# Analysis and Development of Project Delivery Methods of Mega Projects in the Electricity Sector (GECOL)

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## Abstract

The selection of a project delivery method (PDM) can have a significant impact on the success of a construction project. However, to determine which the most appropriate project delivery method is not a straightforward process. The needs of the client and the characteristics of the project should be considered to be as important as the features of the project delivery methods options themselves in determining the effectiveness of the chosen procurement system to meet those needs and characteristics. There are a range of project delivery methods that available, such as the traditional Design-Bid-Build (DBB) process, Design-Build (DB) and Construction Management (CM). A number of projects owners in Libya, particularly governments, prefer some form of competitive bidding (typically the DBB method), and most of the time they insist on it. However, the use of non-traditional delivery methods are more applied in the construction projects for the last five years, and the method variations are becoming numerous. The General Electricity Company of Libya (GECOL) has many issues and problems arising up due to the wrong selection of project delivery method for implementing the design and the construction phase, such as: additional work required, change order, or claim, these issues have extended in: the schedule and budget of the project, and effect in quality. This Paper presents a Weight Factors Matrix Model (WFMM) as decision tool that used to help GECOL Project manager or the decision-makers in determining the appropriate project delivery method to implement GECOL construction project, during the applying of the weight factors matrix model, the result from paper has showed that the GECOL client prefers the Design-Build method as the most appropriate delivery method for implementing their projects.

**Keywords:** Mega Projects, Selection of Projects Delivery Methods, Traditional Design-Bid-Build (DBB) Process, Construction Management (CM), The General Electricity Company of Libya (GECOL).

# **1. Introduction**

The General Electric Company (GECOL) contracted with several international or local contractors for implementation of several projects in the electricity sector, in order to meet the growing demand for electricity in all regions of Libya, as well as to provide electrical power for infrastructure projects being implemented during these years. In addition, the General Electric Company contracted with some of consultant offices inside and outside Libya to supervise of these projects during the design and construction phases. There are many types of projects being implemented in the electricity sector such as are generation power plant projects, control projects, telecommunications projects and high voltage transmission projects. Etc, Based on the size and Budget, schedule, some of these projects can be considered as Megaprojects. Therefore, the General Electric Company requires choosing the appropriate Project Delivery method to implement their projects as first step of the project to ensure completion within a budget, on specified time and the required quality. This is in addition to reduce the risks during the design and construction phases, as well as minimize disputes between the parties of the project. [1]

In this study will be describe for the mega projects in the electricity sector in terms of identifying the type of these projects, its characteristics as well as the size and degree of complexity of these projects. Also it will evaluate and analysis the project delivery method that are used by the General Electric Company for the implementation of their projects. Also, a mechanism tool will be used to select the appropriate Project delivery method that to help the GECOL sector with the aim of completing the project on the budget and time.

# 2. Type of Project Delivery Methods

There is a multitude of various names for PDMs throughout the industry which are mainly hybrids or modified versions of these methods. The main reason for categorization of PDMs similar to every other categorization is to help better understand and then predict the behavior and characteristics of items in one category. Although different categorizations for PDMs are found in literature and this study follows the classification done by Construction Industry Institute (CII) and Associated General Contractors (AGC) in which there are essentially only three fundamental project delivery methods: DBB, DB, and CMR (CII 1997; AGC 2004). [2][3]

- 1- The Design-Bid-Build (DBB) method;
- 2- The Design-Build (DB) method; and
- 3- The Construction Management (CM) method.

#### 2.1Traditional Design-Bid-Build Method (DBB)

In the DBB project delivery method, the owner selects a design team to prepare design plans, technical specifications and construction bid documents. Bids are obtained from interested contractors who base their proposals on these prepared documents. [2][4]

That means, in the DBB project delivery method, the responsibility of a designer is to prepare complete construction document for the owner. The owner then receives bids from contractors based on the design documents and awards a construction contract to the lowest responsive, responsible bidder. The contractor builds the project, and upon completion, the owner assumes responsibility for the operations and maintenance of the project. The owner also provides all financing. Typically, in public organizations the proposal is in an open competition for a 'Lowest Responsive Price'. The DBB project delivery method places the owner at the center of the project parties as the result of separate contractual relationships with the design entity and the contractor. [3][4]

In this arrangement, the owner warrants to the contractor that the plans and specifications are buildable. If problems arise during the course of construction, or even after substantial completion, the owner becomes the intermediary between the contractor and design firm.

### 2.2 Design-Build Method (DB)

With the DB project delivery, owners are no longer in the center between the project parties. Under DB, the owner contracts with a single point of responsibility to provide both the design and construction services .Unlike the DBB scenario where the owner warrants the design to the contractor, the single point of responsibility now has responsibility for and warrants the design to the owner. In this situation, the owner will call upon the single point of responsibility to respond to and correct any design problem that may arise during construction, or following completion of the project. Design –Build gives design firms and contractors the opportunity to work as a team, and to deliver a quality on time and within budget. The Design – Build project delivery method can minimize many of the problems which often lead to claims in the DBB process.

### 2.3 Construction Management Method (CM).

This method is similar to the traditional DBB method except for a major addition that is the construction management company. In this method, the owner hires a construction management company at the start of the project. The construction management company assists the owner in selecting the design company, manages the design process and then assists in hiring the prime contractor and later manages the construction process. This method offers the advantages of professional construction input during the design phase which allows for constructability and value engineering studies. This method allows for more control on project cost, time, quality and safety. The main disadvantage is the lack of overall cost guarantee. [6]

Summarizing, a Construction Management is responsible to coordinate, organize, advise and manage the project. However, there are different levels of involvement between the construction manager and the project.

The management contractor is not in charge of the construction, they just have to manage the organization. The owner chooses this method because:

- 1- the project is very large scale;
- 2- the organization is complex. There are many tasks between different contractors to coordinate; and
- 3- the owner doesn't have the ability to manage the project organization.

## 3. Timing of Project Delivery Method.

In selecting a project delivery method, the owner should realize that the window of opportunity will pass for some as the project moves to various stages of development. Table (1) maps project delivery method selection decision against project development phase. It can be seen that selecting an alternative project delivery method should be done relatively early. Most of the benefits can be realized by engaging the constructor as soon as possible. The decision point for PDM selection should not be confused with the time that the constructor is engaged. As an example, an owner may decide to engage a DB contractor at the end of Preliminary Engineering or even later in order to clarify the scope and reduce the uncertainty. However, the owner should have decided on the type of delivery (for example DB) much earlier, so that the design documents can be properly developed considering the type of delivery method. []

PDM	At the End of Conceptual Design	At the End of Prelim. Eng.	At the End of Final Design	Construction
DBB	•	•	o	
CMR	•	0	o	
DB	•	•		
DBOM	•	•		
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Table 1: the Timing of PDM Selection

Desirable

• Feasible

### 4. Project Delivery Method Selection Models

Selecting a Project delivery method means choosing the best way or method to organize the design and construction process, and that is not always an easy or clear decision. Selecting the right project delivery method that meets specific project requirements is the question that usually faces any owner or client. The choice of a particular style of Project delivery method will depend on many factors. There are two major methods which the weighted factors matrix (WF) and Analytic Hierarchy Process (AHP). The owner can choose either the weighted factor matrix or AHP as a decision aid tool. In practice, all approaches to multicriteria decision making explicitly or implicitly use the concept of relative importance (weight) of criteria. These weights in multi-criteria decision tools express the difference in the level of importance of one criterion in comparison to the other criteria in the set of criteria. **[7]** 

### 5. Project Delivery Method Evaluation

To evaluate of the performance of the project delivery method for any completed project. This evaluation can be done through measure some metrics. One of the most metrics used for evaluating of project delivery methods are time and cost growth.

### 5.1. Cost Growth

The cost growth was defined as the difference between the cost at the completion of the project and the original budget, equation (1) shows how the cost growth is calculated. [8]

### Cost Growth (%) = [(final cost - initial budget) / initial budget]\*100 (1)

Three possible analyses can be derived from using this equation:

- 1- total change in cost, as mentioned above(note that cost analyses will refer to changes in the total cost of the projects unless indicated otherwise),
- 2- change in cost in the design phase—cost at 100% design minus cost at 0% design,
- 3- and change in cost in the construction phase—cost at 100% construction minus cost at 0% construction.

#### 5.2. Schedule Growth

The schedule Growth is defined as the difference between the time used to complete the whole project and the estimated time to complete the project. Equation (2) shows how the Schedule growth is calculated. [8]

#### Schedule Growth %= [(total time used-initial estimated time)/initial estimated time]\* 100 (2)

Three different types of analyses applied to the cost change equation also applied to changes in schedule

# 6. GECOL's Projects Classification

According to the size and degree of complexity of Projects, the GECOL's projects are classified into two types, the small size projects and large or megaprojects. This section illustrates the main features, characteristics and application of these types in the GECOL sector.[9]

### **6.1 Small Size Projects**

The Small Size Project is defined as the project which has a budget less than 0.5 Million LYD and need limited resources. This project has a contract's name is Called Task Order. These types of Projects usually used by GECOL for implementation the distribution projects (substation 0.4 and 11 kV) which have less complexity, and low budget required.

### **6.2 Strategies Projects**

Strategy or large Size project defines as the project which has a budget is more than 0.5 Million LYD, and need more resources. The Large Size Projects are used by GECOL for implementation the Generation and transmission projects which are more complexity, large budget, and more resources required. For these reasons these projects usually use a Limited Tender, i.e. it required a specified Contractor for its implementation.

#### 6.3 Definition of Mega or Strategy Project in GECOL Sector

The definition of Megaproject depended on some criteria such as the size and complexity, amount of budget, resource and the environment of the project. However, The researchers during the life of work has conducted an interview with a number of project managers to reach a common definition for Strategy or megaproject in GECOL sector. The researchers summarized the definition of mega project in the final conclusion as "the project which has a budget is more than 60 Million LYD, execution time from one year to five years, and it is financed from the Government.

#### 6.4 The Existing Project Delivery Methods.

Continuous changes in technology and the increasing complexity and development in facilities introduced innovations in project delivery methods. Therefore GECOL policy is planned to develop the project delivery methods to complete the projects within budget, on Time and according the required specification. So there are several variations of project delivery methods are used in GECOL construction industry which are:

- 1- Design-Bid –Build Single Primer Contractor;
- 2- Design -Build Contractor or EPC contractor; and
- 3- Design-Bid –Build Multiple Primer Contractors.

Table (2) presents results of data that collected about the current project delivery methods used in GECOL from a sample of 67 construction projects issued between 2000 and 2010.

Project Delivery Methods	Frequency	Percentage
Design- Bid- Build Single	40	56.7
Design - Build	12	16.4
Design-Bid-Build Multiply	15	20.9
Total	67	100

 Table 2: Project Delivery Method

According to the Table (2); three primary methods that are used in GECOL to design and build infrastructure projects, where the DBB-S method is (56.7 per cent) of projects, the second most common method is design –bid –build multiply contractors (21 per cent) methods and the design – build .(16.4 per cent).

#### 6.4.1 Evaluate of the Design- Bid- Build Method

To evaluate the Design-Bid-Build method which has used for implementation of the megaprojects in the GECOL; the 14 projects are identified, which have the actual progress is greater than 90%. To measure the performance of The Design-Bid- build method for 14 projects. The Cost and Schedule Growth are calculated using the equations 1 and 2. The result

of theses calculation is presented in Table (3). From the Table (3); it can be seen that, on average, there is about 15.33% increment over the initially estimated cost, and about 16% to 108 % time overrun. There are cases in which the cost actually incurred is same the originally estimated cost, but the time overrun is 17 % (projects no 12, 13, 14) and also there is a case in which the time actually incurred is same the originally estimated time, but the cost overrun is 15 % (project no 9)

S.N	Project name	Cost Difference	Cost Growth	Time Difference	Time Growth
1	Supply and install (2) substations 220kv	7,940,414.70	15	12	30
2	Supply and installation of 2 substations 220 kv	13,056,253.00	15	26	108
3	Supply and installation of 500km Transmission line 4000kv	16,419,326.00	15	18	60
4	Supply and installation of 250 km Transmission line 4000kv	15,136,318.00	15	25	83.33
5	Upgrading for (4) substation 220 KV	12,704,003.40	15	8	26.67
6	Installation of (8) substations 220 KV	18,894,300.00	15	5	22.73
7	Supply and installation of 720 km Transmission line 4000kv	39,391,013.00	15	16	44.44
8	Supply and install (10) substations 220kv	32,517,754.00	15	6	18.18
9	Upgrading for (3) Gas Power Plants	22,162,818.50	15	0	0
10	Upgrading for Gas Power Plants	35,978,247.10	15	6	33.33
11	Extension of Gas Power Plant west mounted	32,205,079.80	15	3	16.67
12	Supply and install (12) substations 33-11 kv	0	0	6	16.67
13	Supply and install (49) substations 33-11 kv	0	0	12	33.33
14	Develop of Tripoli distribution network	0	0	6	16.67

Table 3: Percentage of Cost and Time overrun in each Projects

Based on resulted data gathered from Table (3), and refer to review monthly reports of for some of projects which use the Design-Bid-Build Method, The problems associated with the traditional approach of delivering projects as pointed out by some project managers are:

1- Scope of the project is changed very often due to lack of design document, this issue is exist in transmission line Projects;

- 2- no real competition during contractors selection since contract awards are based on price; and
- 3- Procurement procedures are slow.

### 6.4.2 Evaluate of the Design- Build Method

To evaluate the Design-Build method which has used for implementation of the megaprojects in the GECOL; the 11 projects are identified, which have the actual progress is greater than 90%. To measure the performance of the Design-Build method for 11 projects which have mentioned in Table (4); the Cost and Schedule for Growth are calculated using the equations 1. The result of theses calculation is presented in Table (4). From the Table (4); it can be seen that, on average, there is about 15.33% to 43.3% increment over the initially estimated cost and about 11% to 42.86 % time overrun.

S.N	Project name	Cost Difference	Cost Growth	Time Difference	Time Growth
1	Procurement and installation (EPC) for (2) Substations 400 KV	19,852,624.00	43.3	9	37.5
2	Procurement and installation (EPC) for (4) Substation 400 KV	40,497,245.00	15	4	11.11
3	Procurement and installation (EPC) for (3) Substation 400 KV	28,757,481.00	15	8	27.59
4	National Control Central Project	14,000,000.00	14	18	42.86
5	Procurement and installation (EPC) for Power plant Combine Cycle (North Benghazi.	49,000,861.00	14.2	5	11.9
6	Procurement and installation (EPC) for Gas Power plant (Raweys)	38,037,561.70	14.1	4	11.11
7	Procurement and installation (EPC) for Power plant Combine Cycle (Zawia).	46,544,374.60	15.1	7	16.67
8	Procurement and installation (EPC) for Power plant Combine Cycle (Misurata).	135,925,183.90	24.8	6	14.29
9	Procurement and installation (EPC) for Power plant Combine Cycle (Benghazi).	118,191,854.00	24.8	7	16.28
10	Procurement and installation (EPC) for Gas Power plant (Sarrer)	96,482,107.70	15	4	11.11
11	Procurement and installation (EPC) for Gas Power plant (zawetaina)	36,245,949.00	15	3	12.5

Table 4: Percentage of Cost and Time overrun in each Projects

Based on resulted gathered from Table 4, and refer to review monthly reports of for some of projects which use the Design-Build Method. The problems associated with the Design-Build approach of delivering projects as pointed out by some project managers are:

- 1- lack of latest design requirements;
- 2- absence of latest construction technologies;
- 3- scope of the project is changed very often due to lack of design document, this issue cause change order request; and
- 4- procurement procedures are slow due the delay of Open L/C.

# 7. Development of PDS Selection Model for GECOL Projects

The development of PDS Selection Model for GECOL Projects was carried out in two phases. The first phase is a pilot study, through a literature review is developed to identify a list containing 15 selection factors that influencing in the selection of a project delivery method, while in the second Phase two questionnaires survey and interviews are conducted among GECOL's Engineers to evaluate the major selection factors influence in project delivery method selection.

# 7.1 Identifying the Selection Factors

A comprehensive literature was conducted for identifying major selection factors influencing in the selection of a project delivery method. Those factors can be a direct effect on the success or failure of a project and on the decision that determines which Project delivery method. These main factors have defined from the comprehensive literature survey are:-

1) on Schedule	2) Cost	3) Flexibili	ty	4) Project Scope
5) Size of Project and	Complexity	6) Quality	Level	7) Risk Allocation
8) Price Competition	9) Dis	sputes	10) F	Responsibility
11) Project Manageme	ent Resource	12) Nu	mber of	Contract
13) Contract Type	14) Fundi	ng Cycle		15) Political Issues

### 7.2 Rank of Factors Using Average Mean of Factor

Based on list of selection factors, a structured questionnaire survey round (1) was conducted for the ranking and evaluating of 15 selection criteria. The average mean value for factor was used to achieve an overall ranking of the selection factors. Table (5) above illustrates owner organizations' rank order of selection factors for project delivery selection. it rank in order of importance, these factor are Level of quality, cost Certainty, Complexity, on schedule, flexibility, responsibility, disputes, availability of funding, risk avoid, project management resources, contract type, issues political, project scope, number of contract, and price competition.

Success Factor	Mean	Ranking
Level Of Quality	4.7407	1
Within Budget	4.3333	2
Size & Complexity	4.3333	3
On Schedule	4.3148	4
Flexibility	4.2963	5
Responsibility	4.2407	6
Disputes	4.1481	7
Availability of Funding	4.037	8
Risk Avoid	3.9259	9
Project management by the owner	3.9074	10
Contractor experience	3.8148	11
Issues Political	3.7963	12
Project Scope	3.7222	13
Single Construction Contract	3.6852	14
Price competition	2.333	15

Table 5: Rank of Factors Using Average Mean of Factor

# 7.3 Weight the top 7 Selection Factors

The Rank order centroid method (ROC) is used for weighting the top 7 selection factor as a second step to develop the weight factors matrix. The result of Rank order centroid method (ROC) has been tabulated as shown in the Table (6). From this Table; it's concluded the weight mean for the quality level factor is extremely high weight (w = 37.04%) compared to other factors, followed by within budget factor which was weighted (w = 22.75%), the most third factors was recorded Complexity (w = 15.6%), and On Schedule factor with (w = 10.8%), followed by Flexibility with (w=7.27%), the Responsibility rated as (4.42)%.The participations have selected disputes as less important factor of the GECOL projects, it is weighted (w = 2.04%.).

Factor	Weight	Rank
Level Of Quality	37.04%	1
Cost	22.75%	2
Size and Complexity	15.60%	3
On Schedule	10.80%	4
Flexibility	7.27%	5
Responsibility	4.42%	6
Disputes	2.04%	7

Table 6: Result of Weighting of selection factors using ROC method

# 7.4 Score of Project Delivery Methods

Based on Table (6), a structured questionnaire survey round (2) was conducted to score the top 7 significant factors influencing in the selection of a project delivery method. The respondents asked to give a score from 1 to 5, the score is a value to indicate the degree of suitability of each project delivery method against each selection factors, where 1 represented 'strongly disagree', 2 'disagree', 3 'moderately agree', 4 'agree' and 5 'strongly agree'. A total of 55 questionnaire sets are distributed and 47 responses are received which formed 82.22% of responses. Statistical Package for Social Science (SPSS) version 16 is used to analyze the data. Results are presented in Table 6-14 and the following analyzed the data as the following

#### 7.4.1 . Scoring the DBB.S method against Selection Factors

The first part of structured questionnaire survey round (2) was` conducted to give a score for Design-Bid-Build Single Contractor (DBB.S) method against each selection factor, this value of the score indicates the degree of suitability of Design-Bid-Build Single Contractor DBB-S method project delivery method against each selection factor.

Item	Selection Factors	Mean
1	Within Budget	3.6770
2	On Schedule	2.7660
3	Quality	3.8940
4	Complexity of the project	2.2980
5	Disputes	2.9570
6	Flexibility	2.1490
7	Responsibility	3.8090

**Table 7:** Scoring the DBB.S method against Selection Factors

Table (7) summarizes the results of the questionnaire survey round (2) for indication o the degree of suitability of DBBS against each of selection factor. To test which factors can be achieved by using DBB-S method, the researchers select the selection factors with average mean is higher than 3(Cut off value), it was resulted that GECOL's engineers are agree that DBB-S Method is more Suitable for achieving the cost (m = 3.8936), quality(m=3.8511), and Responsibility (m=3.8298). While they don't agree about the factors schedule, complexity, disputes and flexibility, that why their average mean is ranked to the lowest of the cut off. Therefore The GECOL's participations consider the selection factors Schedule, Cost, Quality level, and Responsibility are the most selection factors when DBB.S is selected to implement the GECOL's project.

#### 7.4.2 . Analysis of Selection Factor Related to DBB.M Method

The second part of structured questionnaire survey round (2) is conducted to enter a score for DBB.M method, the value of score to indicate the degree of suitability of DBB.M method project delivery method against each selection factor.

Item	Selection Factors	Mean
1	Within Budget	3.6770
2	On Schedule	2.7660
3	Quality	3.8940
4	Complexity of the project	2.2980
5	Disputes	2.9570
6	Flexibility	2.1490
7	Responsibility	3.8090

**Table 8**: Analysis of Selection Factor Related to DBB.M Method.

Table (8) summarizes the results of the questionnaire survey round (2) for indication o the degree of suitability of DBB-M against each of selection factor. To test which factors can be achieved by using DBB-M method, the researchers has selects the selection factors with average mean is higher than 3 (Cut off value), it was resulted that GECOL's engineers are agree that DBB-M Method is more Suitable for achieving the cost (m=4.0213), quality (m=3.8936), Complexity (m=3.8511), and On Schedule (m=3.7872). While they don't agree about the factors disputes, flexibility and responsibility, that why their average mean is ranked to the lowest of the cut off. Therefore The GECOL's participations consider the selection factors when DBB.M is selected to implement the GECOL's project.

#### 7.4.3. Analysis of Selection Factor Related to DB Method

The Third part of structured questionnaire survey round (2) is conducted to enter a score for DB method, the value of score to indicate the degree of suitability of DB method project delivery method against each selection factor.

Item	Selection Factors	Mean
1	Within Budget	3.6770
2	On Schedule	2.7660
3	Quality	3.8940
4	Complexity of the project	2.2980
5	Disputes	2.9570
6	Flexibility	2.1490
7	Responsibility	3.8090

Table 9: Analysis of Selection Factor Related to DB Method

Table (9) summarizes the results of the questionnaire survey round (2) for indication o the degree of suitability of DB against each of selection factor. To test which factors can be achieved by using DB method, the researchers has selected the selection factors with average mean is higher than 3 (Cut off value), it was resulted that GECOL's engineers are agree, that DB Method is more Suitable for achieving the budget (m = 3.8936), quality(m=4.1702) Complexity (m=4.0426), and On Schedule (m=4.0638). While they don't agree about the

factor responsibility, that why its average mean is ranked to the lowest of the cut off value. Therefore the GECOL's participations consider the selection factors Cost, Quality level, and size and complexity are the most selection factors when DB is selected to implement the GECOL's project.

# 7.5 Create The Appropriator Project Delivery Method

Based on the result that have collected from the questionnaire survey round (2), the choosing the appropriate delivery method is simply a matter of reviewing the total scores and making the project delivery decision. The most appropriate delivery method was calculated through the completion of a weighted decision matrix, the choosing the appropriate delivery method is calculated by multiplying the selection factor weights by the project delivery scores and then summing the values for each delivery method, the results of this calculation are presented in Table (10). Table (10) shows how an owner might score the project delivery methods for the GECOL project. As can be seen in Table 6.34, the total points were 3.359, 3.716, and 3.962, for DBB-S, DBB-M, and DB, respectively. Since the maximum number of points was assigned to DB, the model would recommend the selection of this method, based on owner needs and project requirements.

	Factor Weight	Project Delivery Method					
Selection		DBB		DBB Multi		DB (Trunkey)	
Factor		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Quality	37.00%	3.8511	1.424907	3.8936	1.440632	4.1702	1.542974
Cost	22.70%	3.8936	0.8838472	4.0213	0.912835	3.8936	0.8838472
Complextiy	15.60%	2.383	0.371748	3.8511	0.600772	4.0426	0.6306456
Schedule	10.80%	2.6383	0.2849364	3.7872	0.409018	4.0638	0.4388904
Flexibility	7.30%	2.2128	0.1615344	2.4468	0.178616	3.8723	0.2826779
Responsibility	4.40%	3.8298	0.1685112	2.5745	0.113278	2.2979	0.1011076
Disputes	2.20%	2.9149	0.0641278	2.766	0.060852	3.7234	0.0819148
Total Weighted Score			3.359612		3.716003		3.9620575
Priority of PDM			3		2		1

Table 10: Create the Appropriator Project Delivery Method.

Note that only the DB project delivery method was recorded high value. Also note that the scores are project dependent and will certainly change from project to project.

## 8. Conclusions.

From the work done in this study and as a result of the field survey on GECOL construction projects (by using questionnaire list) and then from evaluating the proposal PDM model for selecting the best PDM, the following points have been identified as the overall conclusions of the study, these conclusions are :

1) Based on literature review, the study has concluded a total of 15 factors that influence in selection of Project delivery methods, and the result of questionnaire has showed that the following factors are the most important factors for selecting the appropriate project delivery method, these factors are: On schedule, Cost, Quality Level, Size and Complexity, Responsibility, Flexibility, and Disputes.

2) There are three project delivery methods are used for implementing of GECOL's mega projects, these are: Design-Bid-Build single contractor (DBB-S), Design-Bid-Build multiply contractors (DBB-M), and Design-Build (DB). The Design-Bid-Build single contractor and Design-Build are represented the most methods used by GECOL to implement their Projects. Also two primary contracts form are used by GECOL, these are: Unit price contract, and fixed price contract.

3) The result of the average mean calculation for measuring the suitability of Design–Bid– Build single contractor (DBB.S) method against each factor has showed that the DBB-S is a suitable for achieving of cost, quality), while the DBB-S isn't suitable for achieving the factor of time, flexibility, disputes, and responsibility.

4) The result of the average mean calculation for measuring the suitability of Design - Bid - Build multiply contractors (DBB.M) method against each factor has showed that the DBB.M is a suitable for achieving these factors cost, quality, Complexity, and on schedule, while the DBB.M isn't suitable for achieving these factor disputes, flexibility, and Complexity.

5) The result of the average mean calculation for measuring the suitability of Design-Build (DB) method against each factor has showed that, the DB is a suitable for achieving these factors cost, quality, on schedule, complexity disputes, and flexibility, while the DB isn't suitable for achieving this factor responsibility.

6)The result of Applying weighted factors matrix model (WF) is that the GECOL client has selected the Design-Build method as the most appropriate delivery method for implementing their Mega projects.

# RERERENCES

1) Ali. E. Alebarkos, Analysis and Development of Project Delivery Methods Of Mega Projects

in the Electricity Sector (GECOL), Libyan Academy of Post Graduate Studies, Libya, 2012.

2) Lema Mosissa, Alternative Project Delivery Methods for Public Constructions: Cases in Oromia Region, Addis Ababa University, September 2006.

3) L. Gray Ohrn and Thomas Rogers, Defining Project Delivery Methods for Design, Construction, and Other Construction-Related Services in the United States, Northern Arizona University, Flagstaff, Arizona, 2007.

4) Medhat Abd-elrahman Youssef Lashin, Engineering contracts, Libyan Academy of Post Graduate Studies, Libya, 2011.

5) Dhaifallah A. Almazroa, project delivery system decision framework using the weighting factors and analytic hierarchy process, University of Pittsburgh, 2003.

6) Sameh Monir El-Sayegh, Significant Factors Affecting the Selection of the Approporiate Project Delivery Method, American University of Sharjah, United Arab Emirates, 2007.

7) Ali. Touran and Douglas D. Gransberg, A Guidebook for the Evaluation of Project Delivery Methods, Transit Cooperative research program, USA, 2009.

8) Project Management definition research www.123.com

9) GECOL, Processes for contracts& Projects in GECOL, Contract department, 2007.

10)S.Thomas Ng, Decision Criteria their subjectivity in construction procurement selection, University of Hong Kong, 2000.

11) Maizon Hashim1, Melissa Chan Yuet Li, Ng Chu Yin, Ng Sock Hooi, Shim Mong Heng and Tay Lee Yong, Factors Influencing the selection of Procurement systems by Clients, Faculty of Built Environment, Universiti Teknologi Malaysia, Malaysia, 2006.