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INVESTIGATING SELECTION METHODS FOR CONSTRUCTION PROJECT DELIVERY SYSTEMS BASED ON PROFESIONALS' PERSPECTIVE IN QATAR

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Abstract: Many of the delays and cost overruns in Qatar construction projects are associated with the selection of inappropriate Project Delivery System (PDS). A source of concern for the booming Qatar construction industry, PDS selection requires; multifaceted, attribute-dependent, informed decisions, based on prior knowledge of Project Delivery System Selection Methods (PDSSMs). However, due to lack of understanding, the owners usually tend to make their decisions in selecting PDS on holistic approaches, yielding losses and inefficiencies to construction processes. The purpose of this study is to understand various decision making challenges faced by owners, pertinent factors and available PDSSMs; and to propose an appropriate decision making framework. A survey, recording forty eight professionals working directly or indirectly with owners, was conducted to investigate various processes being used for selection of PDS in Qatar. The findings of the survey reaffirmed our hypothesis that the owners in Qatar lack in knowledge and understanding of various PDSs, PDSSMs and pertinent factors in making decisions. Based on the feedback supported by an extensive literature review, a set of pertinent factors affecting decision making processes is identified. Further a simplified theoretical two tier systematic Decision Making Framework (DMF) based on either weighted matrix or multi-attribute analysis is proposed that can be used by the construction industry practitioners for selecting appropriate PDS for their construction projects. Although, knowledge gained from this study is mainly aimed towards Qatar Construction industry, it can be harvested to inform project delivery selection processes in North America as well.

1 INTRODUCTION

Over the past decade, Qatar has experienced a strong economic growth, resulting in diffusion of considerable investments in the real estate, energy and infrastructure sectors. In addition, Qatar's successful bid to host the 2022 FIFA World Cup has further catalyzed the demand to expand country's existing urban and transportation infrastructure. However, Qatar construction industry is facing difficulties coping up with such increased demand. A recent report (Commercial Bank of Qatar, 2012) points out that most of the projects in 2012 witnessed major delays due to setbacks in awarding project contracts as well as preparing and evaluating new project bids. Although, these delays are attributed to prospective shift in focus on FIFA World cup projects, it is observed that owners are implicitly reluctant to initiate projects which pose higher risks and financial uncertainties through conventional project delivery systems. It is further noticed that, fluctuating manpower and material availability, stakeholder concerns and fast track nature of construction processes have heightened the notion of risk in owner's decision of selecting project delivery and procurement systems.

Given the volatile nature of construction industry, Project Delivery System (PDS) becomes the most crucial strategic decision for an owner before starting a new project. PDS is a set of processes that defines risk and contractual responsibilities of the project participants and provides mechanism for executing the design, construction, operation and maintenance activities of the project (Ibbs and Chih, 2011; Keing, 2007; Oyetunji and Anderson, 2006; AGC, 2004). It impacts all phases of the project design and construction, therefore, an appropriately selected PDS enhances the owner's ability to efficiently control the construction processes and accrue financial benefits (Oyetunji and Anderson, 2006; Mahdi and Alreshaid, 2005).

Although appropriate PDS may warrant efficient execution of projects, there is no singular system which can be used as a template for all projects under all circumstances (Ibbs and Chih, 2011). Effective analysis of appropriateness of any PDS requires the owner's understanding of the pros and cons of various PDSs, PDS selection methods (PDSSM) and other related factors that affect the decision making process. However, most of the owners in the construction industry lack understanding of delivery systems and base their decisions on generic approaches rather than structured decision making frameworks (Luu et al., 2003b). A considerable amount of research has been conducted on the appropriateness of various PDSs, mainly on conventional delivery systems like; Design-Bid-Built, Design-Built and Construction Management at Risk (Touran, A. et al., 2011; Chen et al., 2010; Kenig, 2007; Oyetunji and Anderson, 2006; Mahdi and Alreshaid, 2005; Al Khalil, 2002); yet very little, if any, has addressed and evaluated emerging systems like Integrated Project Delivery (IPD) in correlation with traditional PDSs for the construction projects.

In this paper we evaluate various PDS and PDSSM available to the owners in Qatar and identify various factors that affect the decision making process of selecting an appropriate PDS for construction projects. The paper also investigates the perception of the industry professionals in Qatar on various delivery systems and identifies major barriers in adoption of systematic decision making frameworks. A theoretical Decision Making Framework (DMF) is proposed based on our analysis that can be used by the owners and industry professionals for choosing an appropriate PDS for their construction projects.

2 RESEARCH METHODOLOGY

Since our main focus is to evaluate the prevalent PDS in Qatar construction industry and propose a structured DMF for PDS selection, we utilize inductive research approach to identify potential inconsistencies in current practices. A combination of literature review and survey questionnaire is used to capture established attributes and subjective data to describe factors effecting decision making processes behind selection of project delivery systems in Qatar construction industry.

We developed an expert-oriented questionnaire, based on our initial observations and findings, as our primary survey tool for data collection. Although follow-up interviews were planned, we could not carry them out within the research timeframe. The survey was initially piloted with a limited participant sample of five executives at different project management organizations to refine survey goals and objectives. As there are only a handful of major clients in Qatar and all of them have bureaucratic organizational structures, it was decided that the survey should be carried out beyond this small sample group to minimize any influence and bias in the collected data. A comprehensive list of potential participants working directly or indirectly with major clients was prepared using in-house as well as public information databases. Questionnaire was refined based on the feedback of the pilot-survey and was electronically distributed via emails to hundred and eighty (180) participants; selected from a carefully compiled list of construction professionals in Qatar. Out of those 180 participants only 48 responses were received in time of this research, from which 5 responses were rejected due to partial replies and incomplete information.

The survey comprised of 12 main questions with sub-divisions to evaluate perception of industry professionals on various PDS and to identify main barriers in adopting systematic DMF for evaluating those delivery systems. All general information acquired about the participants was kept anonymous and strictly confidential. First five questions were designed to seek respondents' experience regarding existing PDS efficiency, prevalent practices and their perception of need for a systematic DMF for PDS selection. Two of the questions provided data on barriers in adoption of a selection framework and in-practice delivery systems in Qatar construction industry. Last portion of the survey was designed to investigate the level of understanding by industry professionals of basic DBB, DB, CMR and IPD concepts. Last question was designed to obtain specific data about perceived importance of pertinent factors (See Table 1) in participants' work environment pertaining to decisions made for selecting appropriate project delivery system.

3 LITERATURE REVIEW

3.1 Project Delivery System (PDS)

The existing literature categorizes project delivery systems into various groups, however, in this paper PDS categorization is adopted from the Construction Industry Institute (2003) and Konchar and Sanvido (1998) based on the principles of defining responsibilities, risk sharing mechanism and sequencing of activities. We did not consider mixed delivery approaches proposed by other bodies of knowledge for this study due to: (1) we do not see significant differences in their basic roles and risk sharing mechanisms from conventional project delivery systems; (2) we want to minimize complexity in the study. For example, some researchers have considered Construction Management (CM) Agency as separate PDS, but CM Agency particularly does not change the basic roles and risk sharing mechanism between the contracting parties. Therefore, we only considered four major PDS classes for this study i.e., Design-Bid- Build, Design-Build, Construction Management at Risk with inclusion of Integrated Project Delivery as the fourth class due to its unique role, responsibility and risk sharing structure.

3.1.1 Design-Bid-Build (DBB)

DBB is the most commonly used traditional PDS, in which the owner enters into two separate contracts; first with a design firm that develops design and second with a construction firm that execute the project based on owner's construction documents (Hale et al., 2009; Scott et al., 2006). In DBB owner is responsible for design development; design details and assure accuracy of the design. Thomas et al. (2002) argued that DBB provides check and balance through firm control over the design and construction process, hence minimize risks, which benefits specialized project. On the other hand, DBB is criticized for extended time required for the design and construction and adverse contractual relationship between the project teams (AIA, 2005). DBB is also criticized for high cost uncertainty until completion of design. Another draw-back of DBB is that the construction phase is more often awarded on the basis of low-price bid, albeit the fact that low-price bids does not always warrant best value to the project. Further DBB neither offer contractor's involvement in design process nor provides incentives for minimizing change order costs.

3.1.2 Design-Build (DB)

DB is usually considered effective for large scale projects (Kim et al., 2007; Thomsen et al., 2002) and has experienced significant growth in the recent years. In DB, the owner is under contract with a single entity for the design and construction of a project (Hale et al., 2009; AGC, 2004). The contractor is mainly responsible for the design and construction of the project based on fixed lump sum price (Wardani et al., 2006). The typical characteristics of DB are; single point of responsibility, overlapping of the design and construction, potential for schedule compression, allowance for preconstruction design services, transfer of design responsibility to contractor and commitment of lump sum fixed price at the beginning of the project (AGC, 2004). Past research has confirmed lower cost overrun in DB projects than DBB. However, DB system has been criticized for constraining competition as DB projects require more efforts and skills at bidding stage for estimating projects on lump sum basis. DB system is also criticized for being quite subjective, as evaluation is usually made based on schematic design, management planning and past experience. Additionally, the contract is awarded before the design completion, which inherently gives rise to unfavorable risk environment particularly when DB contractor lacks the sophistication required for estimating DB projects.

3.1.3 Construction Management at Risk (CMR)

CMR uses the philosophy of integrated processes, wherein the owner first selects a design firm to design the project and then separately hire a construction management (CM) firm who initially acts as the project manager at design stage and takes responsibility as general contractor at construction stage (AGC, 2004). CM firm usually takes the risk of the construction at a Guaranteed Maximum Price (GMP). AIA (2005) and AGC (2004) highlighted the typical characteristics of CMR as; separate contracts between owner-designer and owner-contractor, selection based on technical qualification, direct contracts with trade sub-contractors, allowance for preconstruction services, GMP, commitment to a fixed delivery schedule, transparency, minimum adversarial relationship and elimination of bid shopping. CMR promotes greater control by the owner over the project design as compared to DB (Cunningham, 2005). Further, CMR in contrast to DB brings general contractor on board to the design process at early stage, where their inputs can benefit the project. CMR has added advantages over other PDS, in term of schedule compression, quality, innovation, cost certainty and elimination of adversarial relationship through excellent teaming.

3.1.4 Integrated Project Delivery (IPD)

Primordially construction industry is fragmented, inefficient and adversarial in relationships, as each team is responsible for its own silo of scope and attempts to maximize individual profits instead of achieving project objectives (Lichtig, 2006). IPD is an emerging PDS, which tends to address these problems by establishing collaborated work practices. It is defined as a delivery approach that integrates project participants, systems, businesses and practices into a structured process that uses the knowledge and wisdom of all participants to enhance project outcomes, increase value for money, reduce waste, and optimize efficiency through all phases of design and construction (AIA, 2007). The basic concept is based on a singular, multi-party agreement between the owner, designer and contractor, with shared project objectives, shared risks and shared rewards (Lichtig, 2005). In IPD, owners has the benefit of cost, schedule and program certainty at early stage, while designer and contractor mutually gain or lose profit based on achieving project outcomes rather than individual team. According to Thomsen (2008), the performance of the team in IPD is maximum and the parties follow-up each other activities due to common profit and loss mechanism. IPD is fundamentally different from traditional PDS in term of contract, processes, communication, contractual relationships, compensation and risk sharing mechanism.

3.2 Project Delivery System Selection Methods (PDSSM)

Previously researchers have proposed elaborate selection methods to facilitate the complex decision making processes. However, for this study we depart from PDSSMs described by Ibbs and Chih (2011). This particular classification affords unique convergence of prevalent generic conceptual approaches individually highlighted by their distinguishing attributes. We would discuss briefly some of these PDSSMs to ground our proposed framework.

3.2.1 Guidance Approach

Selection methods that provide general information and guidance for selecting an appropriate PDS fall under this category and constitute study of individual PDS, comparison of alternative PDS, formalized framework and decision charts. Studies on individual PDS reveal that decision makers require comprehensive knowledge of various aspects of the project to make educated decisions for selecting project delivery systems which fundamentally involves various limitations and uncertainties.

3.2.2 Multi-attribute Analysis Approach

Majority of researchers (e.g., Oyetunji and Anderson, 2006; Al Khail, 2002; Cheung et al., 2001) have used multi-attribute analysis for evaluating various PDS for construction projects. In this approach alternatives are evaluated against multiple factors and the decision of selecting an appropriate PDS is made based on the decision maker's preferences of various PDS alternatives, measured against the performance of various factors. Ibbs and Chih (2011) further subcategorize this approach into four sub-classes based on selection preferences; (1) weighted-matrix approach, (2) multi-attribute utility/value theory, (3) analytical hierarchal process and; (4) fuzzy logic approach. A detailed discussion on these sub categories can be referenced from Ibbs and Chih (2011) research publication.

3.2.3 Knowledge and Experience Based Approach

Knowledge-based system utilizes the past experience and databases to provide decision makers an early indication of the likely future outcome of the new project. This system is simple and can easily be adopted; however, it requires a database of real projects and authentic data, which rarely is available with owners in the industry. Even if such database exists, the past experience cannot give an absolute indication of the new projects, as each project is unique and the outcome and expectation will likely be different than past or existing projects.

3.2.4 Mix-method Approaches

Mix-method approach combines multiple approaches in order to solve the problem of PDS selection. Although, mix-method approach combines the pros of various approaches, it also possesses the inherent cons of those methods as well as complexities of combing various approaches.

3.3 Factor that affect the Decision Making of Selecting PDS

Irrespective of the chosen PDSSM, there are various other factors that are imperative in making right decisions. It is significant to note at this point that PDS selection is but one of the many factors affecting the efficiency and success of a project's outcome (Ibbs and Chih, 2011).

We carried out a comprehensive analysis of relevant available literature to classify and highlight the most important pertinent factors that affect the decision making process (Table 1). These factors are further categorized into five higher classes based on the framework given by Touran et al. (2011), i.e. (1) Project characteristics, (2) Owner characteristics, (3) Regulatory issues, (4) Life cycle issues, (5) Other issues.

The enlisted factors in Table 1 cover most of the decision related issues and are configured to act as customizable checklists for owners to evaluate various PDS for their projects. We formulated our survey to establish metrics for evaluating significance of these listed factors as deemed by the Qatar industry professionals in terms of project delivery selection decision making process. We asked the participants to rank the entire set of factors as per their subjective importance in their work environment pertaining to decisions made for selecting appropriate PDS. The ranking weightage (Table 1) guides owners to the most important information for preliminary PDS selection and exploration of alternate methods.

4 DATA ANALYSIS AND DISCUSSION

The survey questionnaire was distributed to one hundred and eighty (180) participants, from a carefully compiled list of professionals from almost every discipline in Qatar construction industry. A total of forty eight responses were received, representing 26.66% response rate; five (05) of them were rejected due to incomplete information. Among the received survey feedback highest portion of responses were from individuals working with client organizations representing 26%, followed by project managers and design consultants (23% each), contractors (19%) and cost consultants (9%) – Figure 1. Amongst the received responses, 51% respondents were having more than 20 years' experience and working on higher management levels – Figure 2.

The analysis revealed that 61% respondents are of the opinion that projects delivery in Qatar is inefficient or somewhat inefficient in terms of cost, schedule and quality. Around 63% respondents were of the view that none of the client or very few clients evaluate various PDS before starting new construction projects. In addition, 65% respondents believe that none of the clients in Qatar have systematic framework for decision making. It was quite remarkable to see majority of respondents (86%) strongly recommended that every client must have a systematic decision making framework for selecting PDSs, which is currently not in practice. Regarding decision making framework, 59% respondents were of the opinion that the lack of industry knowledge regarding various PDSs, PDSSMs and pertinent factor are the key barrier (Figure 3).

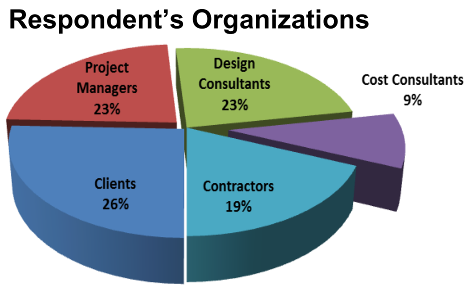


Figure 1: Distribution by respondent's organization

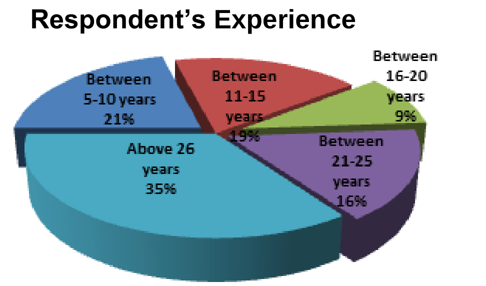
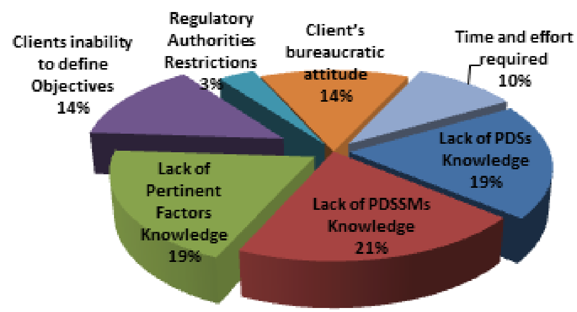


Figure 2: Distribution by respondent's experience

Around 28% respondents suggested client's inability to define clear project objectives and their bureaucratic attitude responsible for restricted use of systematic framework. The survey results ratify our argument that construction industry in Qatar lacks knowledge of various PDS, PDSSMs and pertinent factors and the same are the key barriers in adopting a systematic DMF.

Figure 3: key barriers in adopting systematic Decision Making Frameworks



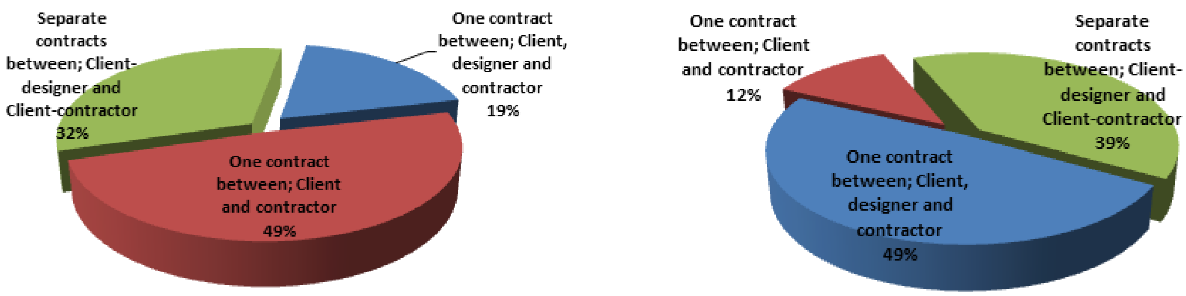


Figure 4: Understanding of CMR & IPD

With regards to in-practice PDSs in Qatar, the majority of the respondents were of the opinion that DBB is most commonly used, DB is used moderately while 63% reported that CMR and IPD are not used at all. We also tried to gauge the overall perception and knowledge of practicing professionals regarding basic understanding of DBB, DB, CMR and IPD through our survey. Survey findings when compared to the existing literature principles, revealed that majority of the construction professionals in Qatar have sound knowledge of basic concepts of conventional delivery systems but considerably lack knowledge and understanding of emerging delivery systems like CMR and IPD – Figure 4. The questions were designed to explore participant's understanding of the concepts at higher level without asking any intricate details, to minimize complexity in responses. The respondents were also asked to rank the importance of pertinent factors established from existing literature on a Likert scale (1 to 5); 5 being very important and 1 unimportant. Respondents in average ranked the entire set of factors as very important or somewhat important. The average ranking scores of the pertinent factors based on our survey are shown in Table 1.

It is noteworthy that highest scoring factor is "cost overrun" despite the fact that almost half of the reviewed literature did not report it to be of any significance. Further, responsibility or liability factor while not reported by previous researchers, rank quite high in our survey findings, highlighting underlying liability issues among Qatar's construction professionals. It is also worth noting that owners in Qatar do not consider facility management costs as significant decision governing factor when initiating projects which is an inefficient practice and may contribute to financial overruns and deficient return on investment (ROI) at later stages of building life cycle.

Table 1: Selected Pertinent Factors from Existing Literature with Ranking of Importance

Selection Factor (Aim statement)	Selection Factors (Measurement Attribute)	* Literature References	Ranking
Project Characteristics			
1. Cost overrun	Project completion within budget and cost	[12-13,8-12,1-5]	**4.72**
2. Schedule delay	Project schedule compression	[1 -20]	**4.53**
3. Project size/nature	Project size, nature and complexity	[19,13,9-11,4-5,1-2]	**4.44**
4. Risk allocation	Clients transfer of risk/allocation to others	[20,12-13,10,8,5-1]	**4.21**
5. Responsibility	Single point of accountability for projects	[8,4]	**4.02**
6. Project design/ innovation	The complexity and innovation in the design is critical	[18-19,14-17,11-12,11,9,6-7,4,1-2]	**3.84**
Owner Characteristics			
7. Coordination/Communication	Effective coordination/ communication	[11,3]	**4.21**
8. Owners goals	Meeting authority requirements, safety and providing equal opportunities	[5,2]	**4.12**
9. Owner control	Clients desire of high degree of control	[18-19,8-13,1-5]	**3.86**
10. Owner staff capability	Clients desire of utilizing own staff	[5, 2,1]	**3.35**
11. Owner PDS experience	Client experience of using a specific PDS	[5, 2,1]	**3.35**
12. Third party Agreements	Flexibility of third party agreement	[5,2]	**3.23**
13. Owner staff involvement	Clients desire of substantial/minimum use of its own staff	[8, 1-5]	**3.23**
Regulatory issues			
14. Competitive bidding	Allowance for competitive bidding	[5,2]	**4.19**
15. Local laws	Local laws restriction on some of the PDS	[5,2,1]	**3.81**
Life cycle issues			
16. Maintenance	Ease in maintenance is critical to Clients	[5,2]	**3.79**
17. Life cycle cost	Project lifecycle cost is critical factor	[5,2]	**3.77**
18. Sustainability	Sustainability is critical to Client process	[5,2]	**3.70**
Other issues			
19. Construction claims/dispute	Clients desire minimum claims and disputes	[11, 5, 2]	**4.26**
20. Adversarial relationships	Client desire no adversarial relationships	[5,2]	**3.86**

* 1 [Moon et al., 2011]; 2 [Toran et al., 2011]; 3 [Mostafavi and karamouz, 2010]; 4 [Chen et al., 2010]; 5 [TCRP, 2009]; 6 [Ng and Cheung, 2007]; 7 [Mafakheri et al., 2007]; 8 [Oyetunji and Anderson, 2006]; 9 [Luu et al., 2006]; 10 [Luu et al., 2005]; 11 [Mahdi and Alreshaid., 2005]; 12 [Anderson and Oyetunji, 2003]; 13 [Luu et al., 2003b]; 14 [Luu et al., 2003a]; 15 [Cheung and Lve, 2002]; 16 [Ng et al., 2002]; 17 [Cheung et al., 2001]; 18 [Tookey et al., 2001]; 19 [Chan et al., 2001]; 20 [Alhazmi and McCaffer, 2000]

5 PROPOSED DECISION MAKING FRAMEWORK (DMF)

Decision Making Framework (DMF) provides guidance to the decision makers for choosing an appropriate PDS. According to Power (2002), DMF establishes standard procedures that interacts with other information systems within organizations and facilitate the decision making process of the managers and other decision makers in an organization. From our survey it is quite evident that majority of professionals believe that project delivery in Qatar is inefficient in terms of cost, schedule and quality. More than half of the respondents report absence of systematic framework for decision making as the main reason for inefficient selection of project delivery systems. Almost all the participants (86%) recommend to change current practices and that clients must consider a systematic decision making framework for selecting PDSs for their projects. Lack of industry knowledge regarding various PDSs, PDSSMs and pertinent factors, bureaucratic attitude and client's inability to define clear project objectives are among the key barriers identified in adopting systematic decision making frameworks (Figure 3).

Considering Qatar industry's lack of experience and knowledge in selecting appropriate PDS it would be prudent not to divulge in extraneous methods but rather to take advantage of prevalent practices, simplified for easier adoption. Therefore, we depart from established guidelines by previous researchers (e.g., Touran et al., 2011; Ibbs and Chih, 2011; TCRP, 2009; Oyetunji and Anderson, 2006) and propose a two tier theoretical Decision Making Framework (Figure 5) to fulfill the needs of Qatar construction industry as identified from our survey. It is important to note that no relationship was found in existing literature, between the criteria for choosing an appropriate PDS and the performance of a selected PDS. Therefore, the DMF only facilitates the decision making process of the decision maker and as such does not guarantee the performance of the selected PDSs.

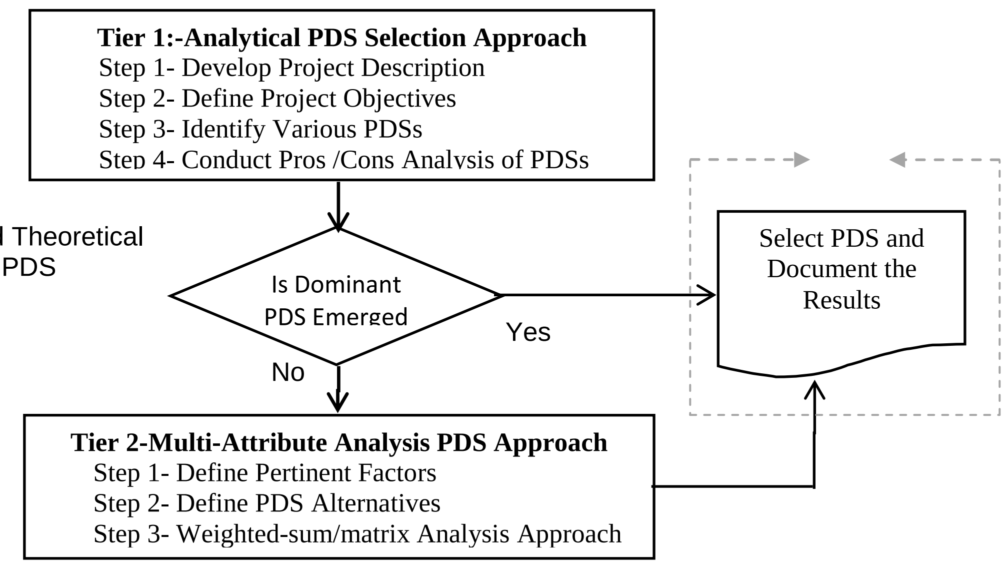


Figure 5: Proposed Theoretical DMF for Choosing PDS

We propose a two tier approach excluding risk analysis (TCRP, 2008) which essentially reduces complexity, eliminates need for an established risk management system and can be adopted with moderate decision making skills, which also conforms to our observations. Tier 1 of proposed DMF is an analytical PDS selection approach which provides a framework to the owners to define project objectives and conduct pros et contra analysis of various PDSs to achieve those objectives. Tier 2 is primarily based on weighted-matrix analysis approach yet it is simple enough to allow use of any multi-attribute analysis technique (e.g., MAUT/MAVT, AHP, Fuzzy logic technique) based on owner's project requirements and level of accuracy required in the decision making process. The proposed DMF first utilizes an analytical approach to identify objectives, understand available delivery systems and then provide rationale to make informed decisions through prioritized weighted analysis. Complex decision scenarios are also supported by providing attribute based analysis tools to owners for exploring alternative decisions.

6 CONCLUSIONS AND FUTURE RESEARCH

The research provides solutions to the common challenges faced by the Qatar construction industry practitioners while choosing an appropriate PDS for their projects. Based on the extensive review of literature, this research categorizes PDSs into four major groups i.e., DBB, DB, CMR and IPD. Authors elaborated various decision making attributes i.e., owners objectives, PDSSMs and pertinent factors, to establish understanding of the intricacies involved in the decision process. This study investigates perception of Qatar industry professionals to form ranking metrics for degree of importance of pertinent factors in terms of their affect on decisions. The survey findings reveal that professionals in Qatar construction industry possess basic knowledge of conventional delivery systems but lack understanding of recent systems like IPD. The study also highlights the lack of knowledge, undefined project objectives and bureaucratic organizational behavior, as prevalent key barriers in adopting systematic frameworks for decision making in Qatar. Evaluation of pertinent factors provides quite interesting and elucidating insights of the construction practices in Qatar industry. It is observed that some factors while not considered to be of any significance by previous researchers, are found to be quite affective in decision making processes by professionals in Qatar. Finally, based on our observations and evaluations a systematic simplified theoretical two tier decision making framework is proposed, as a facilitating tool for industry practitioners.

However, it is important to note that these conclusions are drawn from subjective findings of data with many limitations. (1) The study evaluates PDSs with public-funding or owners-funding only (e.g., DBB, DB, CMR, and IPD). PDSs that uses fully or partially private-funding (e.g., PPP and PFI) have not been considered in our research. (2) The ranking of factors presented is based on average scores and has a potential of being affected by extreme values of the individual respondents. (3) The proposed DMF is developed based on theoretical knowledge from an existing literature and is neither validated nor applied to any case project. Future application of this DMF to a live-project will result in validation and enhanced understanding of applicability.

For the next phase we plan to apply and validate the effectiveness of our proposed DMF in a case study project. We also plan to further expand our proposed framework to incorporate complex analysis techniques like fuzzy logic and AHP. Highlighting the interdependencies in the pertinent factors identified in this research are some other key areas we plan to address in our future works.

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