | 3.77 | 12   |
| Owner’s Willingness to be Involved                  | 3.74 | 13   |
| Ease Change Incorporation                           | 3.68 | 14   |
| Efficiently Utilize Poorly Defined Scope            | 3.66 | 15   |
| Minimize Expenditure Rate                           | 3.64 | 16   |
| Capitalize on Project’s Confidentiality             | 3.61 | 17   |
| Owner’s Willingness to Take Risks                   | 3.59 | 18   |
| Owner’s Available Human Resources                   | 3.57 | 19   |
| Capitalize on Expected Low Levels of Change Orders  | 3.54 | 20   |

### V. DISCUSSIONS

The results have revealed that the top 5 selection criteria for project delivery methods in sustainable construction include: contractor’s capability and experience, capitalize on well-defined scope, control cost growth, reduce risks and control time growth. The reason why contractor’s capability and experience lie on the top of the list is the fact that sustainable construction projects are more complex than their traditional counterparts, that’s why contractors need to have the capabilities required to overcome the challenges of these projects and deliver them successfully [27]. Furthermore, capitalizing on a well-defined scope ranked second which comes as no surprise since there is a huge emphasis in literature on the importance of a well-articulated scope that explains all project features as well as technical specifications in proper details as this has a huge impact on the success of

sustainable construction projects [10, 12]. Not only this but having a well-defined scope minimizes the risk of many changes in the future which could lead to cost and time overruns, thereby hindering the successful delivery of sustainable construction projects [19]. Moreover, financial concerns such as controlling cost growth ranks third which matches the results of similar studies published in the field of project delivery methods where cost related factors were at the top of the selection criteria list. Completion of the project withing the budget constraints is always a major concern for project participants [11, 13].

It is striking to also notice that ensuring lowest cost is further down the list ranking in the 12th position which reveals the awareness of construction professionals regarding the fact in sustainable construction, procurement approach should rely more on qualifications-based selection rather than lowest cost [28]. Additionally, in 4th place came the reduction of risks criterion which once again highlights the fact that sustainable construction projects encounter unique risks that are different from traditional construction such as the need for special materials, governmental approvals, and additional costs due to import of materials [27]. Therefore, it is significant to create a proper risk allocation structure and risk response plans to execute and deliver successful sustainable construction projects [15]. Besides, controlling time growth ranked in the 5th position which echoes previous studies in the conclusion that this criterion is among the influential selection criteria for project delivery methods. Indeed, project's success is positively associate with the ability to compress the schedule to ensure project completion within the specified time constraints [18]. On the other hand, it can also be seen from the results that the lowest ranked criteria were: owner's willingness to take risks, owner's available human resources and capitalize on expected low levels of change orders. Not only this but, the RII per group was calculated and the time group had the highest value of 3.99 followed by the cost group had a value of 3.90. After that, the third group was project's characteristics with of 3.87, followed by the scope group that had a value of 2.72. Last but not the least, the owner and characteristics group had a value of 1.83.

## VI. SUMMARY AND CONCLUSION

Sustainable construction has been gaining a lot of momentum over the past years as a response plan to the negative environmental impacts brought upon by construction activities. Among the crucial project management decisions that affect the success of sustainable construction projects is the selection of project delivery methods as it impacts key performance indicators such as cost, time and quality. Literature review is very rich in providing selection criteria for project delivery methods in traditional construction. However, there is a gap when determining which selection criteria deserve the most attention for project delivery methods in sustainable construction. Therefore, this research sets out to identify the most significant criteria for selection of project delivery methods in sustainable construction. Literature review was conducted to extract a list of the most cited

selection criteria, twenty were shortlisted and used to create a questionnaire survey that was then distributed among construction professionals within the United Arab Emirates (UAE) to gather their perceptions on the significance of each of these criteria. 110 questionnaires were returned and used for analysis. The Relative Importance Index was calculated in order to rank the criteria. The five most significant criteria were: contractor's capability and experience, capitalize on well-defined scope, control cost growth, reduce risks and control time growth. The research highlighted the uniqueness of sustainable construction projects which raises the need for special contractor competence and proper resource allocation risk structure as well as response plan to be able to successfully deliver sustainable construction projects.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

All authors approved the manuscript and they contributed in the writing; Salma Ahmed covered mainly the analysis part while Sameh El-Sayegh concentrated more on the discussion of results.

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