REVIEW ON THE STUDY OF PROJECT DELIVERY SYSTEM SELECTION METHODS

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ABSTRACT

A project delivery method is a system used by an agency or owner for organizing and financing design, construction, operations, and maintenance services for a structure or facility by entering into legal agreements with one or more entities or parties. The selection of an appropriate project delivery system that suits all project and owner needs is one of the key decisions to a successful project. Therefore, this decision should be made based on thorough analysis. The objective of the project is to find the most appropriate project delivery system for a particular project. A fuzzy multi attribute decision-making (FMADM) model is developed. The model accounts for uncertainties and imprecision in the decision space as well as fuzziness in the nature of the decision attributes. The model utilizes fuzzy decision-making approach in order to evaluate the membership function corresponding to the utility of each project delivery alternative. Different commonly used project delivery systems were selected and questionnaire was prepared to analyse these delivery systems using the prepared fuzzy multi attribute decision-making (FMADM) model. The fuzzy multi attribute decision-making (FMADM) model developed was then compared with the conventional statistical analysis, such as Regression analysis to show the advantages of the fuzzy multi attribute decision-making (FMADM) model developed.

Keywords*: Project delivery systems; Fuzzy multi attribute decision making; Univariate data analysis*

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1. INTRODUCTION

Selecting an appropriate project delivery system is one of the most important strategic decisions toward a successful project that affects all phases of project execution as well as the efficiency of project execution. Accordingly, a manifold of research has been developed in order to select the project delivery system that best meets all project requirements and owner needs. In fact, selecting an appropriate delivery system is a decision-making problem.

Recently, different methods and techniques for selecting appropriate delivery system have been proposed. These methods include both qualitative and quantitative techniques. Gordon (1994) introduced the process of elimination as a qualitative method for the selection process. Alhazmi and McCaffer (2000) used Parker's judging alternative technique for delivery system selection; Cheung et al. (2001) proposed the objective-subjective method that includes the application of analytical hierarchy process AHP in selecting an appropriate project delivery system. Mahdi and Alreshaid (2005) also used AHP as the selection method. Oyetunji and Anderson (2006) generated quantitative relative effectiveness values for project delivery selection; they applied these values to the simple multi attribute rating technique (SMART) method for selecting appropriate project delivery system.

Selecting an appropriate project delivery system is a single-objective, multiple-attribute decision-making problem with a single decision making MODEL. Furthermore, the decision is made under uncertainty. The objective of the decision making problem is to meet the project and owner needs. Decision attributes include but are not limited to: speed, certainty of costs, flexibility, risk transfer, and complexity. The decision is made by the owner or project promoter. So far, the proposed methods for selecting an appropriate project delivery system neglect uncertainties by approximating real situations. Accordingly, these models cannot meet the decision making problem characteristics and conditions.

On the account of the fact that the decision making method for selecting appropriate project delivery systems should meet the decision space characteristics and also the decision attributes fuzziness requirements, therefore, the best model that meets all these requirements is **fuzzy multi attribute decision-making** (FMADM) model. Fuzzy decision making approaches are gaining more application during past years in the field of construction engineering and management. As a case in point, Zhang and Zou (2007) developed a fuzzy AHP risk assessment approach for joint venture construction projects in China.

2. LITERATURE REVIEW

Different studies were done in the field of PDS selection and some of them are listed below. Researchers found that Fuzzzy multi attribute decision making model as an effective replacement to conventional PDS selection models.

Ali Hosseini et al. (2016) suggested that the project delivery method (PDM) has great influence in the project outcome. Design-Build, Construction Management and Design-Bid-Build are the three main methods. Each PDM has its own advantages and disadvantages which suit different projects in different circumstances. A general literature review was done and specifically looked into the problem. Firstly, this paper identifies general criteria for selecting PDM. Secondly, it comes up with specific criteria which influence the selection of the PDM for a large infrastructure project. Due to the project characteristics, the identified specific selection criteria differ from the general selection criteria. The paper contributes to the body of knowledge with a list of selection criteria for PDMs aggregated from literature, and points out that this list should be adapted to case specific characteristics before being used to select a PDM.

Ali Mostafavi et al. (2014) suggested that the selection of an appropriate project delivery system that suits all project and owner needs is one of the key decisions to a successful project. Therefore, this decision should be made based on thorough analysis. In this paper, a fuzzy multi attribute decision-making FMADM model is developed. The model accounts for uncertainties and imprecision in the decision space as well as fuzziness in the nature of the decision attributes. The model utilizes fuzzy decision-making approach in order to evaluate the membership function corresponding to the utility of each project delivery alternative. Project delivery system alternatives are ranked using fuzzy technique for order preference by similarity to ideal solution TOPSIS method based on their utility membership functions and by evaluating the distance of each project delivery alternative from fuzzy ideal solutions. In the TOPSIS method, alternatives are ranked based on their closeness coefficient CC. In addition, the risk attitude of the decision maker is considered in the model by using derived utility membership functions corresponding to the risk attitude of the decision maker. The model is applied to a petrochemical project as a case study. In the case study, the model outcome that ranked Turnkey system as the best system conforms to the lessons learned by the decision maker from several past projects. Moreover, sensitivity analysis is done in the case study. The results show the significant value of the FMADM model for selecting appropriate project delivery system for projects.

Awad S. Hanna et al. (2016) suggested that the construction industry is fraught with waste and inefficiencies resulting in projects often failing to meet owners' expectations. Integrated project delivery (IPD) is the newest project delivery system (PDS) and changes the traditional roles and relationships of key project stakeholders. Through increased early collaboration, IPD attempts to eliminate waste and deliver the highest-value projects to owners. It is seen as a potential solution to many of the challenges impeding successful project performance. However, a transformational move toward IPD has yet to reach a tipping point, and its use is not prevalent throughout the construction industry. Little research has been done to quantitatively analyze IPD compared with the more commonly used delivery methods. Through substantial collection of quantitative project performance data and univariate statistical analysis, this study fills the gap in PDS research by evaluating the effects of IPD on building construction projects across a wide range of performance metrics from the perspective of general contractors and construction managers. This research demonstrates that IPD/near-IPD outperformed non-IPD projects with respect to performance in communication, change management, and business performance areas. Communication was found superior in terms of the number of requests for information (RFIs) per million dollars; change management in terms of change-order processing time; and business performance in terms of a project's impact on company image and the potential for return business. A new term called project quarterback rating (PQR), which combines key performance metrics, was used to quantitatively evaluate overall performance. Statistically significant evidence of the overall superior performance of IPD/ near-IPD compared with non-IPD projects was found. These results should encourage owners to consider the use of IPD, or IPD principles in conjunction with other delivery methods, in future capital facilities endeavors.

Bennett and Grice (2010) identified 8 factors representing objectives of PDS selection i.e. speed, certainty, flexibility, quality level, complexity, risk avoidance, price competition, and accountability.

Bingsheng Liu et al. (2014) suggested that the decision-making of the project delivery system (PDS) is an important link in the entire lifecycle of a project and is one of the critical factors leading to project success. PDSs are commonly chosen based on the decision-makers' experience and knowledge and the project's information earlier, without exploring the inherent dependencies between influencing factors and the PDSs. Presently, the re-searches on the factors affecting the choice of PDSs are primarily concentrated on the owner's characteristics, the project's characteristics, and the project's external environment. This paper concentrates at the owner's characteristics and researched the key factors affecting the decision-making of the PDSs. Twenty-two influencing factors of owner's characteristics are summarized through a literature review, and 14 relatively important and high frequency factors with high frequency are chosen after discussion with specialists. A questionnaire survey was conducted based on the information and, is taken as the research sample. Then, rough set method is applied to reduce the redundant factors and result indicates that (1) responsibility, (2) the owner's willingness to be involved, (3) the owner's in-house technical capability, (4) risk allocation, and (5) the owner's willingness to control overdesign are the owner's five most key characteristics factors affecting PDSs decision-making. The result of this project provides a valuable reference for owner in choosing appropriate PDSs and enriches the research methods in the field of PDSs. Although design-build (DB), design-bid-build (DBB), and engineering-procurement-construction (EPC) are deeply studied in the research reported in this paper, the other PDSs such as turnkey, construction management, and project management (PM) would be taken into consideration in further researches.

Bonissone P. P. (2012) suggested that the fuzzy sets theory and fuzzy logic constitute the basis for the linguistic approach. Under this approach, variables can assume linguistic values. Each linguistic value is characterized by a label and a meaning. The label is a sentence of a language. The meaning is a fuzzy subset of a universe of discourse. Models, can be constructed based on this approach to simulate approximate reasoning. The implementation of these models presents two major problems, namely how to associate a label to an unlabelled fuzzy set on the basis of semantic similarity (linguistic approximation) and how to perform arithmetic operations with fuzzy numbers. For each problem a solution is proposed. Two illustrative applications are discussed.

Chan et al (2002) surveyed construction literature from 1990 to 2000 to develop a framework for DB success criteria. The authors grouped the criteria under three project phases: preconstruction, construction, and post construction. The criteria were also grouped based on two factors: objective and subjective. The most significant measures found were time, cost, quality, and satisfaction of key project participants. Other important measures included profitability, technical performance, productivity, and environmental sustain-ability. Although these success criteria were developed for DB, they can also be used to measure the performance of projects completed through other delivery systems.

Nida Azha et al. (2013) investigated about the factors influencing the implementation of integrated project delivery (IPD) in public sector construction projects. These factors are broadly categorised into legal, organizational and technological categories. Further the role of information modeling to foster the integration in project delivery is discussed. Focus is placed on the aspects/characteristics of information modeling that can contribute to implementation of integrated project delivery. Traditional project delivery methods have been found by researchers as inefficient and litigious. As a result, the construction industry is in a critical need of alternative delivery methods.IPD has emerged as a solution, although its implementation is not without challenges. Therefore factors influencing its implementation should be identified as a step towards its probable use in the future for public-sector construction projects. The purpose of this paper is to investigate these factors and suggest an information modeling approach to overcome the impediments.

Pocock (2010) compared the performance of traditional and alternative project delivery approaches using military construction projects. The metrics used to compare delivery types were (1) schedule growth, for which partnered projects were the most successful; (2) cost growth and (3) design deficiencies, both of which were dominated by DB; and (4) modifications, at which combination projects (hybrid use of delivery systems) had an enhanced performance. He also measured the degree of team integration, which he demonstrated was directly impacting project performance.

Rankin et al. (2008) identified a set of performance metrics for the Canadian construction industry. In their study, the metrics that covered both the construction phase and the building life were combined, covering seven performance areas: cost, time, scope, quality, safety, innovation, and sustainability. A pilot study was conducted to verify the metrics, and, as expected, the results showed that cost, time, scope, and safety information were readily available, whereas quality, innovation, and sustainability metrics were unavailable and required considerable additional effort to obtain.

Rojas and Kell (2008) conducted a study focusing on cost performance of CMR and DBB project delivery systems. Their scope was limited to delivering public schools in the U.S. Pacific Northwest. The results show no statistically significant difference between CMR and DBB in construction change order costs, and DBB averages less cost growth than CMR. These results challenge earlier findings regarding CMR cost performance and specifically apply to the construction of Pacific Northwestern public schools.

Touran et al. (2010) conducted interviews with experienced transit project managers in the United States. He found that despite the existence of well-developed and advanced decision support models in the literature, few practitioners fully utilized them due to the difficulties encountered when understanding the methodologies and determining the model parameters.

3. CONCLUSIONS

From the literatures reviewed, different methods used for project delivery system selection has been studied. It is concluded that multi criteria decision making technique is found to be the best solution for project delivery system selection problem. .Because, this technique can handle both qualitative and quantitative factors at a time. There are different types of PDSs and each has its own advantages and disadvantages. Fuzzy multi attribute decision making model (FMADM) has several advantages when compared to the other conventional models. In FMADM it can consider the fuzziness in the input values and thus provides better results.

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