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Framework of Project Delivery System Selection Tool based on Cross Functional Relationship

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Abstract

Construction project implements a typical project delivery method, procurement method, and contract types that have distinguished characteristics. Selecting the most sufficient method that has the benefits to success and reduces the risk of failure of the project has been a concerning point for project owners. This report is intended to suggest a framework of a project delivery system selection that considers the correlation between the project delivery method, procurement method, and contract types. The application of the tool for the owner will be in two steps. The first step to set up the initial goals and risks of the project to properly evaluate the tools and second step for answering the checklist questions based on the goals and risks that were set by themselves. As the characteristics of each type of delivery, procurement, or contract are defined from previous experience, our tool suggests the prior option of selection combination that can aid the owner's decision.

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Keywords: Combined Project Delivery System; Project Delivery Method; Procurement Method; Contract Types

1. Introduction

The definition of project success is a topic that is keep being discussed in the academic and industry field, yet common definition of a project management success was defined with meeting the parameters of the iron triangle: Scope, Budget, and Schedule [1]. As various types of project delivery method, procurement method, and contract types appear for the project, it has become an owner's concern to find out a proper selection of the methods that suits their expectation. Previous studies have shown various methods such as the suggestion of decision supporting system using analytical hierarchy process by project characteristic [2], figuring out proper project delivery methods by empirical comparison between delivery types [3], and empirical analysis based on owner characteristics that affects project delivery types [4].

According to Project Management Institute (PMI), the success of a project is determined from either perspective of the project itself or what the project was intended to accomplish. Among the previous research in defining project success, the dominant stream aims to identify the factors that are likely to contribute to project success, failure, or risk [5] [6]

[7]. With these contributing factors that have been considered decision support systems have been proposed for owners to decide that is sufficient for delivering the project efficiently [8]. Admittedly, the correlation between project delivery method and the contributing factors of project success is highly efficient but there wasn't enough study for selecting the proper delivery method within the restriction of procurement method or contract type. Which is why, this report suggests a tool for including the contributing correlation between the combination type in the project delivery system including; project delivery method, procurement method, and contract type.

The aim of this study is to develop a framework that could aid the owner in deciding various combinations of project delivery systems and show the influence that can be affected by a correlation between project delivery method, procurement method, and contract type. Which is why this study assuming the below limitation to demonstrate the logical flow of a combination of project delivery system more clearly.

- The choices to be assessed are the most common project delivery method (Design-Build, Design-Bid-Build, and Construction Manager at Risk), procurement method (Open Tender, Request for Proposal, Single-Source), and contract type (Fixed Rate, Fixed Price, Guaranteed Maximum Price).
- Critical success factors are interrelated with the type of projects [9], classification of success factors of the project was chosen for supporting owner's decision [10] [11] [12]; project schedule, budget and project complexity. As general factors of deciding project success have various views for the other factors than project schedule and budget. Project complexity is included for integrated factors such as quality, performance, and safety.

2. Overview

The process of implementing the benefit & risk relationship and cross-functional correlation selection tool is done in two phases. The first phase is divided into three steps which is (1) developing project goals and constraints, (2) gathering project checklist question results from the owner, (3) inputting the data into benefit & risk analysis. With analytical process of empirical data into a numerical value, an efficient rank of each method type will be decided for the project success. The second phase is divided into two steps which are (1) determining the most suitable project delivery system by each method type, and (2) review the result with considering the interdependent relationship between project delivery system components. Fundamental point for the adequacy of the data is the consistency of the owner's perspective for the project success. Therefore, determining project goals and constraints are the prior step of the data gathering. Once the project attributes are well defined, it is applied in terms of weightage of benefit & risk checklist measurement. The next step is gathering the checklist results and connecting the data with each benefit & risk of the alternatives. The checklist answers are transferred into an excel database to be linked as benefit or risk of three factors of project success; schedule, cost, and complexity. Most suitable project delivery components are decided by the matrix formulation of the relation between keywords of each option and benefits and risks of three factors of project success. In formulating the integrated matrix, an analysis was carried out using the Analytical Hierarchy Process (AHP) [13], are used to develop relative importance of the checklist questions. The flowchart shown in figure 1 illustrates how the two phases need to be facilitated. This will help in producing the best possible combination for project delivery system.

Fig. 1. Flowchart of the Project Delivery System Decision Process.

3. Phase 1: Data Collection and Inputs based on Benefit and Risks

3.1 Benefit and Risk analysis of each project delivery; procurement; contract types

The relationship between the questions on the checklist and the three factors (Project cost, project duration project complexity) are based on the benefits and the risk characteristics of each of the three project delivery systems (Project Delivery Methods, Procurement Method and Contract type). The relative importance of the checklist questions and three factors are influenced by the concept of Analytical Hierarchy Process (AHP). AHP is one of the various criteria decision supporting method. In this report highlights, the decision-making structure used with methods learned from AHP such as ranking and weighted score between the correlation of multiple criteria. At the top of this hierarchy, the goal of this checklist tool clearly defines 'Most Proper Combination of Project Delivery System for the Project'. After the checklist structure is established, the process of decision begins. The weightage of each checklist questions are directly derived from the owner's selection of priority of project goals & constraints. It will follow with each individual checklist question to be relating within the viewpoint of criteria and help in choosing the most preferable alternative delivery methods. Finally, the alternative delivery option method is ranked based on suitability to the project characteristics. In phase 2, further evaluation of cross-matrix checking of correlation of project delivery method-procurement method-contract type will be converted in a numerical scale to confirm the consistency of the combination.

3.2 Characteristic of Project Delivery Methods [14]

3.2.1 Construction Management at Risk (CMR)

In this system, owner contracts with an entity called Construction Management (CM) which could act solely as an agency or actively including itself with risk on the work. In each method, the CM may be brought on board early in the construction process, sometimes even before a designer is selected. Payment for CM services is generally done on a fixed fee basis, based on a percentage of the total construction cost [15].

3.2.2 Design-Bid-Build (DBB)

Design-Bid-Build is the traditional delivery type where the owner conducts a design competition with objectives to gain a designer for furnishing complete design services. Next, the owner will hold another bidding competition to gain a specific construction contract that is based on the designer's completed construction documents. In DBB, the owner "owns" the details of design during construction and, as a result, is financially liable for the cost of any design errors or omissions encountered during construction [16].

3.2.3 Design-Build (DB)

This is a project delivery method in which the owner procures design and construction services in the same contract from a single legal entity referred to as the design-builder. As the owner no longer owns the details of design, the

owner's relationship with the design-builder must be based on a strong degree of mutual professional trust. The design-builder literally have full controls on the project in this project delivery method [16].

3.3 Characteristic of Procurement Methods

3.3.1 Open Tender

The main characteristics of an open tender are in clear and objective selections. Procurement with open tender method revolves in open competition between participants. The owner will publish basic requirements and specifications of the project locally or internationally. Based on that, all qualified participants need to prepare a bid while considering their own limitations and capabilities. The winning participant will be awarded to the least-cost provider. Thus, it is presumed as an effective competition that adds value for money. This method is highly preferred in public procurement projects as it deemed as the fairest and objective out of all methods [17].

3.3.2 Request for Proposal (RFP)

In RFP, participants are required to submit technical and financial proposals in two separate envelopes. The technical proposal is evaluated first and ranked according to pre-established evaluation criteria, and only the financial proposals of those firms that achieved the minimum qualifying mark (score), indicated in the RFP, are opened and evaluated [18].

3.3.3 Sole Source (Direct Select)

In Sole Source, the owner only appoints one partner without any kind of competition beforehand. Thus, this method hinges only on trust and relationship between owners and partners. However, some projects with this kind of arrangement are usually under pretext that there are no other trade parties with an equal amount of capabilities against the said partner [19].

3.4 Characteristic of Contract Types

3.4.1 Guaranteed Maximum Price (GMP)

In this contract, the work will be reimbursed on a time and materials basis to a fixed ceiling where the builder agrees to complete the work without additional payment once the ceiling is reached. Any cost overrun above that ceiling is a risk that the constructor takes, they would have to accept the payment as the lesser of the actual costs of the work plus a fee or the fixed ceiling amount [20].

3.4.2 Lump Sum (Fixed Price)

It is the traditional means of procuring construction, and still the most common form of a construction contract. Under a lump sum contract, a single 'lump sum' price for all the works is agreed before the works begin. Lump sum contracts apportion more risk to the contractor than other forms of contract, as there are fewer mechanisms that allow them to vary their price, and they need to give a client some guaranteed certainty about the likely cost of the projects. ("Lump sum contract - Designing Buildings" n.d.)

3.4.3 Fixed Rate

This contract is a type of contract based on estimated quantities of items and unit prices (rates: hourly rates, the rate per unit work volume, etc.). In general, the contractor's overhead and profit are included in the rate. The final price of the project is depending on the total quantities needed to carry out and complete the work. The Fixed Rate contract is only suitable for well-known resources involved project but unknown quantities at the time of the contract which will be defined when the design and engineering or construction work is completed.

3.5 Step 1: Filling in the Project Conditions

Project goals and constraints are evaluated from key factors of schedule, cost, and complexity of the project. Organizing and determining precise project attributes is the prior condition that needs to be consulted and understood for the owner to manage the project. The guide for the attributes and general conditions is elaborated as follows:

The project conditions are incorporated into the benefit & risk checklist as weightage of measurement. An owner should choose the fundamental project goals & constraints that can be recognized at the starting of the project. Weightage of each factor (schedule, cost, and complexity) of the project will be determined by the percentage of the items chosen for general goals and constraints from the owner. For example, if 3 items of schedule get chosen as general project goal & constraints when there are a total of 6 choices; 50% of weightage will be included when the schedule is counted for choosing suitable project delivery system. When more than one factor of schedule, cost, and complexity should be incorporated with benefit & risk checklist it would be used with the aggregation of the factors.

3.6 Step 2: Checklist of the Project Characteristics

A checklist will be processed based on the general project conditions chosen by the owner. Measurement will be based on the characteristic of benefits and risks for each factor depending on the items as per the given conditions & each individual answer from the checklists. The sample for a detailed checklist is shown in the table below. Ranking of each project delivery system, procurement method, contract type will be shown as the numeric result. Checklist questionnaire has been made with the following fundamentals:

- Questions that considers ‘must’ factor should be eliminated as this tool is for supporting general projects that are looking for the ideal point within meeting the iron triangle of project success
- Distribution of question relationship should not be biased into a single factor of schedule, cost, or complexity
- Correlation within questions should not be exact or opposite to avoid spillover effect of collecting duplicated data

Project Benefits & Risk Checklists				
No.	Questionnaire	Weightage	Checklist	
			Yes	No
1	Is it an intricate project?	0.667	V	
2	Are you financially constrained for this project?	0.333	V	
3	Is the project duration defined?	0.333	V	
4	Is the project familiar in the industry?	0.333	V	
5	Is the scope of project divided into separate unconnected phases?	0.333		V
6	Is advanced procurement beneficial to the project?	0.333		V
7	Is there a possibility of change in design?	1.000		V
8	Is there a possibility of change in scope?	1.000		V
9	Can the construction start before design completion?	0.667	V	
10	Is there an incentive for early completion?	0.333	V	
11	Is there a urgency to start the project?	0.333	V	
12	Is the penalty for late completion high?	0.333	V	
13	Are you willing to share risk & profit between all stakeholders?	0.667		V
14	Do you want to be strongly involved in the design phase?	0.333		V
15	Do you want to be strongly involved in the construction phase?	0.333		V
16	Are you able to make payments frequently?	0.333		V
17	Is cost more Important than quality?	0.333	V	
18	Is cost more important than project duration?	0.667	V	
19	Is there an incentive reducing project budget & duration?	0.667		V
20	Are you knowledgeable about the construction industry?	0.333		V
21	Does the Project allow high contingency reserve?	0.333		V

Fig. 2. Project Benefits and Risk Checklist

4. Phase 2: Analytical Hierarchy Process (AHP) for Correlation in Project Delivery Systems

In this phase, the correlation effect and suitability between each method in the project delivery system (project delivery methods, procurement methods, and contract type) are analyzed and implemented into the tool.

4.1 Step 1: Quality quantifying methods

Each checklist questions have been focused to be considered the same percentage of a criterion of project cost, duration, and complexity. Which is why 21 questions have been provided for 3 questions each for 6 types of correlation for 7 combination type of 3 criteria (cost, duration, and complexity). For the 21 checklist questions, questions produce a 'dynamic recipe' with 'Yes' or 'No' value assigned for each alternative corresponding factor based on the benefit-risk evaluation made at phase 1. Questions having irrelevant properties and are assigned to '-/blank' on the factors. Thus, all the qualitative relations of benefits & risks are converted into quantitative numbers and ranks.

Subsequently, the user will answer the question with 'Yes' or 'No' and for every matched, it will be quantified as +1, unmatched will be -1, and '-/blank' will get 0. Calculated weightage from project conditions checklist in step 1 of phase-1 will be considered into quantifying the analysis, each question is assigned to the weightage corresponding the seven types of interaction it has on the three factors and possible combinations. The weightage is multiplied to the value of each cell which is then totaled and ranked. The analysis will create a rank of recommendation for the 3 alternatives between each parameter.

Project Benefits & Risk Checklists			Project Delivery Method									Procurement Method									Contract Type								
No.	Questionnaire	Weightage	DBB			DB			CMR			Open Tender			RFP			Direct Selected			Fixed Rate			Fixed Price			GMP		
			Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co
			Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co	Cs	D	Co
1	Is it an intricate project?	1	N	-	Y	Y	-	Y	Y	-	N	-	-	N	-	-	Y	-	-	Y	-	-	Y	-	-	N	-	-	Y
2	Are you financially constrained for this project?	1	Y	-	-	N	-	-	N	-	-	Y	-	-	N	-	-	N	-	-	N	-	-	Y	-	-	Y	-	-
3	Is the project duration defined?	1	-	Y	-	-	Y	-	-	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-
4	Is the project familiar in the industry?	1	-	-	Y	-	-	Y	-	-	N	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	N	-	-	N
5	Is the scope of project divided into separate unconnected phases?	1	-	-	-	Y	-	-	Y	-	-	-	-	-	Y	-	-	Y	-	-	Y	-	-	N	-	-	-	-	-
6	Is advanced procurement beneficial to the project?	1	-	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-	-	N	-	-	Y	-
7	Is there a possibility of change in design?	1	N	-	N	Y	-	Y	N	-	N	Y	Y	-	Y	Y	-	N	N	-	Y	-	-	N	-	-	N	-	-
8	Is there a possibility of change in scope?	1	N	-	N	Y	-	Y	N	-	N	Y	Y	-	Y	Y	-	N	N	-	Y	-	-	N	-	-	N	-	-
9	Can the construction start before design completion?	1	-	N	N	-	Y	Y	-	Y	Y	-	N	N	-	N	N	-	Y	Y	-	Y	-	-	N	-	-	Y	-
10	Is there an incentive for early completion?	1	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	N	-
11	Is there a urgency to start the project?	1	-	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	-	-	-	-	-	-	Y	-
12	Is the penalty for late completion high?	1	-	N	-	-	Y	-	-	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-
13	Are you willing to share risk & profit between all stakeholders?	1	N	-	N	Y	-	Y	N	-	N	N	-	N	N	-	N	Y	-	Y	Y	-	-	N	-	-	N	-	-
14	Do you want to be strongly involved in the design phase?	1	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-	-	-	-	-	-	-	-	-
15	Do you want to be strongly involved in the construction phase?	1	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-	-	-	-	-	-	-	Y	-
16	Are you able to make payments frequently?	1	Y	-	-	N	-	-	Y	-	-	Y	-	-	Y	-	-	N	-	-	Y	-	-	N	-	-	Y	-	-
17	Is cost more Important than quality?	1	Y	-	-	N	-	-	N	-	-	Y	-	-	N	-	-	N	-	-	N	-	-	Y	-	-	N	-	-
18	Is cost more important than project duration?	1	Y	N	-	N	Y	-	N	Y	-	Y	N	-	Y	N	-	N	Y	-	N	Y	-	Y	N	-	N	Y	-
19	Is there an incentive reducing project budget & duration?	1	N	N	-	Y	Y	-	Y	Y	-	-	-	-	-	-	-	Y	-	-	N	N	-	Y	Y	-	N	N	-
20	Are you knowledgeable about the construction industry?	1	-	-	N	-	-	Y	-	-	N	-	-	Y	-	-	Y	-	-	N	-	-	-	-	-	-	-	-	-
21	Does the Project allow high contingency reserve?	1	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-	Y	-	-	Y	-	-	N	-	-	N	-	-

Cs= Cost
D= Duration
Co= Complexity

Fig. 3. Relationship between Checklist questions and Project parameters

Cross-functional relationship process step will be automatically measured by the below steps;

1. Insert weightage of each question according to project constraints and goals selected,
2. Answering all the questions with a (✓) mark on "Yes" or "No", attributed to the project condition,
3. Acquire the total result and ranks of alternatives of each method & type,
4. Check the interdependent relationship within the integrated matrix,
5. Find the best suitable combination for the project.

Project Benefits & Risk Checklists					Project Delivery Method												Procurement Method												Contract Type																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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9	Can the construction start before design completion?	0.667	V		0.00	-0.67	-0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	-0.67	-0.67	0.00	0.67	0.67	-0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.00	-0.67	0.00	0.67	0.67	0.00	0.00	0.67	0.67	0.00	0.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
10	Is there an incentive for early completion?	0.333	V		0.00	0.33	0.00	0.00	-0.33	0.00	0.00	-0.33	0.00	0.00	-0.33	0.00	0.00	0.33	0.00	0.00	-0.33	0.00	0.00	-0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	-0.33	0.00	0.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
11	Is there a urgency to start the project?	0.333	V		0.00	-0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	-0.33	0.00	0.00	-0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
12	Is the penalty for late completion high?	0.333	V		0.00	-0.33	0.00	0.00	0.33	0.00	0.00	-0.33	0.00	0.00	-0.33	0.00	0.00	0.33	0.00	0.00	-0.33	0.00	0.00	-0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
13	Are you willing to share risk & profit between all stakeholders?	0.667	V		0.67	0.00	0.67	-0.67	-0.67	0.00	0.67	-0.67	0.00	0.67	0.67	0.00	0.67	0.67	-0.67	0.00	0.67	0.67	-0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.67	0.67	0.00	0.6

Fig. 4. Project Benefits and Risk Checklist

4.2 Step 2: Decision with considering an interdependent relationship

For this step, an analysis of interdependent relationships is implemented between all parameters. An important point to keep in mind is one specific alternative (e.g. in a parameter of project delivery system) might be unsuitable to other specific alternatives from other parameters (procurement method and contract type). Thus, an integrated matrix will be constructed to evaluate the best possible combination by evaluating compatibilities between these alternatives. The matrix is then compiled by ranks to give out the best possible combinations considering the type of relations.

DBB	-	-	-	1	-1	-1	1	1	-1
DB	-	-	-	-1	1	1	-1	1	1
CMR	-	-	-	1	1	-1	-1	-1	1
Open Tender	1	0	1	-	-	-	1	-1	1
RFP	1	1	0	-	-	-	1	-1	-1
Direct Selection	-1	1	-1	-	-	-	1	1	-1
Fixed Rate	1	0	-1	1	1	1	-	-	-
Fixed Price	1	1	-1	-1	-1	1	-	-	-
GMP	1	-1	1	1	-1	-1	-	-	-
	DBB	DB	CMR	Open Tender	RFP	Direct Selected	Fixed Rate	Fixed Price	GMP

Fig. 5. Interdependent Relationship Matrix

From the above reasoning, the process of interdependent relationship is as follows:

1. Select a method based on the highest quantified point acquired,

[illegible]

Fig. 6. 1st Alternative Process

2. Compare the chosen alternative to its corresponding alternatives from different parameters by utilizing Interdependent Relationship Matrix (Figure 7),

[illegible]

Fig. 7. 2nd Alternative Process

3. Seek the best possible compatibility by referencing to Selection Priority (Figure 8), starting with 1st priority and then moving downward towards lower priority if no feasible match is found,

Selection Priority:		
Correlation behavior	Alternate Rank	Priority
1	1	1
1	2	2
1	3	3
0	1	4
0	2	5
0	3	6
-1	1	7
-1	2	8
-1	3	9

Fig. 8. Priority Selection

4. The best compatibility will be your 2nd chosen alternatives,
5. From the 2nd chosen alternatives to seek the 3rd alternatives by assessing compatibility from Interdependent Relationship Matrix referenced to selection priority as done in Step 2 and 3,

[illegible]

Fig. 9. 3rd Alternative Process

6. Finalize your best possible combination of project delivery method, procurement method, and contract type, each being one of the three alternatives.

5. Conclusions

This report provides a framework that suggests a best suitable project delivery system that considers the benefits and risks between project delivery method, procurement method, and contract type which is measured in a cross-functional relationship. It would help owners to decide on multiple aspects for determining the optimal project delivery system of a specific project. In addition, the framework would facilitate comparison through 3 factors governing project

success. Actualizing the impact of each contributing factor, this tool accommodates the multiple perspectives for each different parameter.

However, this study will still need more improvements to help achieve practicality. The current state of the tools act as a baseline as it is considering the general checklist questions to position the project. To act more extensively, checklist questionnaire could be developed for considering more specific issues pertaining to the project condition. Future recommendation of the study would be to try utilizing the framework against multiple case studies. It will help in evolving the framework by incorporating several factors that might have been overlooked.

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