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Applying Fuzzy Multi-Criteria Decision Making and Different Techniques to Solve Multi Objective Project Planning

Abstract- *For achieving successful projects, effective planning and scheduling should be taken into consideration besides reaching an accepted balance among project objectives. As a result, this research focuses on attaining an effective balancing among a set of objectives that are time, cost, and number of laborers. The purpose of this research is to solve the problem of multi-objective project using multi-technique in a best possible way that accommodate with the nature of project activities. This aim is achieved by facilitating the accuracy of decision taking throughout choosing the best technique among group of techniques used in project planning and control these are; Gantt chart, crashing technique. These techniques are utilized to achieve many objectives. A new mixed approach named as Concurrency-Partitioning and Crashing Techniques (CPCT) has been suggested. In order to overcome the conflicting that might occurs among these objectives, Fuzzy Decision Support System (FDSS) is employed based on fuzzy Multi-Criteria Decision Making method (fuzzy MCDM). The results showed that mixed approach (CPCT) was the best one that achieved multi-objective with best balancing. Both of project time and cost have decreased by 19.5% and 2.6% respectively, while the total number of laborers had increased by 8.8%.*

Keywords- *project planning, multi-objective, multi-technique, Fuzzy Decision Support System (FDSS), Multi-Criteria Decision Making method.*

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1. Introduction

Today, most of the companies suffer the problem of planning and control inherent in some of the large projects. Weakness in effective utilization related to the availability of different techniques and tools (multi-technique) is one of the most related factors. Additionally, the difficulty in efficient management and coordination among various project objectives (multi-objective) leads to uncertainty/fuzzy in selection of the best result which in turn leads to increase the waste of time, cost, and resources. There are many planning and scheduling techniques besides representation tools, below is a brief description of some of them:

- *Gantt chart:* is the method that used to show progression of the project graphically. Project management could be performed simply if it is observed as small manageable entities where the dependencies are visibly cleared, parallel processes are declared, project progression could be tracking and total processing durations are determined [1].
- *Critical Path Method/Program Evaluation and Review Technique (CPM/PERT):*are the most of important planning tools which are used to help project manager in the process of evolving a realistic schedule as well to monitor project progression. The two tools are closely related to each other [2].
- *Crashing technique: is* considered a particular part of compression techniques used in scheduling problems. This technique includes decreasing the total duration of project scheduling related to any activity or activities after taking number of alternatives in order to analyze them to determine a way of getting maximum duration compression of schedule for the minimum added cost. Reduction in the duration of schedule activity and increase the resources assignment are some of the approaches used for crashing a project schedule [3].
- *Concurrent engineering: is* a systematic method combines the primary ideas of a project which is applied in research, development, design, production, marketing, distribution, and sales. This method produces more effective and shorter design cycle while keeping product reliability and improves its quality through compression the schedule to permit simultaneous or overlap performing of many activities [4].
- *Overtime Work or Multiple Shifts Methods*

Shift work can be defined as the working hours of groups of workers and individuals whose begin

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working on a project whenever the first groups of workers for the same activity stop their jobs for the day [5]. A decision has to be made by contractors when it is important to compress a schedule. This decision is employed to select a method that speeds up the schedule while reducing the effect of cost on the project. Hence, a number of methods could be utilized for doing this. For example, increasing the on-site workers is the first responsible of a contractor to schedule compression [6]. A number of studies specify that the most usual way for raising the number of on-site workers involves either forcing more workers, increasing working-hours, or performing more than one shift [7].

2. Fuzzy Decision Support System and Multi-Criteria Decision Making

Project management usually suffers from the problem of alignment between the objectives to be achieved for any project, which leads to difficulty in providing a decision to the decision-makers during planning, scheduling and control processes of projects. To solve optimization problems with multi-objective function, Fuzzy Multi-Criteria Decision-Making (Fuzzy MCDM) is considered to deal with such problems [8,9]. The evaluation of a number of possible solutions (also called feasible solutions) in order to find the optimum one is called decision-making. The problems MCDM are usually used to define decision-making problems that deal with multiple criteria (objectives) of different effects [10,11]. For solving real-world problems, many studies have presented a system supports fuzzy decision (FDSS) to be used as tool for MCDM. These studies have implemented the FDSS in a well-manner for various application areas that include uncertainty and ambiguity conditions. In addition, these studies have completely employed the ability found in fuzzy logic toolbox within MATLAB software to create a computerized system that supports problem-solving and complex decision making [12].

3. MCDM hierarchy

MCDM has the capability of solving decision and planning problems that include more than one objective.
A hierarchical structure is used to describe MCDM involving four levels:

- Defining the problem of research and identifying its goal.
- Determining the criteria and sub-criteria used in accomplishing the goal.
- Identifying the decision alternatives.
- In order to form a structural hierarchy, the problem objective is put at the top level, the criteria and sub-criteria in the middle and the decision alternatives at the bottom level.

The entire hierarchy of the MCDM problem is shown in Figure 1 [13,14]. After establishing the hierarchy structure, a table used for decision is created in which the criteria are specified by the columns; while the alternatives are specified by the rows. Each cell in this table represents the intersection between a column and a row; in which, the value defines the estimation of the alternative for one objective. the normalization is required because of different range of these values; that means the values for each column must be normalized to be ranged within 0 and 1 corresponding to potential assumption, and according to the equation 1 [13].

$$\boldsymbol{N_{i,0\ to\ 1}} = \frac{x_{max} - x_i}{x_{max} - x_{min}} \quad (1)$$

Where N_i the normalized objective value for the corresponding alternative; x_i represents the value of the objective; x_{min} and x_{max} represent the smallest and the largest value of x_i respectively [16,17].

4. Structure of FDSS System

Generally, four parts are used to define a FDSS including fuzzification, decision rules, knowledge base, and defuzzifcation as illustrated in Figure 2.

I. Fuzzification

Is defined as the process of converting the real-world variables into set of linguistic variables using the membership functions corresponding to the input variables [19,20]. Various formats of fuzzy numbers, also called fuzzy membership functions, are available where each decision-makers decide to use the appropriate formats for the corresponding problems depending upon the historical information or their experiences. Some of these formats are triangular fuzzy number and trapezoidal fuzzy number shown in Figure 3 [21].

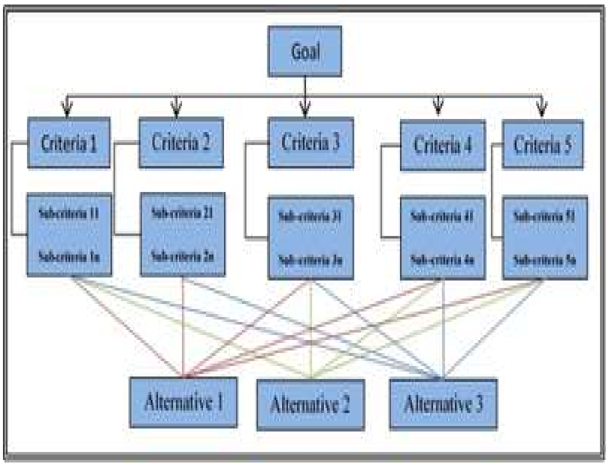

Figure 1: Hierarchy of the MCDM

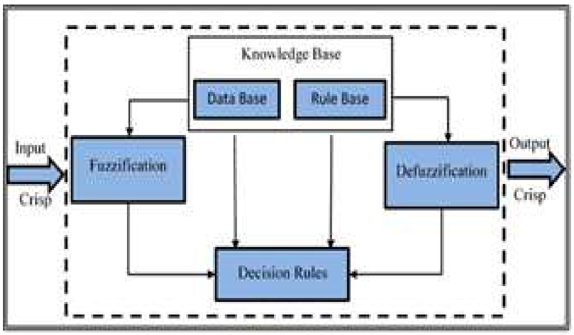

Figure 2: The architecture of the FDSS

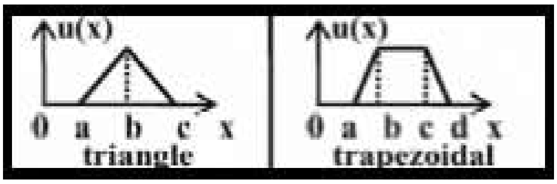

Figure3: Fuzzy Numbers Formats

II. Decision Rule

It is the most essential part in FDSS. This part employs the expert knowledge in order to transform the values of fuzzy input into fuzzy output. IF-THEN fuzzy rules' format is used to express this knowledge. The number of required fuzzy rules is determined by the number of input variables and their related linguistic value. Following is the general format of the fuzzy decision rule:

$Rule\ i$ = IF $X1$ $is\ A1i\ and\ \ldots\ an$ $Xn\ is\ Ani$ THEN Y is Bi, i = 1, 2 (2)

Where:

$X = (X1, X2, \ldots, Xn)$ is the input variables of the fuzzy system, Y is the output linguistic fuzzy variables of the fuzzy system, $A = (A1, A2, \ldots, An)$ and B are fuzzy sets in a predetermined universe of discourse, and M is the number of fuzzy rules [22,23].

III. Knowledge Base

The essential information used by fuzzification process, the decision rules, and defuzzification process are included in the knowledge base and can be summarized as follows:

1) Information related with the fuzzy rule base as defined by the expert knowledge.

2) Information related with specifying the construction of the fuzzy membership functions needed to implement fuzzification and defuzzification processes. For instance, the triangular fuzzy number is determined by three point's $l \le m \le n$, where l, m and n are the lowest probable value, the most probable value, and the highest probable value consecutively. Hence, the triangular fuzzy number can be defined by its continuous membership function $\mu\tilde{A}(x) : X \rightarrow [0, 1]$ as follows [24] [25]:

$$\mu\tilde{A}(x) = \begin{cases} \frac{(x-l)}{m-l}, & l \le x \le m \\ \frac{n-x}{n-m}, & m \le x \le n \\ 0, & \text{otherwise} \end{cases}$$

(3)

The trapezoidal fuzzy numbers can be described by four points $l \le m \le n \le P$. Hence, it can be represented by its continuous membership function $\mu\tilde{A}(x) : X \rightarrow [0, 1]$ as follows [26]:

$$\mu\tilde{A}(x) = \begin{cases} \frac{x-l}{m-l}, & l \le x \le m \\ 1, & m \le x \le n \\ \frac{p-x}{p-n}, & n < x \le p \\ 0, & otherwise \end{cases}$$

(4)

IV. Defuzzification

It is the process of transforming a set of fuzzy values into a crisp value. This process can be implemented by the membership functions corresponding to the output variables. Figure 4 illustrates some of the popular methods used for defuzzification [16]. For Centroid of area (COA), the crisp output XCOA for a given membership function $\mu\tilde{A}(x)$ is calculated as the following formula [22]:

$$x_{\text{COA}} = \frac{\int \mu\tilde{A}(x)x\,dx}{\int \mu\tilde{A}(x)\,dx} \qquad (5)$$

5. Literature Survey

Following are some of the most recent studies that are conducted with project management planning and control field as well as the most recent studies that are specialized in obtaining the optimal solution out of a set of available solutions by the means of optimization techniques. Liang [27] has proposed an approach to solve decision problems of multi-objective project management under fuzzy environments, including two phases of fuzzy mathematical programming known as TPFGP. Minimizing the total project costs, total accomplishment duration and total crashing costs relative to the indirect costs, direct costs, penalty costs, activities' duration and budget limitations were the goals of designing the suggested model. The results have shown that reducing accomplishment duration by varying project duration might conflict with reducing of both of total project costs and crashing costs, in addition, the study has suggested employment of additional resources to reduce project accomplishment duration. Singh et al. [28]: have aimed to minimize project cost through introducing a technique known as (Unit Crashing). The adopted technique has used a repeated method to crash the total critical activities by a specified amount, hence, reducing total project cost. The study had usefulness in cases where cost was important consideration. Chung [29] has suggested a model by utilizing a method of fuzzy multi-objective linear programming (FMOLP) for managing the problem of conflicting that might occurs among project goals and help in finding a suitable decision for such problems. The proposed model has taken into consideration the minimization of total project cost and crashing cost with regard to pertinent constraints, indirect and direct cost. The study has considered the uncertain conditions of input data. Sahu and Sahu [30] have presented time management, with optimum cost by means of crashing. An alternative approach has been given in order to get optimal cost and time in addition to minimum duration for the project with totally crashing in the critical path. The proposed method has been performed by directly minimizing the critical slope value hence minimizing the duration of the project. The results of this study have given such a preferable crashing values in addition to manage the time effectively. Al Hazza et al. [31]: have employed fuzzy logic method in construction projects in order to create aconceptual structure depicts the relationship between the contractor and project owner, and to analyze a control system of time–cost tradeoff. The used method had found that the widely effected factors were quality and risk assessment with some potential tradeoff between project time and cost.

6. Proposed Model

For the purpose of finding suitable planning and scheduling approaches that help projects' managers in achieving predetermined projects' objectives, a proposed model is introduced "multi-objective project planning and control based on multi-technique reinforced by a system supports decision making through utilizing fuzzy multi-criteria decision making (fuzzy MCDM) method" named as (MOMT-FDSS). This model aims to solve the problem of conflicted objectives with the best possible solution to reach optimization and are described in three modules; the first module includes assigning multiple project planning and control techniques in which; mixing between two techniques is suggested that are Concurrency-Partitioning and Crashing Techniques (CPCT) for obtaining the desired project objectives , the second module, includes solving multi-technique optimization problem using fuzzy multi-criteria decision making (fuzzy MCDM); the last module represents the analysis of the outcome results. These modules are described in details as demonstrated in Figure 5.

I. Stage 1: Defining Planning and Scheduling Inputs

At this stage, the required data for the problem are defined, which are: Number of activities (N); Activity symbol (A_i, where i = (1,2, 3, …., N); Activity Duration (D_i); Activity Precedencies (APi); Activity Cost (AC_i); Material Cost (MC_i); Indirect Cost per day ($IC_{/d}$); Direct Cost per day (DC/d); Laborer wage per day (LW/d); Equipment Rent per day (ER/d); Estimated project budget(EC); Project Duration (PD); Number of Laborers per activity: engineer, technical, skilled, unskilled (LN); Number of Working Days for laborers or equipment related to job's type (WD); Daily working hours per shift (Dh/S); Total Project Time (T); Total Project Cost (C); Total Number of Laborers (TL).

II. Stage 2: Identifying Project Planning and Control Objectives

In general, each project aims to achieve one or more objectives such as time, cost, quality, performance, and resources.

III. Stage 3: Inputs Representation Using Gantt Chart and CPM Network

In this stage, project activities are represented using Gantt Chart and CPM according to the steps shown in Figure 6. The following abbreviations could be defined as follows:
Type of job (j); Total Laborer Wage (TWj); Sum of Laborers Wage (SWj); Total Equipment Cost (TE); Number of Equipment (EN); Sum of Equipment Cost (SC); Normal Laborers and Equipment Cost (LECn); where LECn = SWj + SC; Indirect activity Cost (IC); Direct and Indirect Activity Cost (DIi); Total Project Cost

(TC); Total Number of Laborers for CPM (TLCPM).

IV. Stage 4: Applying Multi-Technique as Decision Alternatives

According to the predefined objectives that can be achieved through project planning and control, planning and scheduling techniques are adopted as decision alternatives for avoiding conflicting results. In the proposed model, some of the following techniques are applied:

1) Crashing Technique

The main steps of crashing technique can be described as shown in Figure 7.

The following abbreviations could be defined as follows :

Normal Time (NT); Crashing Time (CT); Normal Cost (NC); Crashing Cost (CC); Cost Slope (CS); Indirect Project Cost (IPC); Project Duration (PD); Project Direct Cost (DC); Crashing Cost Slope (Ccslop); Crashing Cost Slope Cumulative (CCp); ΔT of The New Activity (ΔTn); CS of The New Activity (CSn); Number of Labor added for each activity (TLa); Number of Equipment added for each activity (TEa); Number of Labor after crashing (TL crashed); Laborers and Equipment Crashed Cost (LECc); where LECc = SWj + SC.

2) Concurrency Technique with Partitioning (CP)

This technique is applied in project planning process with the aid of Gantt chart; where the total planning and execution concurrently some of project activities after partitioning some of them, if they, need without affecting the rest of the activities in terms of their precedencies and execution time. These activities are also executed within their defined time. Figure 8 describes the main steps of this technique.

3) *Overtime with Multi-Scenario*

Overtime is used to speed up or minimize the time required for project execution through increasing of actual work hours related with laborers. The number of working days is calculated for each activity according to the steps shown in the flowchart of Figure 9.

In overtime approach, the following abbreviations could be defined as follows: Number of Working Days with Overtime for laborers or equipment related to job's type (WDo); Overtime Hours (OH); Daily working hours per shift with overtime (Dho/S); Laborers and Equipment Cost with overtime (LECo); where LECo = SWj + SC.

This technique could be applied on the critical activities using MS Project software. In the proposed model, overtime hours are added for critical path activities with multi-scenario which are:

Scenario A: adding two working hours per day;
Scenario B: adding four working hours per day;
Scenario C: adding another six hours shift beyond working hours per day (working with two shifts).

4) Concurrency-Partitioning and Crashing Technique (CPCT)

The researcher suggests a new approach that mixes between two techniques, concurrency and crashing after partitioning some of project activities. This approach is named as Concurrency-Partitioning and Crashing technique (CPCT). The purpose of this combination is to be considered an addition alternative that could be compared with other applied techniques in order to facilitate the process of decision-making. Figure 10 shows the main steps of applying this approach.

Module No.1

I. Establishing Membership Functions of Fuzzy

The next step is to define the membership functions related with each input and output variables. The trapezoidal fuzzy numbers and triangular fuzzy numbers are used to build the input and output variables of the suggested system. The membership function of the input objectives are divided into a set of linguistic values: small (0,0,0.5), medium (0.25,0.5,0.75)

and large (0.5,1,1), while the membership functions of the (MPCI) are divided into seven linguistic values: tiny (0,0,0.05,0.166), very poor (0,0.166,0.33), poor (0.166,0.33,0.5), satisfactory (0.33,0.5,0.66),
good (0.5,0.66,0.83), very good (0.66,0.83,1), and excellent (0.83,0.95,1,1) . The input variables shown in Figure 11 is built as a triangular shape. The output variable (MPCI) is constructed from both triangular and trapezoidal shapes as shown in Figure 12.

Module No.2

II. Utilization of the (FDSS) to Rank and Analysis the Scenario

This phase includes ranking and analyzing the output results to determine the best one (highest MPCI value).

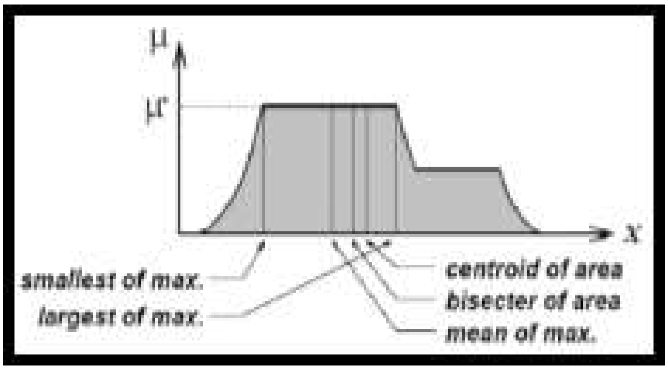

Figure 4: Methods of Defuzzification Process

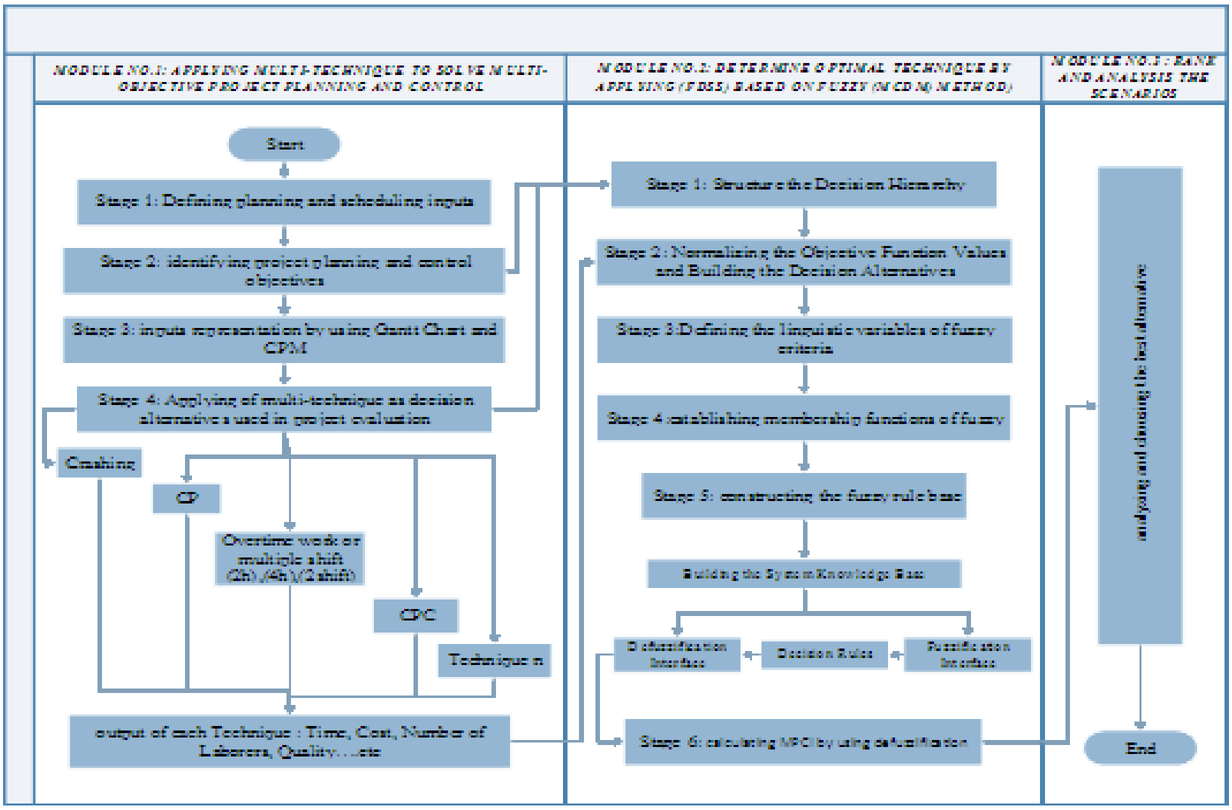

Figure 5: Flow Chart of the (MOMT-FDSS) Model

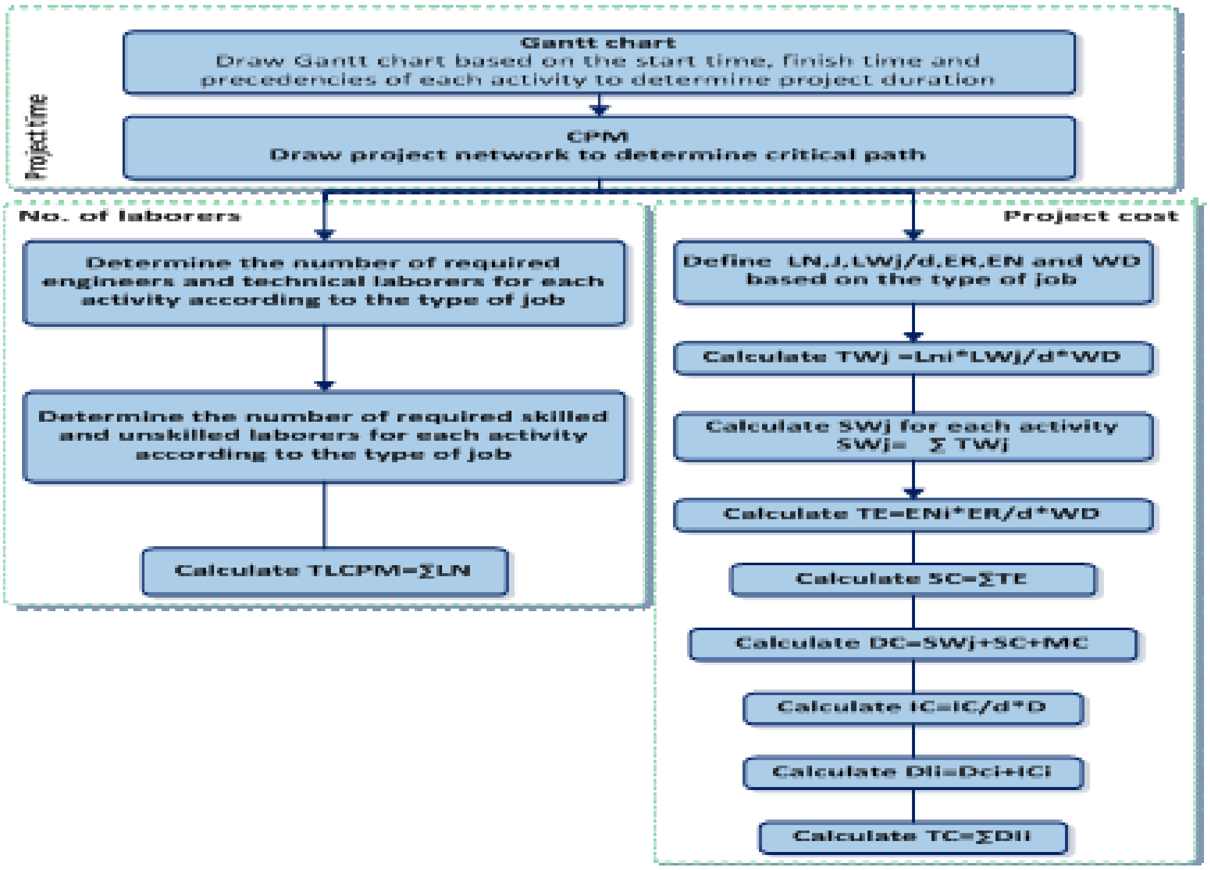

Figure 6: Flowchart of Critical Path, Cost and Number of Laborers Calculation

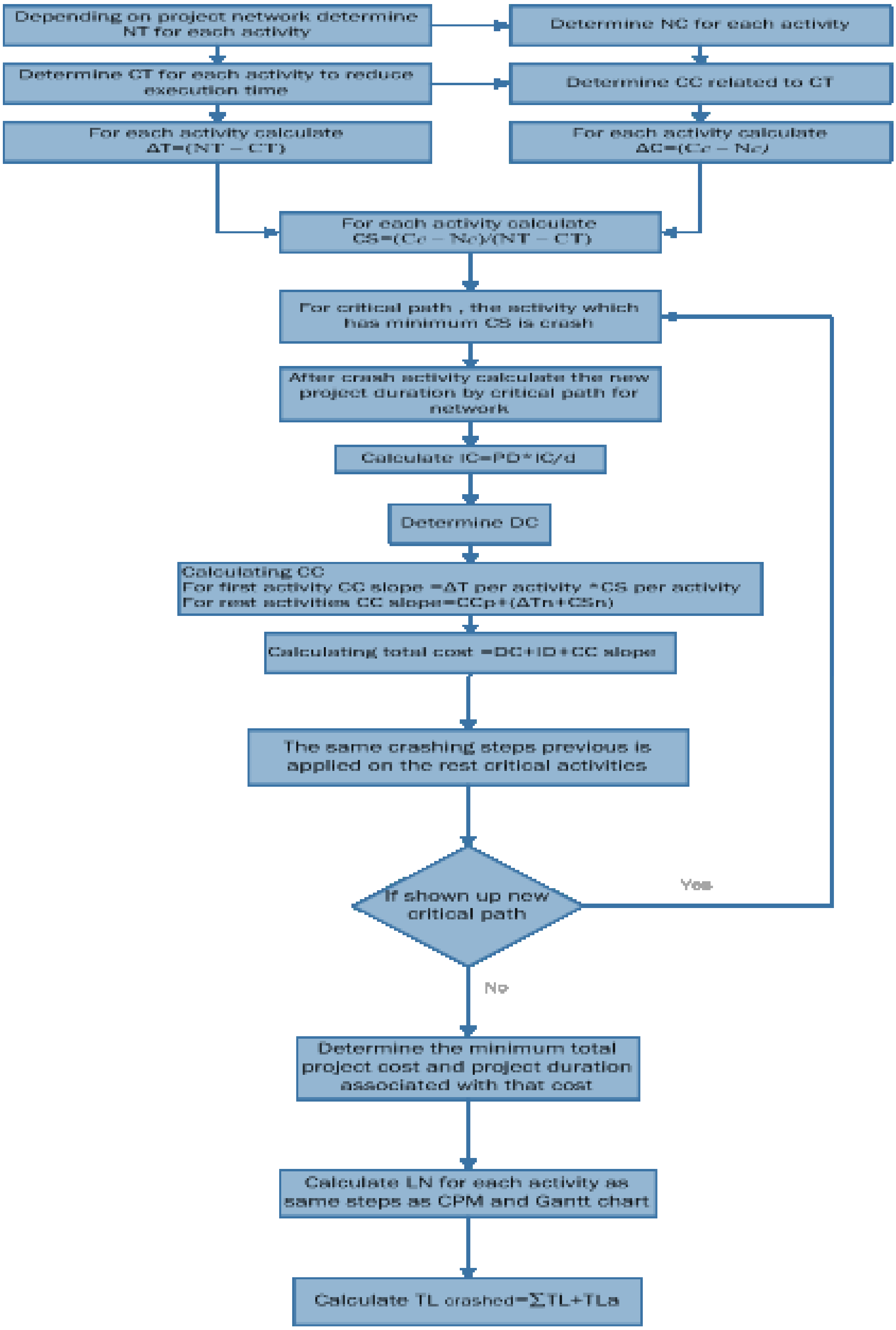

Figure 7: Flowchart of Crashing Technique Steps

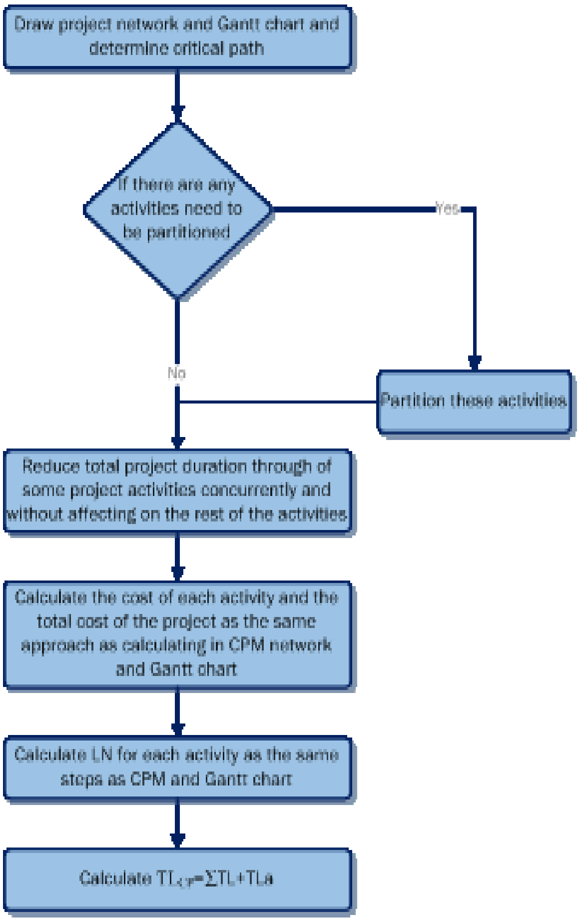

Figure 8: Flowchart of CP Technique

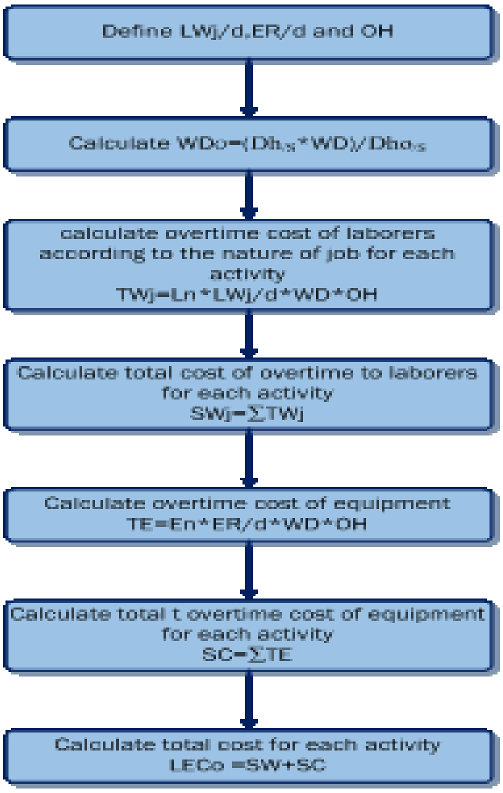

Figure 9: Flowchart for the Steps of Overtime with Multi-Scenario

7. Model Implementation

Module No.1

the proposed model is applied on Al-Za'franiya Electrical Power Transformation Substation Project as a case study through the subsequently implementation of stages specified for each module and previously mentioned in Figure 5, the following objectives have been identified and adopted as objectives for project planning and control, (Possible time minimization; Possible cost minimization; Possible laborers minimization**)**. The project budget was 4,613,000,000 IQD and consisting of direct cost of 3,855,000,000 IQD and indirect cost of 1,000,000 IQD/day. The planned project duration was 758 days, and the number of laborers was 632 laborers with six working hours/per day for seven days in a week.

I. Crashing Technique

This technique is applied to be one of the possible alternatives and to utilize its results in decision making for improving the process of planning. The procedure of implementing this technique has been shown in the flowchart of Figure 7. The minimum time and cost have been determined through crashing the activities and were 623 days and 4,524,840,000 IQD respectively. By applying the rest of steps mentioned in Figure 7, the overall required number of laborers is calculated, and it is 677 laborers.

II. Concurrency Technique with Partitioning (CP)

After concurrency, partitioning, and overlapping processes, the overall project duration resulted was 697 days and overall cost was 4,552,000,000 IQD and 646 laborers.

III. Overtime with Multi-Scenario

In order to utilize overtime method in reducing the duration of project execution; three scenarios have been applied on the critical activities, MS Project software is used to calculate the project duration of each scenario and as shown in Table 1.

IV. Concurrency-Partitioning and Crashing Technique (CPCT)

By utilizing concurrency technique and its related Gantt Chart and network, the mixed approach (CPCT) is applied according to the flowchart of Fig.10. crashed time and cost have been calculated for the partitioned activities (3, 3P1, 3P2, 17, and 17P1), Minimum time and cost resulted from crashing process are determined, where the minimum time was 610 days and the minimum cost was 4, 492,465,000 IQD. By applying the rest steps of the flowchart in Fig.10, the overall required number of laborers was 688.

Module No.2

After applying some of project planning and scheduling techniques on selected project in the first module of the proposed model, conflicted results were produced relative to the predetermined objectives, hence, these techniques are considered to be decision alternatives and according to the sequence shown in Table 2. In order to take a decision for the optimal technique, fuzzy MCDM Method is employed.

I.Normalizing multi-objective Values and Building the Decision Alternatives

According to the difference between the obtained results, related to the time, cost and number of laborers, normalizing is applied. After building the internal structure of the problem, Table 3 is constructed to illustrate the original values and their normalized values for each objective and for all of alternatives of the seven tools and techniques applied.

II.Constructing the Fuzzy Rules and Knowledge Base

In this case study, three objectives (T, C, and TL) have been predetermined each with three states; so, the overall fuzzy decision rules were (3^3=27 rules) and as shown in Table 4 which represents constructing of fuzzy rules for two suggested scenarios.

III.Calculating MPCI by using Deffuzification

In this case study, the number of inputs are three; so, three 3D graphs are shown in fig.13 to demonstrate the relationship among T, C, and TL relative to MPCI. In Fig.13-a, the effect of T and C on MPCI is displayed, and it is clear that the effect of T was greater on MPCI compare to that of C, where the MPCI increases with the increase of T rather than with that of C. Fig.13-b shows the effect of both of T and TL on MPCI, where T is the more influence objective compared to TL. In other words, MPCI increasing is related with the increase of T instead of TL. Finally, Fig.13-c depicts the relationship between C and TL and their effects on MPCI. The figure shows that any increasing in MPCI is greatly related with the increasing of C regardless of TL, because TL has less effect on MPCI. The rule viewer is used to show a graphical representation of the three objectives, T, C, and TL, as inputs, with MPCI via all the fuzzy rules. This viewer can take any value of these inputs as shown in Fig.14. MPCI value, the output, can be described as follows: IF the T value is (0.827), the C value is (1), and the TL value is (0) THEN MPCI will be (0.935).

Module No.3: Based on the two scenarios that have been constructed, different results have been obtained corresponding to each alternative and as depicted in Table 5 which shows that in both of scenario 1 and scenario 2, the seventh alternative (A7) presents the maximum MPCI which is the best value while the minimum MPCI is for the first alternative (A1) which is in turn represents the worst value. Table 6 demonstrates the difference between project plan calculated by CPM network and the suggested mixed approach (CPCT) which is the optimal one among other project planning techniques and tools.

Table 1: Results of Overtime with Multi-Scenario

Scenario	Project Duration (day)	No. of Laborers	Direct Project Cost (IQD)	Indirect Project Cost (IQD)	Entire Project Cost (IQD)
A	624	632	3,949,402,500	624,000,000	4,573,402,500
B	597	632	3,992,010,000	597,000,000	4,589,010,000
C	579	632	4,004,252,500	579,000,000	4,583,252,500

Table 2: Symbols of Alternatives

Technique	Alternative
CPM	A1
Crashing	A2
CP	A3
Overtime (Scenario A)	A4
Overtime (Scenario B)	A5
Overtime (Scenario C)	A6
CPCT	A7

Table 3: Results with their Normalization

Alterantive	T	N_T	C	N_C	TL	N_{TL}
A1	758	0.000	4,613,000,000	0.000	632	1.000
A2	623	0.754	4,526,175,000	0.720	677	0.196
A3	697	0.341	4,552,000,000	0.506	646	0.750
A4	624	0.749	4,573,402,500	0.329	632	1.000
A5	597	0.899	4,589,010,00	0.199	632	1.000
A6	579	1.000	4,583,252,500	0.247	632	1.000
A7	610	0.827	4,492,465,000	1.000	688	0.000

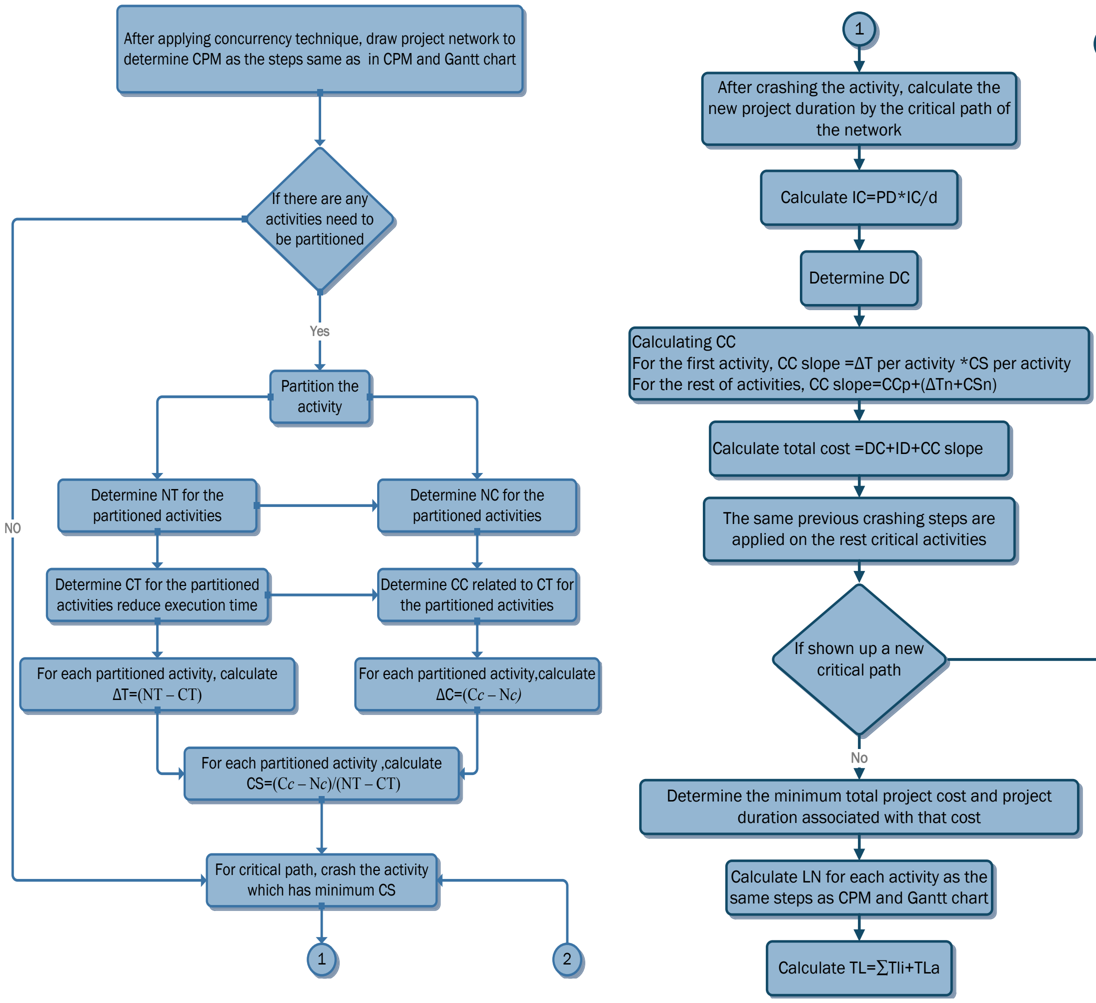

Figure 10: Flowchart of Suggested Approach (CPCT)

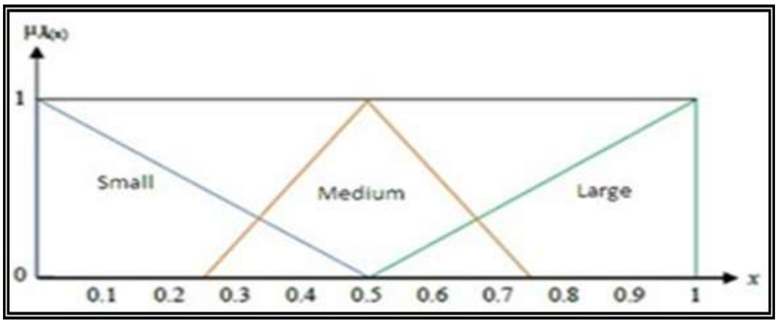

Figure 11: Membership Function of Linguistic Input Variables

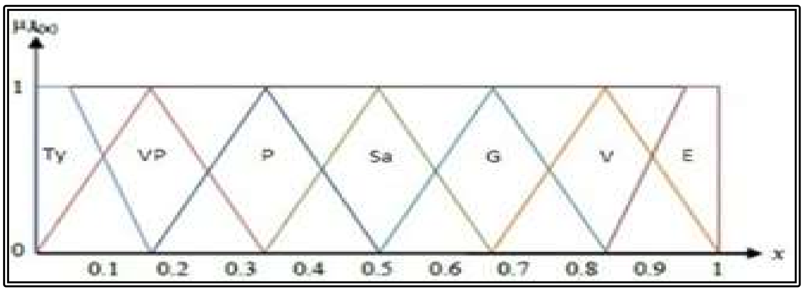

Figure 12: Membership Function of Linguistic Output Variables

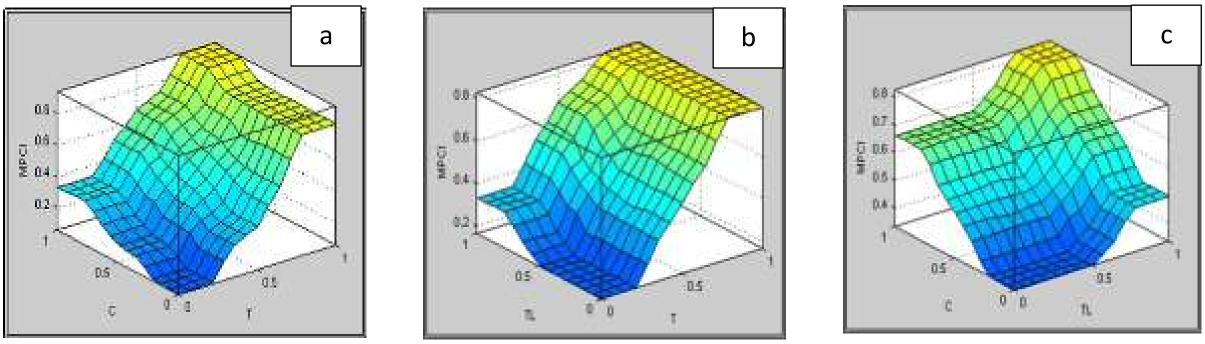

Figure 13: 3D Graph; (a): Time and Cost Effect on MPCI; (b): Time and Number of Laborers Effect on MPCI; (c): Cost and Number of Laborers Effect on MPCI

Table 4: Constructing of Fuzzy Rules for the two suggested scenarios

Rule No.	Objectives			MPCI	
	T	C	TL	Scenario 1	Scenario 2
1	Small	Small	Small	Tiny	Tiny
2	Small	Small	Medium	Tiny	Tiny
3	Small	Small	Large	Very poor	Very poor
4	Small	Medium	Small	Very poor	Very poor
5	Small	Medium	Medium	Very poor	Poor
6	Small	Medium	Large	Poor	Poor
7	Small	Large	Small	Poor	Poor
8	Small	Large	Medium	Poor	Poor
9	Small	Large	Large	Poor	Poor
10	Medium	Small	Small	Poor	Poor
11	Medium	Small	Medium	Poor	Poor
12	Medium	Small	Large	Satisfactory	Satisfactory
13	Medium	Medium	Small	Satisfactory	Satisfactory
14	Medium	Medium	Medium	Satisfactory	Good
15	Medium	Medium	Large	Good	Good
16	Medium	Large	Small	Good	Good
17	Medium	Large	Medium	Good	Good
18	Medium	Large	Large	Very good	Good
19	Large	Small	Small	Very good	Very good
20	Large	Small	Medium	Very good	Very good
21	Large	Small	Large	Very good	Very good
22	Large	Medium	Small	Very good	Very good
23	Large	Medium	Medium	Very good	Very good
24	Large	Medium	Large	Very good	Very good
25	Large	Large	Small	Excellent	Very good
26	Large	Large	Medium	Excellent	Excellent
27	Large	Large	Large	Excellent	Excellent

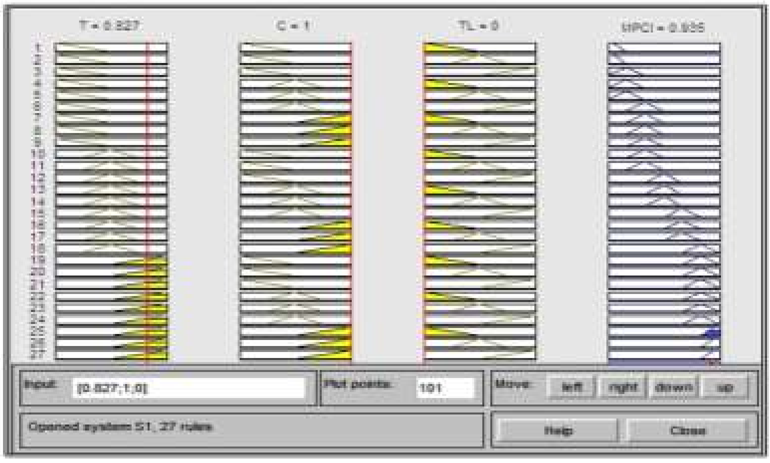

Figure 14: Rules Viewer

Table 5: MPCI Values Corresponding to their Alternatives for the Two Scenarios

Alterantive	N_T	N_C	N_{TL}	MPCI	
				Scenario 1	Scenario 2
A1	0.000	0.000	1.000	0.165	0.165
A2	0.754	0.720	0.196	0.889	0.796
A3	0.341	0.506	0.750	0.510	0.422
A4	0.749	0.329	1.000	0.826	0.744
A5	0.899	0.199	1.000	0.830	0.664
A6	1.000	0.247	1.000	0.830	0.664
A7	0.827	1.000	0.000	0.935	0.830

Table 6: Results Comparison of the Selected Project

Alterantive	Technique	Time (days)	Cost (IQD)	No. of Laborers
A1	CPM	758	4,613,000,000	632
A7	CPCT	610	4,492,465,000	688
% of Change from the original plan		19. 525	2.612	108.860

8. Conclusions and Recommendation

This research presented a model that employed multi-technique for project planning and scheduling to achieve multi-objective. The proposed model is reinforced by a system supports decision making for the optimal technique that covers the predetermined project objectives in a balanced way. The reason behind this is to solve the problem of conflict among project objectives, where this model could be considered for an unrestricted number of objectives like time, cost, resources, quality, … etc. Seven techniques and tools have been applied as decision alternatives including: CPM, crashing, concurrency technique with partitioning (CP), and overtime with multi-scenario, in addition, a new mixed approach is presented. This approach combines (CP) technique and crashing technique, and it is called Concurrency-Partitioning and Crashing technique (CPCT). The results have shown that the suggested mixed approach (CPCT) was the best one among other techniques and tools; where both project time and cost have been decreased by 19. 525% and 2.612% respectively, while the total number of laborers has increased by 8.860%. For future work, extra objectives could be taken into consideration such as quality, resources, and risk in addition to the adopted objectives. In addition, other planning and scheduling technique could be applied as alternatives

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