Development of Fuzzy Logic model for Project Management Success (PMS)

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Abstract

The most critical and challenging task of Project Manager in an organization is the successful management of projects. However, failure in managing projects is encountered regularly, which causes waste of company resources. The aim of this research is to simultaneously optimise the time, the cost, the quality, the scope and the PMS of a project and hence providing an aid to project manager in taking effective decisions.

In this paper a Fuzzy logic Matlab model for PMS is developed. A stage wise fuzzy reasoning approach is used as it reduces the fuzzy if-then rules making the system less complex. A set of examples are given at the end to show the applicability and validity of the proposed methodology.

Keywords: *PMS, PM, Matlab, Simulink, Fuzzy Inference System (FIS)*

1.0 Introduction

Project Management (PM) has evolved as a new management technique/methodology in the last fifty odd years. The use of PM helps organization to face with new challenges. Unfortunately PM has been considered as too complicated which results in frequent misunderstanding and poor practices in organizations [1]. Large scale of Engineering and Management projects has dominated PM up to a vast extent. Effective management of projects is crucial for the development and survival of any economy because development is about growth and growth is about series of successful managed projects [2].

According to A Guide to the PM Body of Knowledge [3]," PM is the application of knowledge, skills, tools and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands among: 1. Scope, time, cost and quality, 2. Stakeholders with differing needs and expectations, 3. Identified requirement (needs)and unidentified requirements (expectations)"[3]. PM includes the process to ensure that the project will satisfy the needs for which it was taken [4]. It involves a team of people which in a controlled manner defines a desired objective or goal.

A project, no matter the size or magnitude, must be completed under certain constraints [5]. The "Triple constraints of PM" or "The PM triangle" are as follows: Scope-project size, goals and deliverables, Time- time frame available to complete the project, Cost-amount budget for the project. The PMS is impacted by balancing Scope, Time and Cost. High quality projects delivers the required product, service with scope, on time and within budget, leading to Project Success. In project management environment time-cost-quality trade off problem is a multi-objective optimisation problem, which mainly focuses on selecting nodes with their corresponding time, cost and quality for a task to minimize project completion time and cost, while project quality is maximised leading to Project Success.

In this paper we have considered following constraints i.e. cost, time, scope and quality which determines PMS. This paper has been divided into five parts. Part I gives the general introduction of PM. Part II defines fuzzy reasoning approach in PM. Part III comprises of Modelling and simulation. Part IV gives Results. Part V and Part VI Conclusion and References respectively.

2.0 Fuzzy Reasoning approach in PM

Fuzzy logic reasoning approach can be used as an effective tool for determining PMS of any organization. The purpose of fuzzy control is to influence the behaviour of a system by changing an input or inputs to that system according to a rule or set of rules that model how the system operates [6].

2.1 Designing of stage-wise fuzzy model

In this study we have used stage-wise fuzzy reasoning approach [7] which reduces fuzzy if-then rules by dividing the whole system into fuzzy inference stages [8]. As shown in figure 1.0 two Fuzzy Inference Systems (FIS) namely FIS 1 and FIS 2 are created in Matlab using Fuzzy logic toolbox [9].

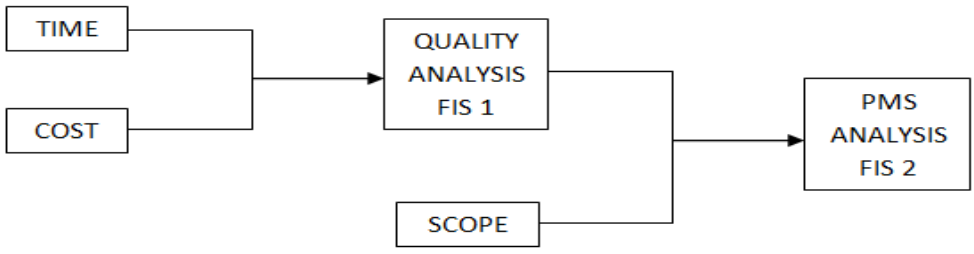

Figure 1.0 stage-wise fuzzy model

If we look at the figure 1.0 then we can see that in the first stage the inputs 'Time' and 'Cost' are combined to build 'Quality Analysis'. Similarly in the second stage 'Quality Analysis' is further combined with 'Scope' to build PMS Analysis.

2.2 Defining Universe of Discourse (UOD), Fuzzification of constraints and Membership function's (MF's)

In this research we have fuzzified each of the constraints i.e. time, cost, scope, quality and PMS with five linguistic variables (fuzzy subsets: Very Low-VL, Low-L, Medium-M, High-H, Very High-VH) using triangular MF's. Each of the constraint has been a UOD of [0 100]. Examples of fuzzified constraints are shown from figure 1.1 to figure 1.5

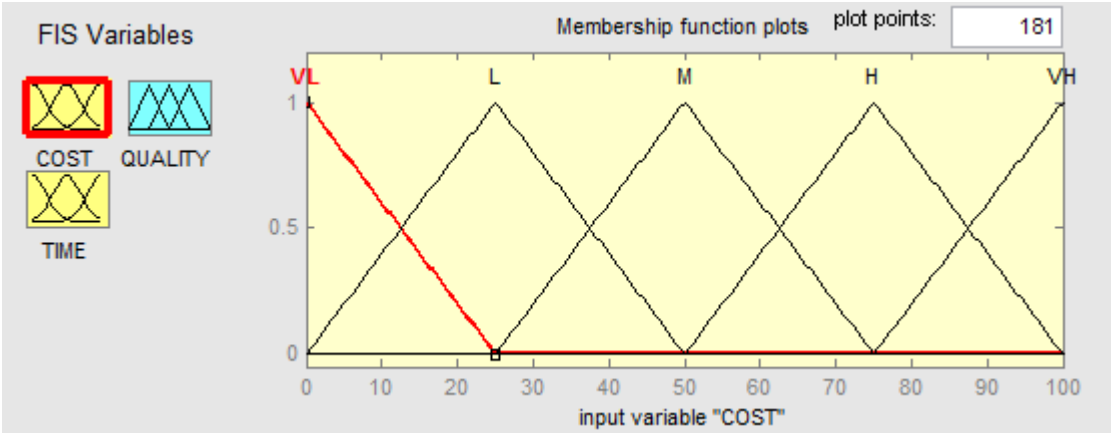

Figure1.1 Fuzzified input parameter 'Cost'

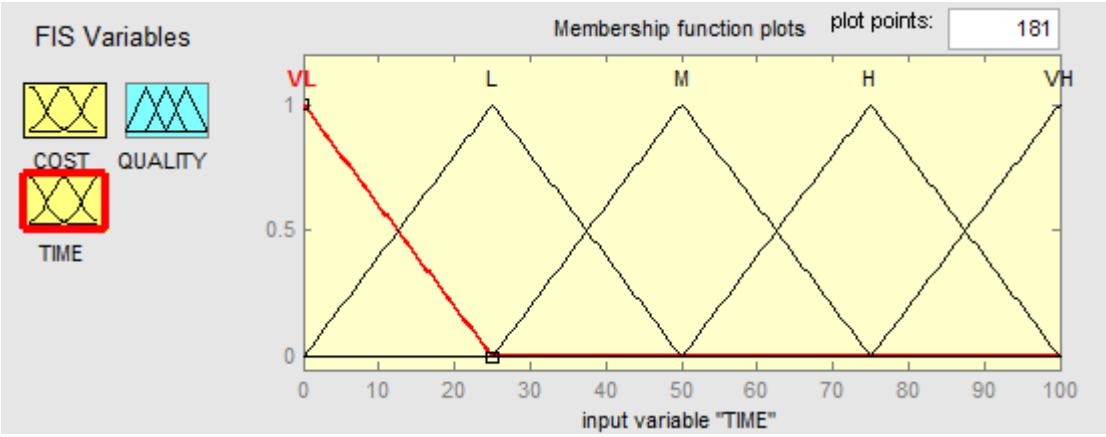

Figure 1.2 Fuzzified input parameter 'Time'

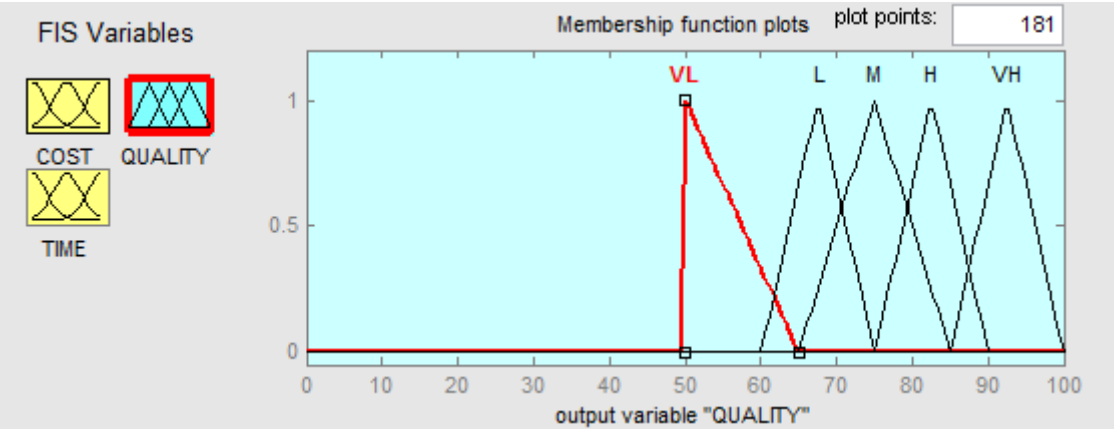

Figure 1.3 Fuzzified output parameter 'Quality'

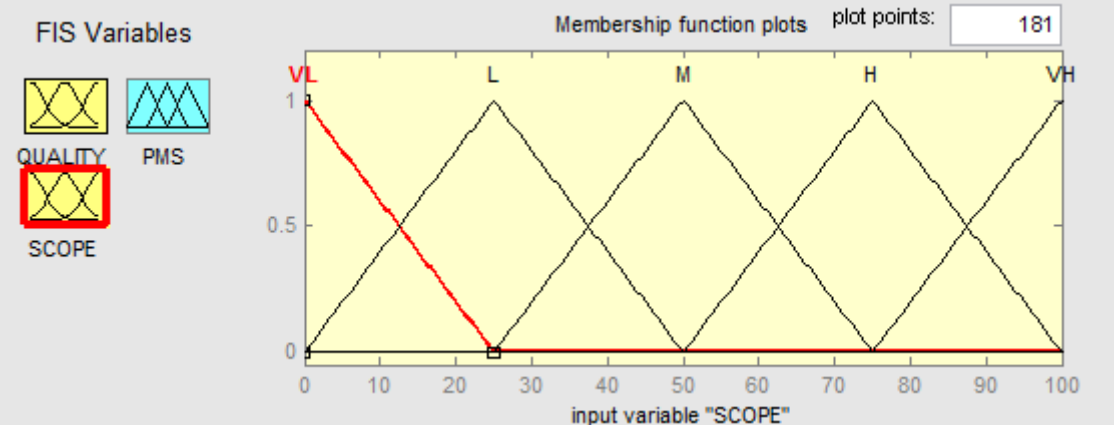

Figure 1.4 Fuzzified input parameter 'Scope'

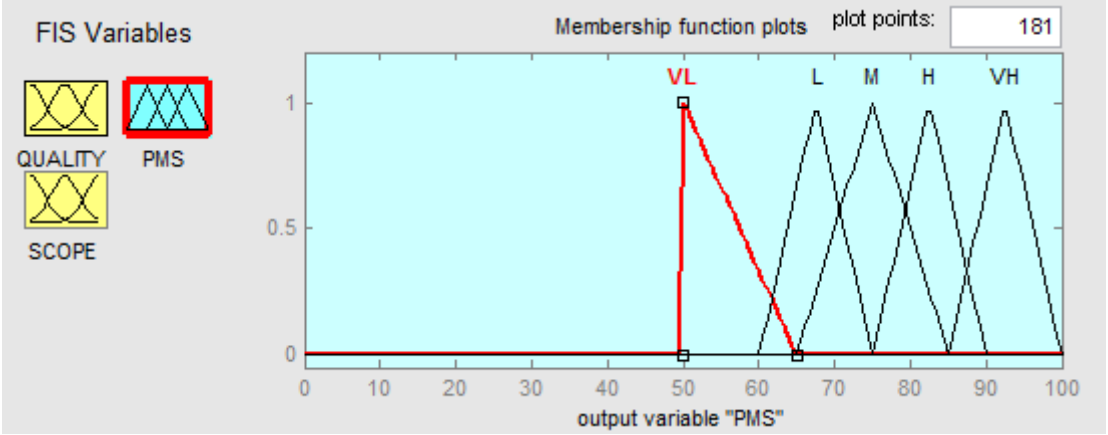

Figure 1.5 Fuzzified output parameter 'PMS'

2.3 Defining fuzzy control rules

In this section two fuzzy rule bases [7] are developed based on experts opinions to evaluate Quality of project and PMS respectively. The fuzzy rules are defined and based on personal experience of experts. Fuzzy control rules for the two fuzzy controllers (i.e. FIS 1 and FIS 2) are defined as follows:

Fuzzy controller FIS 1 (refer to fig 1.0):

'Time' and 'Cost' are the fuzzy input variables and Quality is the fuzzy output variable. The fuzzy control rules can be seen from table 1.0

Rule	Cost	Time	Quality
1.	VL	L	VL
2.	VL	M	VL
3.	VL	H	VL
4.	L	VL	VL
5.	L	M	L
6.	L	VH	M
7.	M	VL	L
8.	M	M	M
9.	M	H	H
10.	M	VH	VH
11.	H	VL	L
12.	H	L	M
13.	H	M	H
14.	H	H	VH
15.	H	VH	VH
16.	VH	VL	M
17.	VH	L	H
18.	VH	M	VH
19.	VH	VH	VH
20.	VH	VH	VH

Table 1.0 Fuzzy control rules-'FIS 1'

As can be seen from the table 1.0 there are total 20 rules. As an example consider rule number 6. In this rule if a cost spent to an activity is low (relative to normal cost) with a time of very high then the consequence quality of performing the activity will be medium. The fuzzy rules are defined and based on personal experience of experts and varies from one expert to another.

A Surface viewer for FIS 1 is shown in figure 1.6 which demonstrates relationship among cost, time and quality of a project. To achieve the surface we have used the rule bases and MF's of the respective FIS controllers.

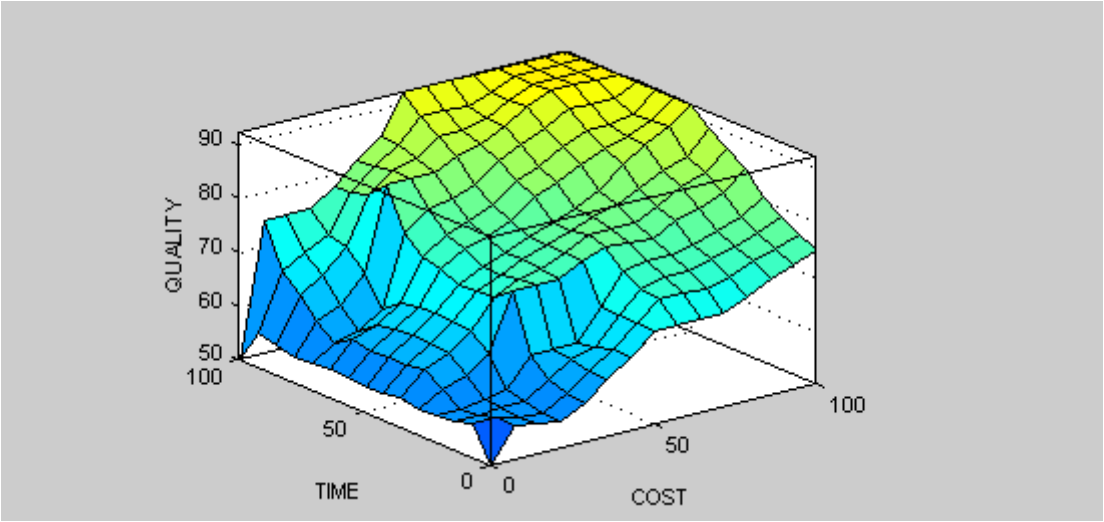

Figure 1.6 A Surface viewer for FIS 1

As can be seen from the figure 1.6 if one has numerical value of Cost and Time in the scale of 0-100 (while 50 defines the standard cost and time), he can obtain the Quality in the scale of 0-100. Having an if-then rule and initial values for cost and time we can find the quality amount.

Fuzzy controller FIS 2 (refer to fig 1.0):

Quality and Scope are the fuzzy input variables and PMS is the fuzzy output variable. The fuzzy control rules can be seen from table 1.1

Rule	Quality	Scope	PMS
1.	VL	L	VL
2.	VL	M	VL
3.	VL	H	L
4.	VL	VH	M
5.	L	VL	VL
6.	L	M	L
7.	L	VH	H
8.	M	VL	VL
9.	M	M	M
10.	M	H	H
11.	M	VH	VH
12.	H	VL	VL
13.	H	L	M
14.	H	M	H
15.	H	H	VH
16.	H	VH	VH
17.	VH	L	M
18.	VH	M	VH
19.	VH	H	VH
20.	VH	VH	VH

Table 1.1 Fuzzy control rules-'FIS 2'

A Surface viewer for FIS 2 is shown in figure 1.7 which demonstrates relationship among Quality, Scope and PMS.

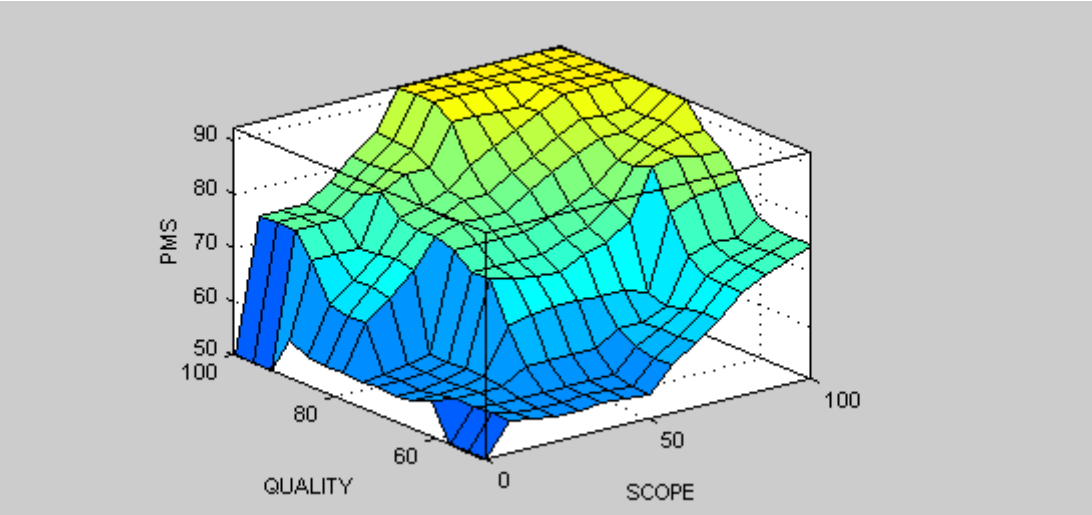

Figure 1.7 A Surface viewer for FIS 2

As can be seen from the figure 1.7 if one has numerical value of Quality and Scope in the scale of 0-100 (while 50 defines the standard cost and time), he can obtain the PMS in the scale of 0-100.

3.0 Modelling and Simulation

The proposed stage wise fuzzy reasoning model for PMS was developed in Matlab Simulink software (fuzzy logic toolbox) as shown in figure 1.8. Fuzzy logic controller was used to link both the FIS's together.

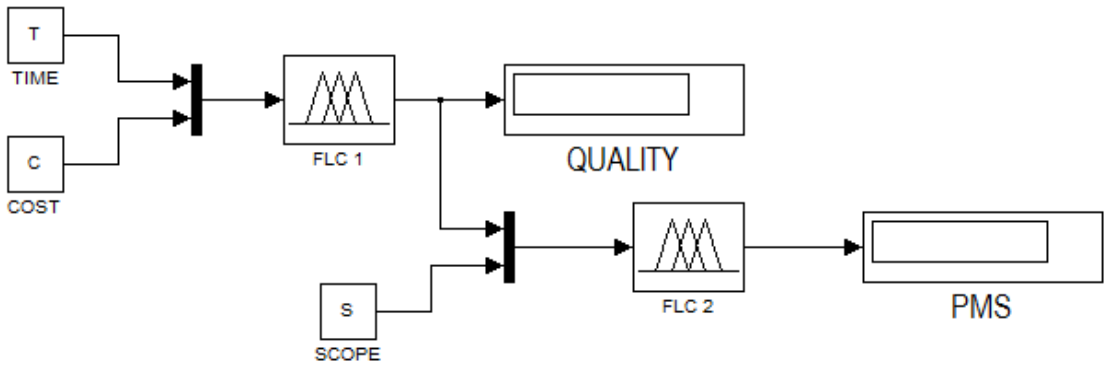

Figure 1.8 Fuzzy reasoning Simulink model

4.0 Simulation results

Results of various simulations for different set of inputs i.e. Time(T), Cost(C) and Scope(S) are shown below.

Set 1:

T = 70; C = 80; S = 60;

The simulation (t=2 sec) results are shown in figure 1.9

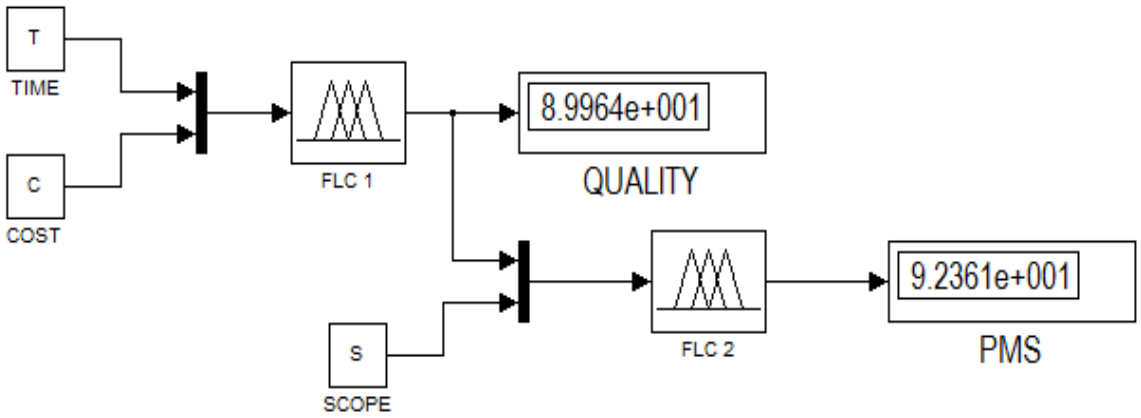

Figure 1.9 Simulation results

Set 2:

T = 50; C = 50; S = 50;

The simulation (t=2 sec) results are shown in figure 2.0

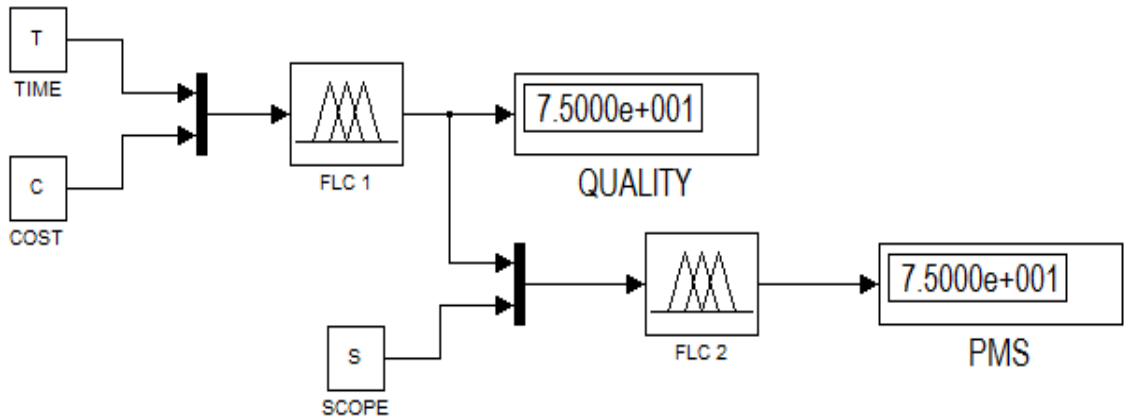

Figure 2.0 Simulation results

Set 3:

T = 90; C = 45; S = 45;

The simulation (t=2 sec) results are shown in figure 2.1

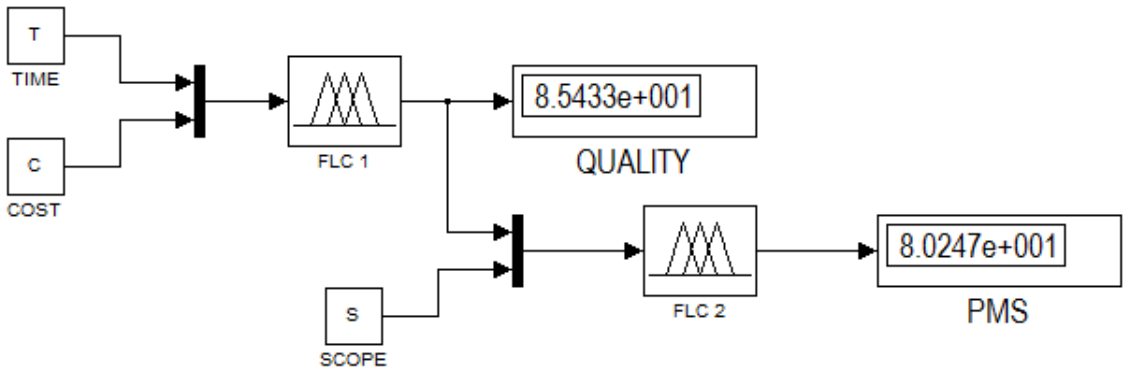

Figure 2.1 Simulation results

5.0 Conclusion

A new approach for evaluation of PMS of an organization using fuzzy logic reasoning has been proposed. The stage wise fuzzy reasoning provides a logical approach to PMS. The stage wise fuzzy reasoning approach was employed as it serves two purposes: (i) for determining Quality parameter based on Cost and Time of project. (ii) for determining PMS based on Quality and Scope of project. A Matlab simulink model for PMS has been developed and the results are shown. The proposed framework develops a model that optimises the project constraints.

As an extension for future work one can consider the other constraints which further enhance the PMS of an organization. A fuzzy ordinal approach for PMS can also be employed which provides an effective methodology if the number of input parameters are quite large.

6.0 References

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