

## Multi-Attribute Utility Model for Selection of Appropriate Procurement Method in the Construction Projects

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### ABSTRACT

The selection of an appropriate procurement method is becoming an increasingly important issue due to complex decision-making that has to be made by clients early in the project lifecycle. The aim at this paper is to improve and enhance procurement system in the construction industry through developing a model using the multi-attribute utility theory (MAUT) as a decision support system for the selection of appropriate procurement method for construction projects in the Gaza Strip. Factors that influence the selection of an appropriate method for construction projects in Gaza Strip were identified. The results indicated that the top significant six factors that have most influence on the selection of procurement methods in the Gaza Strip construction projects are: price competition, degree of project complexity, time constrains of project, project size, client's financial capability, and client's experience in procurement methods. The study concludes that there is no variety of procurement methods used in the Gaza Strip construction industry where a traditional procurement method is preferred. This is because most of professionals' in Gaza Strip are not familiar and not widely experienced with the other alternative procurement methods. A model was developed using Multi Attribute Utility Theory to select the most appropriate procurement method. The multi-attribute utility -theory (MAUT) as a decision support system was able to identify the appropriate procurement method.

**Keywords:** Procurement method, MAUT, Construction project,

### 1.0 Background

Procurement methods for construction industry can be defined as the organizational structure adopted by client for the management of the design and construction of a building project (Masterman, 2002). Different procurement methods are used for different construction projects and the correct choice may help to avoid problems and be the key to the attainment of project specific goals (Eyitope et al., 2012). The selection of an appropriate procurement method can reduce construction project costs by an average of 5%. and enhance the probability of project success (Naoum, 1994). A wrong procurement method often leads to project failure or client's dissatisfaction (Love et al., 1998). The selection of procurement system therefore becomes a very important task for clients who have the responsibility to select the most appropriate procurement method for their construction projects. This

has become imperative because the client is faced with various options to procure his project (Okunlola, 2012). Many clients have been selecting procurement systems in a cursory manner, and some clients even use a specific procurement system by default without making a deliberate choice. A recent UK study showed that 89% of respondents were dissatisfied with the procurement system they had previously employed. Inexperienced clients often have to rely on expert advice when selecting a procurement approach and this could result in inappropriate decisions with unforeseeable consequences. Experienced clients may also suffer if they simply based their selection upon biased past experience and the conservative decisions of their in-house experts or consultants. The selection of an appropriate procurement system is one of the most important problems in the construction sector and it is a complex decision-making process due to risks and uncertainties. Moreover, it depends largely on the accurate identification of client requirements. At the time of the decision, the clients and stakeholders often have little information and the project plans are not detailed enough to make a judgment about the project with certainty of outcomes (Tran and Molenaar, 2012)

Accordingly, the decision to select the appropriate procurement method to implement a construction project is crucial. Though it does not necessary lead to a successful project but with other factors taken into consideration can influence the success of the project (Okunlola & Olugbenga, 2010). The use of alternative procurement methods has increased recently due to many factors including the increase in complexity and size of projects, increased owner sophistication and requirements, demand for shorter delivery period and others.

## **2.0 Factors Influencing the Selection of Procurement System**

Several previous studies have identified number of factors influencing the selection of procurement system in construction. The selection criteria for project procurement will influence which procurement system should be used in a particular project. Different client has differing needs and requirements whereby construction projects vary so considerably, in every respect, that no single system of procurement can be suitable for every project (Luu, Ng, and Chen, 2003; Cheung et al., 2001). Moreover, there are some criteria to establish a profile of the client requirement and preferences for the procurement methods such as speed (during design and construction), certainty, flexibility in accommodating design changes, quality, complexity, risk allocation/avoidance, responsibility, and dispute and arbitration (Love et al., 2005). The selection criteria that are identified as the most common criteria influencing the choice of procurement method in the Malaysian construction industry are time, controllable variation, complexity, quality level, price certainty, competition, responsibility division, risk avoidance, price completion, government policy and client's familiarity in a procurement method (Maizon et al., 2006), while the results indicate that there are nine procurement selection criteria commonly used by Australian clients: speed, time certainty, price certainty, complexity, flexibility, responsibility, quality level, risk allocation and price competition (Thomas, 2001) . No single procurement system can be applied universally on all construction

projects. Each procurement system is chosen for a particular project based on certain criteria which use in the selecting procurement systems and those criteria are: Time (Speed); Quality level; Risk allocation/avoidance; Flexibility to change design during both design and construction period; Responsibility; Complexity; Price competition; Certainty of cost and time; Disputes and arbitration; Project type; Client's experience; Experienced contractor availability; Client's willingness to be actively involved; Project site location; Client's trust in other parties; Political constraints; Project size; Regulatory impact; Market competitiveness; Client's requirement for value for money; Material availability; Client's financial capability. While the principal factors and criteria that influence selection of procurement systems are Client's willingness to be actively involved; Flexibility to change design during both design and construction period; Risk allocation/avoidance; Project size; Client's experience; Certainty of cost and time; Experienced contractor availability; Client's trust in other parties; Client's requirement for value for money; and Project type. (Odhigu et al., 2011). However, the decision is not easy as there are many factors that affect the project procurement method decision. These factors are related to time, cost, scope, quality, owner organization, cash flow, project characteristics, risk, and relationships. It is important that donors, clients and consultants understand these factors as it will assist them in making the right choice of procurement method for their projects (Sayegh, 2007).

When project client, or consultant and decision-makers are selecting a procurement system for a project, their previous experience plays an influential role. This question sought to determine the main criteria clients use in selecting procurement systems (Shiyamini and Rameezdeen, 2006).

As far as Gaza Strip construction industry is concerned, project procurement seems to be one of the key areas, which have to be developed largely. From the researcher points of view, majority of the public and private construction projects are procured through traditional procurement system, especially by measure and pay and the number of different types of procurement systems used in Gaza is less when compared to other countries. The traditional system with measurement contract method are also widely used throughout the Middle East except in Iran and Iraq. Bahrain, Egypt, Jordan, UAE, Qatar, Oman and Saudi Arabia are also using this method in most of their construction projects as part of the tender and contract documentation (Rosli et al., 2006). Therefore, there is a need to explore new ways of procuring construction projects. Further, in Gaza Strip, the practice of procurement selection seems to be rather unstructured and ad hoc. There is no logical and consistent approach is used to select an appropriate procurement system for a particular project. Therefore, a development and application of such approach for the selection is essential to aid clients and consultants in selecting the most appropriate procurement system. This research aims to improve and enhance procurement system in the Gaza Strip through support the clients and consultants in the selection process of an appropriate procurement method for their construction projects. The main objectives of this study are summarized as the following: To study and investigate the major practices of variant types of procurement methods used in Gaza construction industry. To identify the most common factors that affecting

the selection of procurement method in construction projects in Gaza Strip. To identify and rank the most important key factors affecting the selection of procurement method according to the clients and their representative perspectives.. To develop a framework for the selection of procurement method in Gaza Strip.

### **3.0 Definitions of Procurement Method**

Since this research mainly relies on investigating the key factors influencing the selection of procurement methods, it was necessary to establish the definitions of the procurement method.

Mathonsi & Thwala (2012) stated that 'Procurement method' is a contemporary term, which is known to many practitioners and researchers of the construction industry by different terms; these include terms such as project approach, procurement systems, procurement delivery methods or project delivery systems, etc. Masterman (2002) argues that there is a need to accept that contemporary procurement methods can now embrace not only design and construction, but also financing, operating, facilities management etc. The following definitions best define a procurement method

- It is an organizational structure adopted by the client for the implementation and at times eventual operation of a project (Masterman, 2002).
- It is a comprehensive process by which designers, constructors, and various consultants provide services for design and construction to deliver a complete project to the client (Molenaar et al., 2009)
- It is a key means through which the clients create the pre-conditions for the successful achievement of project-specific objectives (Rameezdeen and Ratnasabapathy, 2006).
- A procurement method (or sometimes known as procurement system) "is an organizational system that assigns specific responsibilities and authorities to people and organizations, and defines the various elements in the construction of a project" (Love et al., 1998:p.222). In conclusion, there is no specific definition to address the procurement. However, it seems more practical to say that the whole delivery system of a project is concerned when we address procurement.

### **4.0 Types of Procurement Methods**

Davis et al. (2008) stated that a plethora of methods for procuring construction projects is available to meet the needs of clients. Deciding what method to use for a given project is a difficult and challenging task as a client's objectives and priorities need to marry with the selected method to improve the likelihood of the project being procured successfully. The decision as to what procurement method to use should be made as early as possible and underpinned by the client's business case

for the project. The risks and the potential affect the client's business should be considered.

Davis et al. (2008) classified procurement systems as the following two major methods

1. Traditional Procurement Method (Separated);
2. Non-Traditional Procurement Method which include the following three methods:
  - A. Design and Construct Procurement Method (Integrated);
  - B. Management Procurement Method (Packaged); and
  - C. Public Private Partnership Procurement Method

Mathonsi & Thwala (2012) stated that the traditional method is called 'traditional' because it has been in existence for a long time and has been the only choice available for most clients of the construction industry for many years. Davis et al., (2008) stated that in the traditional approach, the employer accepts that design work will generally separate from construction, consultants are appointed for design and cost control, and the contractor is responsible for carrying out the works. Over the past number of years, the construction industry has undergone changes in a manner never seen before. The increased size and complexity of the construction projects, financial challenges, political and social consideration, and information technology are just some of the changes that have been taking place. These changes had led to the development of alternative procurement systems other than the famous traditional one. Although the development of non-traditional procurement systems seemed to be the favorite to most clients of the construction industry, It must, however, be emphasized that there is not yet a specific method used to select the most appropriate procurement method.

Natasa & Car-Pušić (2008) stated that many clients today, however, are increasingly dissatisfied with the traditional approach and its operational characteristics and actively seek alternative methods of procurement, organization and management to meet their increasingly complex demands.

Masterman (2002) defines a non-traditional procurement system as a diversified contemporary procurement system(s) that not only considers design and construction, but also considers financing, operating and facility management and also define the design and construct procurement method as "An arrangement where one contracting organization takes sole responsibility, normally on a lump sum fixed price basis, for the bespoke design and construction of a client's project".

Mathonsi et al., (2012) stated that design and construct procurement method is a system where one organization, usually but not exclusively the contractor, takes responsibility for the design and construction of the project, in theory at least. The client deals only with one organization. Davis et al., (2008) stated that with design and construct procurement method, a contractor accepts responsibility for some or all of the design. El Wardani (2004) clarified that in the design and construct contracts, there is usually a single point of responsibility. The employer therefore has

the advantage of only one firm to deal with – and one firm to blame if things go wrong. In practice, the employer's requirements are detailed to the extent that the contractor's design contribution, and liability, is diminished.

Mathonsi et al., (2012) stated that under a management-oriented procurement system, the management of the project is carried out by an organization working with the designer and other consultants to produce the designs and manage the physical operations which are carried out by contractors. Davis et al., (2008) stated that several variants of management procurement forms exist, which include; management contracting, construction management and design and manage. There are some subtle differences between these procurement methods. In the case of management contracting, the contractor has direct contractual links with all the works contractors and is responsible for all construction work. In construction management, a contractor is paid a fee to professionally manage, develop a programme and coordinate the design and construction activities, and to facilitate collaboration to improve the project's constructability.

Larmour (2011) stated that public private partnership (PPP) procurement method involves two or more organizations working together to improve performance through agreeing mutual objectives, devising a way for resolving any disputes, and committing themselves to continuous improvement, measuring progress and sharing gains and pains. Examples include framework agreements and joint ventures. Table (1) clarified advantages, disadvantages, and when each procurement method should be used

No.	Procurement Method	Advantages	Disadvantages	When should be used
1	Traditional procurement method	<ul style="list-style-type: none"> <li>• Accountability due to a competitive selection;</li> <li>• Competitive equity;</li> <li>• Price certainty at the award of the contract;</li> <li>• Variations (changes) to the contract are relatively easy to arrange and manage; and</li> <li>• A tried and test method of procurement which</li> </ul>	<ul style="list-style-type: none"> <li>• Timely process to produce the full contract documentation;</li> <li>• Overall project duration may be longer than other procurement methods; and</li> <li>• No input into the design or planning of the project by the contractor.</li> </ul>	<ul style="list-style-type: none"> <li>• A programme allows sufficient time;</li> <li>• Consultant design is warranted;</li> <li>• A client wishes to appoint designers and contractors separately;</li> <li>• Price certainty is wanted before the start of construction;</li> <li>• Product quality is required; and</li> <li>• A balance of risk is to be placed between the client and constructor.</li> </ul>

		the market is very familiar with.		
2	Design and construct procurement method	<ul style="list-style-type: none"> <li>• Client has to deal with one firm and reduces the need to commit resources and time to contracting designers and contractors separately;</li> <li>• Price certainty is obtained before construction commences;</li> <li>• Overlap of design and construction activities can reduce project time; and</li> <li>• Improved constructability due to contractor's input into the design.</li> </ul>	<ul style="list-style-type: none"> <li>• Difficulties can be experienced by clients in preparing an adequate comprehensive brief;</li> <li>• Client changes to project scope can be expensive;</li> <li>• Difficulty in comparing bids since each design will be different;</li> <li>• Client is required to commit to a concept design at an early stage; and</li> <li>• Design liability is limited to the standard contracts that are available.</li> </ul>	<ul style="list-style-type: none"> <li>• Building is functional rather than prestigious;</li> <li>• Building is simple rather than complex, it does not require technical innovation;</li> <li>• Brief for scope design is likely to change;</li> <li>• Programme can be accelerated by overlapping design and construction activities;</li> <li>• Single organization is required to take responsibility and risk for design and construction.</li> </ul>
3	Management procurement method	<ul style="list-style-type: none"> <li>• The client deals with only one firm;</li> <li>• Potential for time savings for the overall project as design and construction activities are overlapped;</li> <li>• Works packages can be let competitively at prices that are current;</li> <li>• Improved constructability</li> </ul>	<ul style="list-style-type: none"> <li>• Price certainty is not achieved until the final works package has been let</li> <li>• Informed and proactive client is required.</li> <li>• Poor price certainty</li> <li>• Close time and information control required</li> <li>• Client must provide a good quality brief to the</li> </ul>	<ul style="list-style-type: none"> <li>• When the project is large, complex, fast moving where early completion is desirable.</li> <li>• When the client has a considerable degree of flexibility on design matters.</li> <li>• the project needs an effective cost control.</li> </ul>

	<p>through constructor input into the design;</p> <ul style="list-style-type: none"> <li>• Roles, risks and responsibilities for all parties are clear;</li> <li>and</li> <li>• Flexibility for changes in design.</li> </ul>	design team; and	
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To sum up, although there is many procurement systems, most of the clients still prefers to use traditional one for its known methodology and simple application. Some client tends to use different procurement system when they have a special type of project. There is no specific method that could be followed to identify which procurement method should the client chose.

#### 4.1 Local Studies

Enshassi and Modough (2012) stated that a project can be procured using different procurement methods ranging from single source: direct hiring, negotiation, restrictive bid, to open competition procurement. An owner may select a contractor through competitive bidding, such as the lowest-bidder system and the non-lowest-bidder system. Procurement type is a critical decision because it defines the method to select the key player in the project, which is the construction firm that is expected to deliver the project. This decision greatly impacts the performance because if the construction firm is not qualified to achieve the project goals, serious problems may arise during and after construction.

Different procurement systems with evaluation criteria have been developed to assist owners during the contractor selection process. The main advantages of these methods and evaluation systems is that they provide a systematic and objective procurement approach that takes into consideration numerous factors other than the price of the bid.

The finding obtained from three case studies exposed in Gaza Strip is the existence of a proportional relation between awarding bids to lowest price and the problems encountered during implementation when used a traditional procurement method. The three cases of the study were awarded to lowest price contractors; the results show the existence of the following problems: Considerable delay in the project handover, Disputes between the project partners, Contractor's claims against the client which lead to disputes issues, Low level of quality in some items and Increase of the final project cost.

Accordingly, there is a need to change the traditional system for contractor selection and awarding contracts from the "lowest price" to "multi-criteria selection" practices. This can be implemented by establishing alternative



procurement methods to select contractors based on technical and financial criteria.

The World Bank, Country Procurement Assessment Report (CPARs), West Bank and Gaza (2004) stated that the most used procurement methods for works and goods are National Competitive Bidding (NCB) and Shopping (Table 2).

Insert Table 2

Moreover, for national shopping (NS), in many cases: (i) municipalities did not use written invitations in soliciting quotations; (ii) local governments did not prepare quotation evaluation reports and did not issue purchase orders, relying instead on the quotations opening minutes and committee decisions; (iii) the value of some contracts were above the NS thresholds.

National competitive bidding (NCB), (i) In most projects and during the intifada period, the time allowed to bidders to submit bids was much less than the 30 days required under the Trust Fund Agreement; and (ii) ministry of health component, more than one bid submission place address and bid opening address were listed in bidding documents.

Sole Source (Direct Contracting) was used although the Trust Fund Agreement does not stipulate its use and WB no-objections were not sought. Procurement documents were noted that in many cases, key information was missing in various procurement documents.

## **5.0 Developing a Framework**

The decision to select the appropriate procurement method to implement a construction project is crucial. Though it does not necessary lead to a successful project but with other factors taken into consideration can influence the success of the project. From the researcher points of view, clients and consultants in the Gaza Strip do not have a specific procedure in selecting their procurement method to implement their construction projects but base it on familiarity with a particular method. Hence, clients use procurement methods compatible with their corporate environments. So, most of clients in the Gaza Strip use the traditional procurement method because they do not have the relevant experience and familiarity for other non-traditional methods. This is because of the fact that there, is no theoretical framework on which to derive either an ideal or an optimum approach to select the appropriate procurement method.

One of the objectives of this research was aimed to developing a framework using the multi-attribute utility -theory (MAUT) as a decision support system for the selection of appropriate procurement method for construction projects in the Gaza Strip. The conceptual framework of the multi-attribute utility theory (MAUT) was suggested to match clients' prioritized factors with the benchmarked performance of the procurement methods in achieving a selection criterion (utility coefficient), to select appropriate procurement method for construction projects in Gaza Strip.

### **5.1 Multi-attribute Utility Theory (MAUT)**

Fellows et al. (1983) stated that a multi-attribute utility theory is a methodology which can be used as a tool to measure objectivity in an otherwise subjective area of management. As a procurement system is the overall managerial approach by which a client commissions and obtains a project, the multi-attribute utility theory was considered the foremost technique appropriate for examining the criteria of clients and the preferences of procurement experts and consultants weights for each method in the most objective way. By indicating the relative utility of each client requirement and procurement method against a numerical scale, it is possible to obtain a set of utility factors.

The multi-attribute utility theory (MAUT) is used mostly to solve complex problems that involve the consideration of several criteria in relation to different outcomes. The decision makers assess the value of possible outcomes based on utility i.e. relative desirability of each possible outcome.

Okunlola and Olugbenga (2010) illustrated that the multi-attribute utility theory (MAUT) involves four steps which are:

1. Client weights the relative importance of each significant factor that affecting the selection of procurement method;
2. Rationalized priority ratings are calculated (by dividing each of the priority ratings by the sum of all the ratings) and then entered into the decision chart. The sum of the rationalized priority ratings should always be equal to 1.
3. Each rationalized priority rating is taken in turn and multiplied by each of the utility factors; the results will then be entered into the appropriate columns.
4. The totals of each of the results columns, under each procurement method, are calculated and ranked in descending order. The most appropriate procurement method will have the highest total result.

### **6.0 Data Collection Procedure**

A survey questionnaire is designed to obtain further information in order to support the study objectives and it is also designed based on identified the main and sub-factors that will be affect the selection of best procurement method in construction projects in the Gaza Strip, and to assist in future in formulated a model for the selection of procurement method After the preliminary testing of questionnaire, a pilot study was conducted to evaluate the questionnaire and the tests of validity and reliability were done according to the pilot study Procurement specialists and engineers' consulting offices with the first class are involved in the decision of selecting a procurement method because they have a good experience in procurement management for a whole large construction projects in the Gaza Strip and the targeting experts were asked to prioritize the factors influencing the selection of procurement method based on Likert scale. According to the results of

sample sizes; a total of 68 organizations (i.e. 29 procurement experts and 39 consultants from engineers' consulting offices with the first class) responded to the survey. The data was then analyzed using the Statistical Package for Social Sciences (SPSS) and the factors ranked according to their Relative Importance Index (RII). and the factors with Important Index exceeding or equal to 81% were recognized as important significant factors based on the consensus of the respondents to be used in factor analysis.

From the questionnaire result analysis, ten factors were identified as significant important factors affecting the selection of procurement method in construction projects in the Gaza Strip, which are: Price competition (RII = 89.80%), Degree of project complexity (RII = 88.60%), Time constrains of project (RII = 87%), Project size (RII = 86.20%), Client's financial capability (RII = 85.80%), Client's experience in procurement methods (RII = 85%), Availability of qualified personnel (procurement expert) (RII = 84.80%), Risk avoidance/allocation (RII = 83.20%), Project type and nature (RII = 82%), and Availability of procurement system in the local market (RII = 81.40%). The most common procurement method that selected by the respondents in construction projects in the Gaza Strip is a traditional procurement method (Separated method) which represent around two third (69.10%) from the total sample and the high percentage of this result reflects a bad indicator to ensure that there is no a variety of procurement methods selected and used in construction projects in the Gaza Strip

Furthermore, the results show that 75% of the respondents are familiar with traditional procurement method as this method is widely experienced, known, and spread in different organizations in the Gaza Strip while only 25% of the respondents are familiar with other procurement methods

## 6.1 Data analysis

Considering a decision-making problem with M alternatives procurement methods and N significant factors whereby the alternatives procurement methods is denoted as:  $a_i$  (for  $i = 1, 2, 3, M$ ) significant factors as  $C_j$  (for  $j = 1, 2, 3 \dots N$ ). The decision maker knows the performance values  $a_{ij}$  (for  $i = 1, 2, 3, M$  and  $j = 1, 2, 3, N$ ) of each of procurement method in terms of each of the significant decision factor. Also that for each significant decision factor, the decision maker has determined its relative importance denoted as  $C_j$  (for  $j = 1, 2, 3, N$ ). Lastly that the relative importance of the N factors satisfies the following normalization constraint

$$\sum_{j=1}^n C_j = 1$$

This is termed the rationalized priority rating and is calculated as

$$C_j = RIp / \sum (RIp)$$

$$P=1$$

Where  $R_{lp}$  - is the relative importance index (RII)

It is used to calculate the performance of the alternatives procurement methods by an additive utility (the weighted sum model) of the following form

$$P_i = \sum_{j=1}^n a_{ij}C_j$$

For  $i = 1, 2, 3, \dots, M$  where  $P_i$  is the preference value of procurement method  $a_{ij}$  ( $i = 1, 2, 3, M$ ) when all the significant important factors are considered simultaneously. For maximization case in this research, the best alternative is the one which has the largest preference value.

Table 3 below, published the rationalized priority rating ( $C_j$ ) by the respondents in this research.

Insert Table 3

In a further research, respondents (procurement specialists and engineers' consulting offices) were asked to rate the suitability of procurement methods in achieving a selection factor based on main factor groups using a Likert scale of 1 to 10. A rating of 1 means, low suitability in achieving a selection factor and 10 means, very high suitability in achieving a selection factor. The procurement methods considered were those in use in Gaza Strip such as traditional procurement method, design and build procurement method, management procurement method and public private partnership procurement method such as BOT method. The benchmark performance values ( $a_{ij}$ ) of these procurement methods will be calculated and after that, the totals of each of the results columns, under each procurement method, are calculated and ranked in descending order. The most appropriate procurement method will have the highest total result.

## 6.2 Multi-attribute Utility Theory Application

Two forms were used to apply the multi-attribute utility theory (MAUT) In the first form, procurement experts are asked to rate the suitability of procurement methods in achieving each significant factor based on a Likert scale. The second form was developed from consultants to calculate the benchmark performance values ( $a_{ij}$ ) of different procurement methods in order to identify the most appropriate procurement method in construction project.

## 6.3 Multi-attribute Utility Theory Verification

MAUT verification and validation are essential parts of the conceptual framework development process if MAUT to be accepted and used to decision support system.

Validation ensures that the theory meets its intended requirements in terms of the methods employed and the results obtained.

#### **6.4 Verification Cases**

Two cases were taken to evaluate the MAUT verifications and to measure its accuracy and strength in selection of appropriate procurement method. Three procurement experts participated in Coastal municipalities' water utility (CMWU) project for case 1 and three consultants participated in Islamic University project for case 2.

##### **Case 1: Design and build of Wadi Gaza wastewater treatment plant**

The following case shows the results of MAUT verification. Three procurement experts participated in Coastal municipalities' water utility (CMWU) project. Design and build procurement method was selected for this project. The contract value for this project was \$ 1,304,000.00 with project duration of 365 calendar days. The project was completed on 2013. The three experts were asked to rate the suitability of procurement methods in achieving each significant factor based on a Likert scale, the results introduced in Table 4 below and Table 5 shows the weighted sum model results for the selection appropriate procurement method.

Insert table 4

Insert table 5

From the results obtained in Table 4 and Table 5, it was concluded that the weighted sum model results by procurement experts revealed that, design and build procurement method was the most appropriate procurement method option with preference value  $P_i$  equal 8.34. Management procurement method was ranked second most appropriate procurement method with preference value  $P_i$  equal 7.88. It means that if a client has a construction manager, then he can consider the management procurement method. Traditional system was ranked the third appropriate procurement method for this project with preference value  $P_i$  equal 7.76 while public private partnership procurement method was ranked the least appropriate procurement method with preference value  $P_i$  equal 7.25.

After this result, the researcher of this study asked the procurement manager for this project about the performance of the project concerning on procurement issues, the procurement manger confirmed that this method is the most appropriate option for the project. This conclusion proves that the verification of MAUA approach.

##### **Case 2: Construction of continuous medical education centre at the Islamic University**

The second case that was used to verify the MAUT was to construct a continuous medical education centre at the Islamic University in Gaza. This project was completed in 2010 and constructed under the Engineering office supervision. MAUT verification was done by targeting external three consultants for this project. Traditional procurement with measure and pay method was selected for this project. The contract value for this project was \$ 309,000.00 with project duration of 120 calendar days. The three external consultants were asked to rate the suitability of procurement methods in achieving each significant factor based on a Likert scale, the results introduced in Table 6 and Table 7 shows the weighted sum model results for the selection appropriate procurement method.

Insert Table 6  
Insert Table 7

From the results obtained in Table 6 and Table 7, it was concluded that the weighted sum model results by consultants revealed that, traditional procurement method was the "best in class" i.e. the most appropriate procurement method option to implement this project with preference value  $P_i$  equal 7.88. Management procurement method was ranked second most appropriate procurement method with preference value  $P_i$  equal 7.73 while design and build method was ranked the third appropriate procurement method for this project with preference value  $P_i$  equal 7.41. Again, public private partnership procurement method was ranked the least appropriate procurement method with preference value  $P_i$  equal 7.34 and this result confirmed that the verification of MAUT theory

## 7.0 A Framework Development

The main objective of designing a conceptual framework is to assist a decision maker for procurement method selection. The framework facilitates the following:

- Assists clients and their representatives in the initial decision on making an appropriate procurement selection for any kind of construction project;
- Ensures systematic and consistent approach for procurement selection through the application of relevant research methods;
- Provides better understanding on selection criteria which affect the procurement selection and various types of alternative construction procurement systems in practice;
- Provides report on ranked list of procurement systems.

A framework was designed for construction clients and/or their consultants particularly those who use an unrealistic method to select the appropriate procurement system and are responsible for the selection process. Primarily, this framework guides how to select a most appropriate procurement system for a particular type of construction project. This framework not only considers the requirements of clients and project's profile but also the impact of external

environment on procurement selection. In this way, it will be possible to ensure that the project is procured in an efficient and effective way that adds value for the client. Development of the model consists of three main phases, which are database input phase, process, and modeling the factors phase and data base output phase. Figure 1 shows a conception framework for the selection of an appropriate procurement method.

Insert Figure 1

## 8.0 Conclusion

There are twelve most influential factors/criteria affecting the selection of procurement method in construction projects in Gaza Strip. .

It was concluded that, both procurement specialists and consultants from engineers' office generally agree on the importance of factors affecting the selection of procurement method.

Both the conventional (traditional) and non-conventional procurement methods are currently embraced in Gaza Strip. Around two-thirds of construction projects are executed using variants of traditional procurement method; The other procurement methods are used with infrequently.

Gaza Strip construction sector remains in the phase of exclusively using traditional methods. This may be presumably due to procurement staff and consultants are well familiar with traditional methods and this familiarity was found regarding to a long age existence of the traditional procurement systems in the Gaza Strip construction industry.

It seems that the current procurement methods (traditional) have directly contributed to projects overrunning in terms of cost and time, suggesting that this method is unsuitable for a modern, progressive construction industry in Gaza. There is tendency between professionals to see a design and build procurement method used more in Gaza Strip.

Among the variant types of traditional procurement method, measurement method based on bill of quantities had the highest selection share. The popularity of this method is mainly due to the government influence on the construction industry of Gaza Strip.

It was concluded that the combination of national culture and organizational culture of construction in Gaza has created an environment that did not favor the use of new procurement methods. The organizational culture of construction in Gaza is characterized by the separation of design and construction from the colonial days. The construction professionals are found to be collectivists and feminine. Therefore, this mixed culture does not challenge the status quo. There is no room for new procurement methods to be experimented in the Gaza Strip construction industry.

The multi-attribute utility theory (MAUT) as a decision support system was developed to help clients to choose the appropriate procurement method. The model was able to identify the appropriate procurement method.

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EARLY VIEW

No.	Procurement Method	Advantages	Disadvantages	When should be used
1	Traditional procurement method	<ul style="list-style-type: none"> <li>• Accountability due to a competitive selection;</li> <li>• Competitive equity;</li> <li>• Price certainty at the award of the contract;</li> <li>• Variations (changes) to the contract are relatively easy to arrange and manage; and</li> <li>• A tried and test method of procurement which the market is very familiar with.</li> </ul>	<ul style="list-style-type: none"> <li>• Timely process to produce the full contract documentation;</li> <li>• Overall project duration may be longer than other procurement methods; and</li> <li>• No input into the design or planning of the project by the contractor.</li> </ul>	<ul style="list-style-type: none"> <li>• A programme allows sufficient time;</li> <li>• Consultant design is warranted;</li> <li>• A client wishes to appoint designers and contractors separately;</li> <li>• Price certainty is wanted before the start of construction;</li> <li>• Product quality is required; and</li> <li>• A balance of risk is to be placed between the client and constructor.</li> </ul>
2	Design and construct procurement method	<ul style="list-style-type: none"> <li>• Client has to deal with one firm and reduces the need to commit resources and time to contracting designers and contractors separately;</li> <li>• Price certainty is obtained before construction commences;</li> <li>• Overlap of design and construction activities can reduce project time; and</li> <li>• Improved constructability due to contractor's input into the design.</li> </ul>	<ul style="list-style-type: none"> <li>• Difficulties can be experienced by clients in preparing an adequate comprehensive brief;</li> <li>• Client changes to project scope can be expensive;</li> <li>• Difficulty in comparing bids since each design will be different;</li> <li>• Client is required to commit to a concept design at an early stage; and</li> <li>• Design liability is limited to the standard contracts that are available.</li> </ul>	<ul style="list-style-type: none"> <li>• Building is functional rather than prestigious;</li> <li>• Building is simple rather than complex, it does not require technical innovation;</li> <li>• Brief for scope design is likely to change;</li> <li>• Programme can be accelerated by overlapping design and construction activities;</li> <li>• Single organization is required to take responsibility and risk for design and construction.</li> </ul>
3	Management procurement method	<ul style="list-style-type: none"> <li>• The client deals with only one firm;</li> <li>• Potential for time savings for the overall project as design and construction activities are overlapped;</li> <li>• Works packages can be let competitively at prices that are current;</li> <li>• Improved constructability through constructor input into the design;</li> <li>• Roles, risks and responsibilities for all parties are clear; and</li> <li>• Flexibility for changes in design.</li> </ul>	<ul style="list-style-type: none"> <li>• Price certainty is not achieved until the final works package has been let</li> <li>• Informed and proactive client is required.</li> <li>• Poor price certainty</li> <li>• Close time and information control required</li> <li>• Client must provide a good quality brief to the design team; and</li> </ul>	<ul style="list-style-type: none"> <li>• When the project is large, complex, fast moving where early completion is desirable.</li> <li>• When the client has a considerable degree of flexibility on design matters.</li> <li>• the project needs an effective cost control.</li> </ul>

Table 1: Advantages and disadvantages for each type of procurement method

Type	Procurement Method				Total Financing
	ICB	NCB	Other	NBF	
US \$ million					
Works	12.60	170.24	50.98	1.17	234.99
	0.00	103.31	41.37	0.00	144.68
Goods	9.37	2.67	5.59	0.16	17.79
	4.37	1.57	6.96	0.00	12.90
Services	11.52	0.60	9.49	2.53	24.14
	10.52	0.60	8.50	0.00	19.62
Miscellaneous	0.00	2.63	29.34	9.89	41.86
	0.00	2.63	27.85	0.00	30.48
Total	33.49	176.14	95.40	13.75	318.78
	14.89	108.11	84.68	0.00	207.68

Table 2 WB project cost by procurement method, source: WB, CPARs report (2004)

No.	Factor	Respondents	
		RII (%)	Rationalized priority rating (Cj)
1	Price competition	89.80	0.105
2	Degree of project complexity	88.60	0.104
3	Time constrains of project	87.00	0.102
4	Project size	86.20	0.101
5	Client's financial capability	85.80	0.101
6	Client's experience in procurement methods	85.00	0.100
7	Availability of qualified personnel (procurement staff)	84.80	0.099
8	Risk avoidance/allocation	83.20	0.097
9	Project type and nature	82.00	0.096
10	Availability of procurement system in the local market	81.40	0.095
	Total	853.80	1

Table 3 Rationalized priority rating by respondents (Cj)

No.	Significant factor	Traditional				Design & build				Management				Public private partnership			
		a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>	a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>	a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>	a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>
1	Price competition	8	6	9	7.67	9	8	8	8.33	6	7	6	6.33	5	7	7	6.33
2	Project complexity	7	9	8	8.00	9	8	8	8.33	8	7	6	7.00	10	10	10	10.00
3	Time constrains	6	7	7	6.67	8	9	9	8.67	7	8	5	6.67	4	6	7	5.67
4	Project size	9	7	7	7.67	8	9	9	8.67	9	8	9	8.67	7	10	8	8.33
5	Client's financial capability	8	8	7	7.67	9	10	8	9.00	9	9	8	8.67	9	9	8	8.67
6	Client's experience	7	9	8	8.00	9	7	9	8.33	10	8	7	8.33	8	9	7	8.00
7	Availability of qualified personnel	7	8	9	8.00	8	7	8	7.67	7	9	9	8.33	6	4	5	5.00
8	Risk avoidance	7	7	8	7.33	9	9	10	9.33	8	10	8	8.67	4	6	7	5.67
9	Project type and nature	8	6	9	7.67	7	9	6	7.33	9	9	10	9.33	8	6	7	7.00
10	Availability of procurement system in the local market	9	8	10	9.00	8	8	7	7.67	8	7	6	7.00	7	9	7	7.67

Table 4 The average benchmark performance values (a<sub>ij aver.</sub>) of procurement methods (Case 1)

No.	Significant factor	C <sub>j</sub>	Traditional		Design & build		Management		Public private partnership	
			a <sub>ij</sub> aver.	Result (P <sub>i</sub> )	a <sub>ij</sub> aver.	Result (P <sub>i</sub> )	a <sub>ij</sub> aver.	Result (P <sub>i</sub> )	a <sub>ij</sub> aver.	Result (P <sub>i</sub> )
1	Price competition	0.105	7.67	0.81	8.33	0.87	6.33	0.66	6.33	0.66
2	Project complexity	0.104	8.00	0.83	8.33	0.87	7.00	0.73	10.00	1.04
3	Time constrains	0.102	6.67	0.68	8.67	0.88	6.67	0.68	5.67	0.58
4	Project size	0.101	7.67	0.77	8.67	0.88	8.67	0.88	8.33	0.84
5	Client's financial capability	0.101	7.67	0.77	9.00	0.91	8.67	0.88	8.67	0.88
6	Client's experience	0.100	8.00	0.80	8.33	0.83	8.33	0.83	8.00	0.80
7	Availability of qualified personnel	0.099	8.00	0.79	7.67	0.76	8.33	0.82	5.00	0.50
8	Risk avoidance	0.097	7.33	0.71	9.33	0.91	8.67	0.84	5.67	0.55
9	Project type and nature	0.096	7.67	0.74	7.33	0.70	9.33	0.90	7.00	0.67
10	Availability of procurement system in the local market	0.095	9.00	0.86	7.67	0.73	7.00	0.67	7.67	0.73
11	Total	1		7.76		8.34		7.88		7.25
12	Rank order			3		1		2		4

Table 5 The weighted sum model results for the selection appropriate procurement method (Case 1)

No.	Significant factor	Traditional				Design & build				Management				Public private partnership			
		a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>	a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>	a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>	a <sub>ij1</sub>	a <sub>ij2</sub>	a <sub>ij3</sub>	a <sub>ij aver.</sub>
1	Price competition	6	6	8	6.67	8	7	8	7.67	7	6	6	6.33	6	8	7	7.00
2	Project complexity	8	7	8	7.67	6	7	7	6.67	9	7	8	8.00	9	9	8	8.67
3	Time constrains	6	8	5	6.33	9	10	10	9.67	8	7	8	7.67	6	7	6	6.33
4	Project size	9	8	8	8.33	6	8	7	7.00	9	7	8	8.00	7	6	8	7.00
5	Client's financial capability	7	8	7	7.33	9	6	8	7.67	8	9	7	8.00	6	8	8	7.33
6	Client's experience	8	10	9	9.00	5	8	7	6.67	7	9	8	8.00	7	9	8	8.00
7	Availability of qualified personnel	9	9	7	8.33	7	7	8	7.33	8	8	10	8.67	8	7	6	7.00
8	Risk avoidance	7	8	8	7.67	9	8	8	8.33	8	7	8	7.67	8	7	8	7.67
9	Project type and nature	9	9	8	8.67	8	7	6	7.00	9	6	7	7.33	7	7	8	7.33
10	Availability of procurement system in the local market	10	8	9	9.00	7	5	6	6.00	8	8	7	7.67	8	7	6	7.00

Table 6 The average benchmark performance values (a<sub>ij aver.</sub>) of procurement methods (Case 2)



No.	Significant factor	C <sub>j</sub>	Traditional		Design & build		Management		Public private partnership	
			a <sub>ij</sub> aver.	Result (P <sub>i</sub> )	a <sub>ij</sub> aver.	Result (P <sub>i</sub> )	a <sub>ij</sub> aver.	Result (P <sub>i</sub> )	a <sub>ij</sub> aver.	Result (P <sub>i</sub> )
1	Price competition	0.105	6.67	0.70	7.67	0.81	6.33	0.66	7	0.74
2	Project complexity	0.104	7.67	0.80	6.67	0.69	8	0.83	8.67	0.90
3	Time constrains	0.102	6.33	0.65	9.67	0.99	7.67	0.78	6.33	0.65
4	Project size	0.101	8.33	0.84	7	0.71	8	0.81	7	0.71
5	Client's financial capability	0.101	7.33	0.74	7.67	0.77	8	0.81	7.33	0.74
6	Client's experience	0.100	9	0.90	6.67	0.67	8	0.80	8	0.80
7	Availability of qualified personnel	0.099	8.33	0.82	7.33	0.73	8.67	0.86	7	0.69
8	Risk avoidance	0.097	7.67	0.74	8.33	0.81	7.67	0.74	7.67	0.74
9	Project type and nature	0.096	8.67	0.83	7	0.67	7.33	0.70	7.33	0.70
10	Availability of procurement system in the local market	0.095	9	0.86	6	0.57	7.67	0.73	7	0.67
11	Total	1		7.88		7.41		7.73		7.34
12	Rank order			1		3		2		4

Table 7 The weighted sum model results for the selection appropriate procurement method (Case 2)

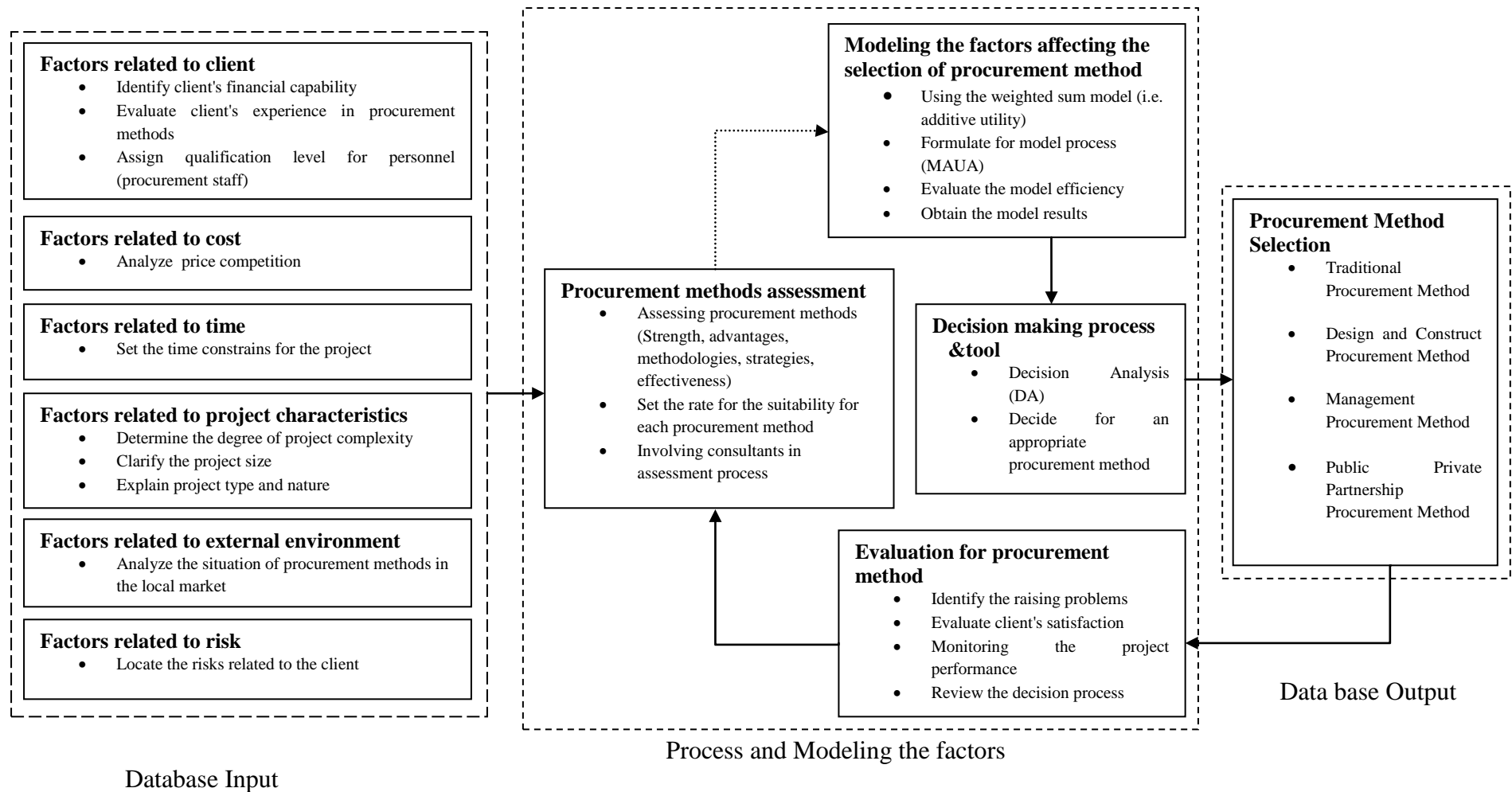


Figure 1: Framework for the selection of an appropriate procurement method