Comparative Study of Delay in Time in Commercial Building by Statistical Method and Fuzzy Logic

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Abstract— In this research work an effort has been made to optimize the time by reducing the delays occur in the pre-scheduled activities by using fuzzy logic. To understand and explain scenario better data of any construction site is collected and is compiled in C++ Programming Language. By comparing the actual result of Delay Management obtained by CPM method with the result obtained by Fuzzy CPM method.

Key words: Construction Management, Delay, Statistical Method, Fuzzy Logic, Time Optimization, MS Project, C++ Language

I. INTRODUCTION

Delay is fairly common in construction projects. The Employer, the Contractor, and the third party or the force majeure that the parties to a contract cannot control are the major and most common factors of Delay occurrence. Late completion of a project would become a delay in time and it results substantial losses on society as well as the project cost. The charges of the damage caused by a project delay is remunerated by the Contractor in principle in the form of 'liquidated damage'. Delay Analysis (DA) is a scrutiny into what has caused the project to run late and who is responsible for the delay events. Investigation - It is proposed to identify all delay events and parties which blameable for them. Explanation and analysing – Collect the information in order to identify the responsible party. Conclusions - Prepare a presentation of the case. Here, this study includes the two methods for getting the solution of the definite problem. Delay calculation by Statistical Method or Critical Path Method and other is Delay calculation by Fuzzy logic. To make analysis by these two methods, MS Project 2007 and C++ language has been used.

II. OBJECTIVES

The main objective of this study is to calculate the duration of delay and define strategies for minimizing delay in construction project. Primary objective is to identify the major causes and the effects of delays in construction project.

III. LITERATURE STUDY

Rahul S. Patil, et.al (2013) – "Statistical Methods for Construction Delay Analysis". This paper contains the occurrence of delay is common in most construction projects, due to various reasons and causes before or during construction phase. As the delay impact on time and cost overrun, analysing of these delay(s) makes easy to give responsibility to concern party. This helps to avoid or minimize delays in future work. Numerous analytical methods are available for analysing these impacts and selection of proper method depends upon: statistical data available, time available, limitation of method and money available for analysing. Most common techniques for delay analysis are "as-planned vs. As-built", "impacted as-planned", "as-planned but for", "collapsed as-built", "window analysis", and "time impact analysis".

Mr. Saurabh M. Dugad, et.al. (2015) – "Causes of Delay in Residential Construction Projects". In this published paper study showed the major factors that causing delay in construction are: Material, Manpower, Equipment, Finance, Environment, Changes, Government Actions, Contractual relation, Scheduling and controlling techniques.

Mete MAZLUM, et.al. (2015) – "CPM, PERT and Project Management with Fuzzy Logic Technique". In this paper, the project management techniques, fuzzy PERT and fuzzy CPM are studied, which are used in the fuzzy project management. This study also includes, certain and fuzzy activity times of three different firms are used. With certain activity times, classic CPM and PERT optimization and with using triangular fuzzy numbers for fuzzy data, CPM and PERT optimization are analysed.

IV. ADVANTAGES OF FUZZY LOGIC METHOD FOR DELAY ANALYSIS

1) Fuzzy approach creates flexible framework that can built on top of the experience of experts.
2) Fuzzy logic is tolerant to imprecise data.
3) Delay analysis based on fuzzy logic can create an effective control system.

V. COMPARISON OF STATISTICAL METHOD & FUZZY LOGIC

A. *Statistical Method*

This method gives the imprecise value of delay.

Calculation of the delay in activities are too difficult.

B. *Fuzzy Logic*

This method gives the precise value of Delay in activities, because it will consider the half activity time which is responsible for delay.

Calculations are quite easy in relevant software.

VI. WORKING METHODOLOGY

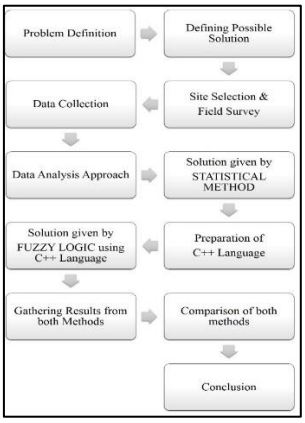

Fig. 1: Working Methodology

VII. CASE STUDY

This research is based on a real project executed in Surat City, Gujarat, India. The following project management steps are used to execute the project:

- Prepare a detailed project schedule
- Periodically update the progress achieved
- Highlight project delays and reasons thereof

The project schedule is prepared in reasonable detail using Microsoft Office Project 2007.

VIII. DELAY CALCULATION

A. By Statistical Method or Critical Path Method

Activity	Description	Delay Duration
G2	The contractor had a labour problem so it took 3 days extra to complete activity G2	3
G14	Contractor advised the owner on the need to increase the thickness of the floor slab. This change required 1 extra day to accomplish	1
G38	Due to late delivery of Wooden Frame	3
G51 G53 G54	Due to rain, work has been stopped.	2
G57	Due to rain, work has been stopped.	8
G61	Due to owner have shortage of updated currency in cash	30
Total Delay		47 Days

Table 1: Delays and reasons thereof

B. By Fuzzy Logic Technique

- Step 1 Group the delayed activities which are of same nature:

Group ID	Activities included	Delay Duration
Labour	G2	3
Procurement	G38	3
Natural	G51, G53, G54, G57	10
Other	G14, G61	31

Table 2: Group of Activities

The next step is to assign qualitative properties to these groups. We assigned three qualitative properties to each of these four elements namely, Poor (P), Moderate (M) and Excellent (E) on the basis of frequency of occurrence and adverse effect on the whole project as shown in the Table – 3.

Elements	**Delay Duration**	**Property**		
		Poor	**Mode rate**	**Excell ent**
Labour	3	A	H	L
Procurement	3	H	A	L
Natural	10	H	A	L
Other	31	A	H	L

Table 3: Qualitative Properties on the basis of frequency

Elements	**Delay Duration**	**Property**		
		Poor	**Moderate**	**Excellent**
Labour	3	L	H	A
Procurement	3	A	L	H
Natural	10	L	A	H
Other	31	L	H	A

Table 4: Qualitative Properties on the basis of frequency

Now, assign the numerical range to the group of activity for their frequency of occurrence and adverse effect of them their property class L, M or H.

To compute the delay, the mathematical approach used in this study is of Bilal M. Ayyub and Achintya Haldar[8]. In the present study, the Linguistic variables and their values are changed with a minor modification in the membership function which are according to considering project.

- Step 2: Assume Value of Linguistic Variable & Membership Function:
  - High = (0.8|0.6, 0.9|0.8, 1|1)
  - Average = (0.3|0.2, 0.4|0.9, 0.5|1, 0.6|0.8, 0.7|0.1)
  - Low = (0|1, 0.1|0.8, 0.2|0.6)
- Step – 3 Input and output in C++ Programming

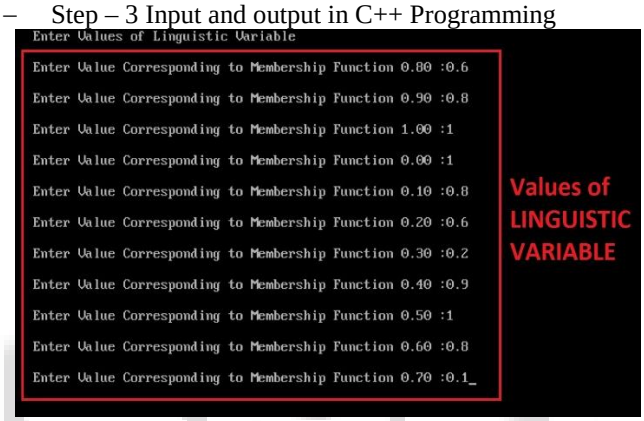

Fig. 2: Input – 1 Linguistic Variable

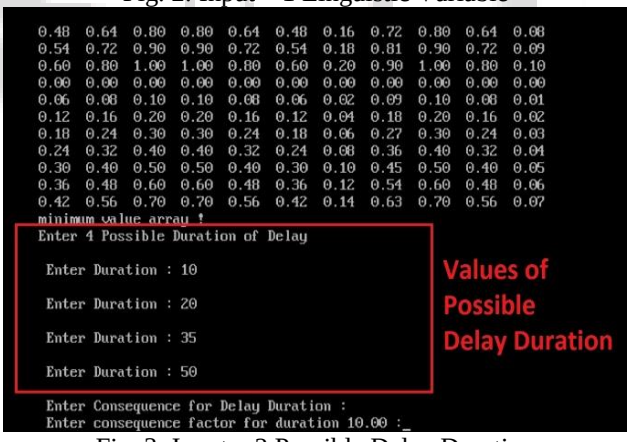

Fig. 3: Input – 2 Possible Delay Duration

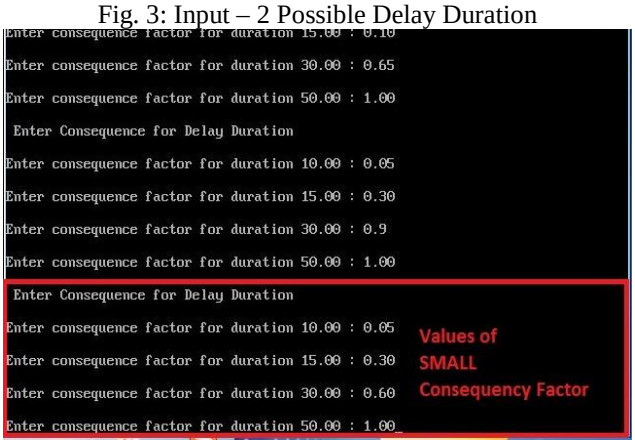

Fig. 4: Input – 3 Values of High, Average & Low Consequences

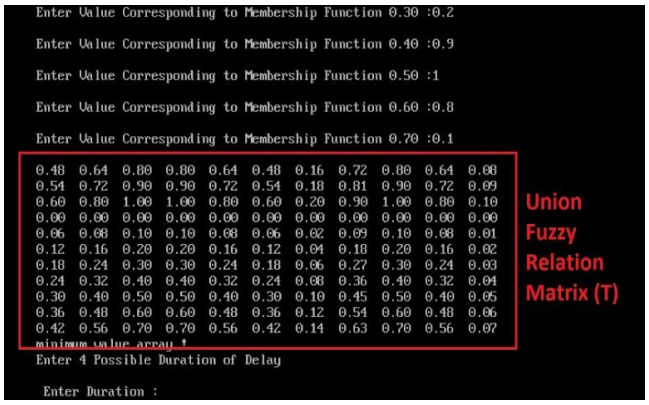

Fig. 5: Output – 1 Union Fuzzy Relation Matrix (T):

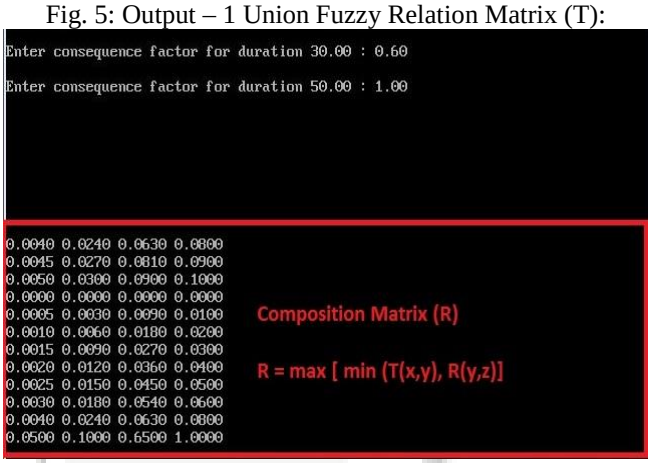

Fig. 6: Output – 2 Composition Matrix (R):

Freq.	Duration of Delay				Sum of Row	Col.1 * Col.6
	10	15	30	50		
0.00	0.0040	0.0240	0.0630	0.0800	0.1710	0.0000
0.10	0.0045	0.0270	0.0810	0.0900	0.2025	0.0203
0.20	0.0050	0.0300	0.0900	0.1000	0.2250	0.0450
0.30	0.0005	0.0030	0.0090	0.0100	0.0225	0.0068
0.40	0.0010	0.0060	0.0180	0.0200	0.0450	0.0180
0.50	0.0015	0.0090	0.0270	0.0300	0.0675	0.0338
0.60	0.0020	0.0120	0.0360	0.0400	0.0900	0.0540
0.70	0.0025	0.0150	0.0450	0.0500	0.1125	0.0788
0.80	0.0030	0.0180	0.0540	0.0600	0.1350	0.1080
0.90	0.0040	0.0240	0.0630	0.0800	0.1710	0.1539
1.00	0.0500	0.1000	0.6500	1.0000	1.8000	1.8000

Table 5: Components of the Composition Matrix R(T x R0)

The probability mass function (P) of the activity duration is computed as given by:

$$P_n = \frac{Value\ for\ n\ day\ from\ row\ having\ highest\ sum\ of\ component\ in\ Comp.Matrix}{Sum\ of\ all\ values\ from\ row\ having\ highest\ sum\ of\ component\ in\ Comp.Matrix}$$

$$P_{10} = \frac{0.0500}{0.05+0.10+0.65+1.00} = 0.0278$$

$$P_{15} = \frac{0.1000}{0.05+0.10+0.65+1.00} = 0.0556$$

$$P_{30} = \frac{0.6500}{0.05+0.10+0.65+1.00} = 0.3611$$

$$P_{50} = \frac{1.0000}{0.05+0.10+0.65+1.00} = 0.5556$$

Average Delay Duration by use of Fuzzy Logic:

= (0.0278 x 10) + (0.0556 x 15) + (0.3611 x 30) + (0.5556 x 50)

= 39.7222 Days

IX. Result

Schedule Time	Actual Completion Time	Delay in Project
335 Days	382 Days	**47 Days**

Table 6: Result of Delay in Project by Statistical Method

Schedule Time	Actual Completion Time	Delay in Project
335 Days	374.7222 Days	**39.7222 Days**

Table 7: Result of Delay in Project by Fuzzy Logic Method

X. Conclusion

On the basis of current study on the method of delay computation by Statistical Method in MS Project 2007 and Fuzzy Logic Method in C++ Programming Language, I can conclude that the Fuzzy logic method is give more precise data as compare to the Statistical method.

In this particular case study, by the use of Fuzzy logic method the delay duration (39.7222 Days) is achieved 7.2778 days lesser from the delay (47 Days) calculated by statistical method.

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References

[1] Rahul S. Patil, et.al (2013) - Statistical Methods for Construction Delay Analysis, IOSR, Volume 9, Issue 21
[2] Mr. Saurabh M. Dugad, et.al. (2015) - Causes of Delay in Residential Construction Projects, IJSRD, Vol. 3, Issue 04, ISSN (online): 2321-0613
[3] Mete MAZLUM, et.al. (2015) - CPM, PERT and Project Management with Fuzzy Logic Technique - 4th International Conference on Leadership, Technology, Innovation and Business Management classic PERT and CPM

