Presenting a Model Based on Fuzzy Application to Optimize the Time of IBS Projects in Gas Refineries

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Abstract. Nowadays, the construction industry has started to embrace IBS as a method of attaining better construction quality and productivity and reducing risks related to occupational safety and health. The built of pre-fabricated component in factories reduces many problems related to lack of purposing uncertainty in scheduling calculation and time management of projects. In the case of using IBS method for managing time in projects, former studies such as Allan Tay's research, indicates that this method can save up at least 29% of overall completion period versus the conventional method. But beside mentioned advantages of this technical method, the projects could be optimized more and more in scheduling calculations. This issue is critical in gas refineries, since special parameters such as risk of spreading poison H_2S gas and mandatory of performing projects in short time period events such as maintenance overhauls demands to perform projects in optimum time. Custom scheduling calculation of project planning uses the Critical Path Method (CPM) as a tool for Planning Project's activities. The researches of this paper's authors indicated that Fuzzy Critical Path Method (FCPM) is the best technique to manage the uncertainty in project scheduling and can save up the construction project's time versus the custom methods. This paper aims to present a model based on fuzzy application in CPM calculations to optimize the time of Industrial Building System.

1 Introduction

IBS can be defined as a construction system which components are manufactured in a factory, on or off-site, Positioned and assemble in to structures with minimal additional site work [1]. The typical classifications is shown in Fig. 1, [2].

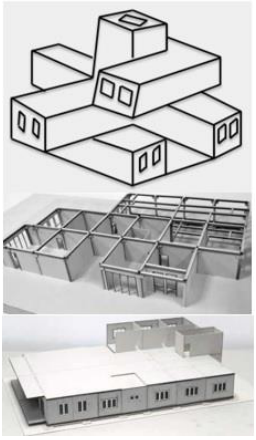

Figure 1. Industrialized building system types (Box-Frame, Beam-Panel system and panel systems)

Former studies indicate that IBS can save up about 29% of overall completion time versus the conventional method [3].

Beside mentioned advantages of these technical methods, the projects could be optimized more and more in scheduling calculations. The researches of this paper's authors indicated that Fuzzy Critical Path Method (FCPM) is the best technique to manage the uncertainty in project scheduling and can save up the construction project's time versus the custom methods.

Table 1. Building system classification according to relative weight of component

No	General System	Conventional Method	Production Material	Comparisons
1	Overall Construction Period	24 months + 17 days	19 months + 12 days	Saving up to 135 days or 29% overall completion period.
2	Main Building Structure	464 days	329 days	
3	Foundation Work	83 days (usual piling method)	50 days (raft foundation)	Saving up to 33 days

2 Fuzzy critical path method (FCPM)

FCPM is an extension of Critical Path Method by fuzzy

approach. In this method, fuzzy function defines the time of project activities to manage their uncertainties. For understanding the main concepts of FCPM, consider the project network indicated in Fig. 3. This project network is a part of a small one-story Industrial building System project that contained of excavation, concreting and installing the building structures. The resistance system against the earthquake is A.D.A.S bracing.

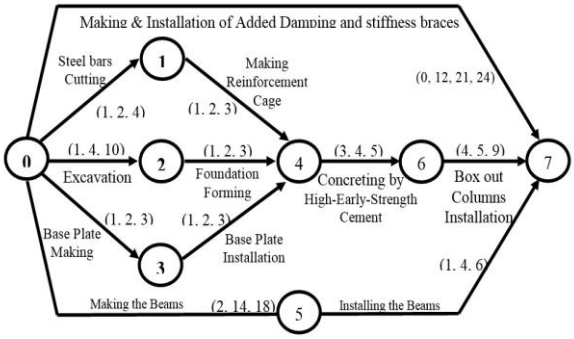

Figure 2. The project network.

As it could be seen from Fig. 2, 10 of whole 11 activity times have triangular fuzzy type format and only the remaining one is in trapezoidal form. In order to determine the project time According to CPM calculation, it is necessary to rank the fuzzy numbers and select the maximum. For ranking the fuzzy numbers brings from CPM calculations, 5 methods available. The result shows in Fig. 3 [4].

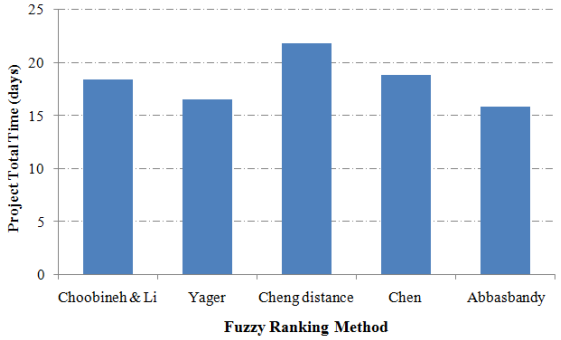

Figure 3. Project total time calculated based on different fuzzy ranking methods

In FCPM calculations, as the results indicate, selecting the fuzzy ranking method for each project scheduling has main influence on determination of project total time and critical path. Also suitable fuzzy ranking method, compatible to project nature should be considered by project management team. The scheduling calculation of this paper's authors indicated that Fuzzy Critical Path Method (FCPM) can save up project total time versus the custom project management methods.

3 Presenting a fuzzy base model to optimize the time of (IBS) projects

For implementing a model based on Fuzzy technique In order to optimize the time of (IBS) Projects various membership functions and linguistic variables have been defined by judgment of experts. Linguistic variables, such as Site Organization, weather, Labor Skills and Quality of equipment, need to be translated in to mathematical measures. The value of these considered variables can be classified in to 5 types: Very Poor, Poor, Medium, High and Very High. These are not clearly defined but are meaningful classifications.

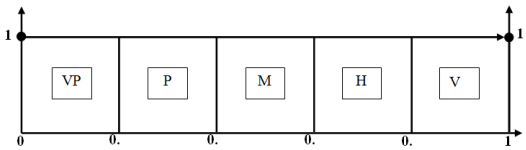

Figure 4. Categorization of membership functions

So in first step the entire project activities will be converted to any of categories mentioned above. The values of membership function may also change with respect to activity and the results obtained from the simulation of different graphs are thus interpreted and modified as per requirements of duration change. Second step is the schedule calculations and analysis.

As described in the example of section 2 (the project network indicated in Fig. 2) project network calculation is a very time consuming process. So we need to use software tools for the optimizer model. The research of this paper indicated that, fuzzy toolbox of MATLAB is the best tools for our goal.

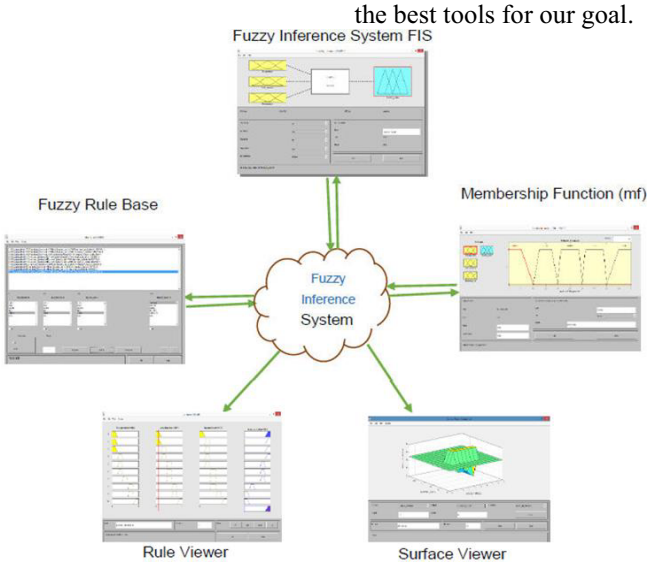

Figure 5. Pictorial view of fuzzy inference system in MATLAB

Output is a crisp result which is obtained after undergoing the process of: Pre-Processing (1), Fuzzification (2), Rule base (3), Inference Engine (4) and Defuzzification (5) [5]-[12]. The output can be decided by user to obtain required result after the whole inference process, which can be desired result of whole designed fuzzy system. In the first step the scenario of analysis is designed.

4 The result of implementation of proposed model in a gas refinery

Corresponding author of this paper has implemented the Recommended model to manage the project of a specific Gas Refinery in east-north of Iran in statistical society of 30 selected projects among all of industrialized projects (Selected according the Cochran formula).

Table 2. Configuration of Selected Projects for Research Calculation and Analysis

Project ID	Title of project
P001	Construction of Pardis Staff dormitory
P002	Construction of Oily Water Separator
P003	Degassing of Granulation Unit
P004	Construction of Housing Services center
P005	Construction of Ware House Administrative Building
P006	Movement of Gonbazli Dehydration sole
P007	Extending of Central Restaurant
P008	Construction of Sculpture Platform
P009	Optimization of Shahid Mohajer Pool
P010	Construction of Gas station
P011	Construction of Shahid Torshizi Sewage
P012	Construction of TPL Fencing
P013	Construction of oil Loading Pavement
P014	Construction of Transportation Sole
P015	Performing of Refinery F & G System
P016	Construction of Sculpture Unit Road
P017	Construction of Senior Operator Room
P018	Construction of HSE Energy Chanel
P019	Performing P.F Wall in Torshizi Residential
P020	Performing of Pardis Complex Gas line
P021	Performing of Pardis Complex Data line
P022	Performing of Pardis Complex Water line
P023	Performing of Pardis Complex 6Kv Elec line
P024	Performing of Pardis Complex Sewage line
P025	Construction of Contractor Building
P026	Performing of O.W.S Supports
P027	Zero Flaring
P028	Construction of CMF Pipe Line
P029	Performing of General Civil Maintenance
P030	Restaurant's Cold and Mechanical Room

Table 2 indicates the configuration of selected projects. The members of expert team in this research were Chosen from contractors, consultant and supervisors of owner and the time of research took about two years between 2014 up to 2016. Table 3 indicates the identification of research expert team and the result of analysis is shown in Fig. 6.

The result of analysis indicates the implementation of the recommended model, lead to reducing the total time of selected project (as a minimum 7% of project total time) versus the custom methods. The rate of this reduction estimated by Corresponding Author, and the result is according to Fig. 6.

Table 3. The identification of expert team of research

Member No.	Job Title - Duration of Experience
1	Supervisor - Civil Engineer - 14
2	Supervisor - Civil Technician - 17
3	Consultant - Civil Engineer - 16
4	Contractor- Civil Engineer - 12
5	Supervisor- Mechanical Eng -14
6	Supervisor- Mechanical Eng -17
7	Contractor- Mechanical Tech -16
8	Consultant- Mechanical Eng -8
9	Contractor- Mechanical Tech -15
10	Supervisor- Electrical Engineer-17
11	Consultant- Electrical Engineer-16
12	Contractor- Electrical Tech -15
13	Contractor- Electrical Tech -14
14	Contract Administration Staff- 17
15	Contract Administration Staff- 16
16	Budget Expert Staff - 12
17	Budget Expert Staff - 16
18	Business Administration Staff - 12

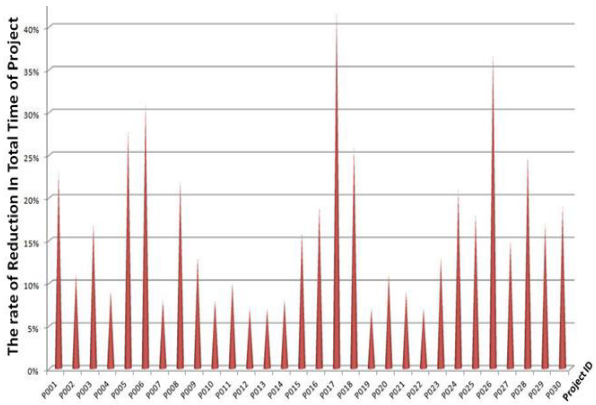

Figure 6. Research Results (Project ID - rate of Reduction in Total Time)

5 Conclusions

In the field of using new technical method in construction industry such as IBS, many studies indicate that these new technical methods can save up at least 29% of overall completion period versus the conventional method. So when these new technical methods are merged by intelligent project planning approaches, the results can improve more and more. Custom scheduling calculation of project planning uses the Critical Path Method (CPM) as a tool for measuring activities time progress.

Whereas CPM has the main weak point which is related to lack of purposing uncertainty in scheduling calculation. The research of this paper's authors indicated that Fuzzy Critical Path Method (FCPM) that added Fuzzy approach to CPM is the best technique to manage the uncertainty in project scheduling and it can save up as a minimum 7% of project total time versus the custom project management methods.

So when this project planning approach is merged with new technical method in construction industry such

as IBS, we can save up more than 36 percent in total time of project. Finally, we can save up one third of project total time.

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