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Project Management Efficiency –A Fuzzy Logic Approach

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Abstract*: *Fuzzy logic is a relatively new technique for solving engineering control problems. This technique can be easily used to implement systems ranging from simple, small or even embedded up to large. The objective of this paper is to present an approach that utilizes a fuzzy decision making system (FDMS) to quantify the Project Management Efficiency (PME). The algorithm developed in this paper is based upon fuzzy logic, giving it the ability to solve complex problems plagued with uncertainty and vagueness. A fuzzy decision making system is designed and implemented using the MATLAB Fuzzy Logic tool box for the evaluation of the PME. This algorithm once refined to each area under the industry of software development can be used for subsequent projects, saving large percentages of time, money, and effort, without sacrificing quality

Index Terms*: *Project management efficiency; Fuzzy decision making system; Fuzzy sets; Project time delay; Project time delay gradient.

I INTRODUCTION

Effective management of projects is crucial for the development and survival of any economy because development is about growth and growth is about a series of successfully managed projects [11]. A project may be viewed as "the entire process required to produce a new product, new plant, new system, or other specific results" [10].In this fiercely competitive world, project organizations are forced to look for scientific tool that assist them in the evaluation of their projects. The project management team is responsible for producing the project output and hence the project management team must be constantly aware of the project goal, project purpose and project management efficiency. Project effectiveness, which is a synonym of project success, is measured or assessed in terms of the degree of achievement of project objectives.

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No doubt, for the successful completion and maintance of software projects, there is a need for effective project managers. The long proclaimed ineffectiveness of software projects to maintain their schedule, cost, and quality, continues to plague most development projects [6, 2, 5]. It has been observed that over half of all software development projects are considered a failure with respect to their cost and schedule [6, 3]. The software crisis must be addressed and, to the extent possible, resolved. To do so require more accurate schedule and cost estimates, better products, and higher productivity. All these can be achieved through more effective software management.

These factors include, but are not limited to, time constraints, tangible costs, and projects.

Extensive research has been done to develop sophisticated tools that can analyze and provide accurate information for the choice of investments and projects. Many of these researchers though, have faced the dilemma that much of their data is plagued by uncertainty, vagueness and approximation. This paper provides a good example and guide to processing vaguely defined variables, and variables whose relationships cannot be defined by mathematical relationships.

There is continuing interest by academics and practitioners alike in measuring and coping with project schedule uncertainty. Fuzzy logic has been proposed as an alternate approach to probability theory for quantifying uncertain related to activity duration. However, the fuzzy logic approach is not widely understood, and generally accepted computational approaches are not available.

The objective of this paper is to present an approach that utilizes a fuzzy decision making system (FDMS) to quantify the Project Management Efficiency (PME). The evaluation of PME can serve for project managers and for project organizations as an indicator for the level of achievement of the project management objectives. PME may help in the evaluation of the performance of project teams.

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II OUTLINE OF STUDY APPROACH

As mentioned above, for the project management efficiency (PME), the major measure is project time delay (PTD) and an additional set of variable namely Project time delay gradient (PTDG) is also considered. Hence the combined impact of PTD and PTDG might be evaluated, for example, according to fuzzy decision rule like the following:

If PTD is Low (L) and PTDG is high (H), then PME is very high (V_H).

However, the boundaries of Very High, High, Medium, and Low of any decision variable are determined by experts of the project organization.

A fuzzy decision making system is a scientific tool that can be used to solve the problem. This means that information of expert knowledge and experience in a FDMS system is used for determining PME. The development of such a fuzzy decision making system is easily implemented using the MATLAB software. MATLAB fuzzy tool box is a menu driven software that allows the implementation of fuzzy constructs like membership functions and a database of decision rules. The software is easy to use and it is user friendly. The Project Management Efficiency (PME) can be determined by entering the values of PTD and PTDG.

Section III presents the introduction of fuzzy logic and fuzzy set theory (FST).Section IV provides a discussion of fuzzy decision making system (FDMS) steps. Section V explains the model building and FDMS to determine the PME.

In section VI, scenario is explained for various variable values using FDMS build using MATLAB software. Finally the conclusion and future aspects are to be presented in last section.

III FUZZY LOGIC AND FUZZY SET

Fuzzy logic is a relatively new technique (first appeared in 1970s) for solving engineering control problems. This technique can be easily used to implement systems ranging from simple, small or even embedded up to large. The key idea of fuzzy logic is that it uses a simple and easy way in order to get the output(s) from the input(s), actually the outputs are related to the inputs using if-statements and this is the secret behind the easiness of this technique. The most fascinating thing about Fuzzy logic is that it accepts the uncertainties that are inherited in the realistic inputs and it deals with these uncertainties in such away their affect is negligible and thus resulting in a precise outputs.

Although fuzzy control was not the first engineering application of fuzzy logic, it was the first application that drew huge attention to the practical potential of fuzzy set theory. It uses many elements of fuzzy logic to define a rule-base for the controller.

Fuzzy set theory (FST) is a generalization of the ordinary set theory.

A fuzzy set is a set whose elements belong to the set with some degree of membership μ.

Let X be a collection of objects. It is called universe of discourse. A fuzzy set A ∈ X is characterized by membership function $\mu_A(x)$ represents the degree of membership, Degree of membership maps each element between 0 and 1.

It is defined as :

$$A = \{(x, \mu_A(x)); x \in X\} \qquad 1$$

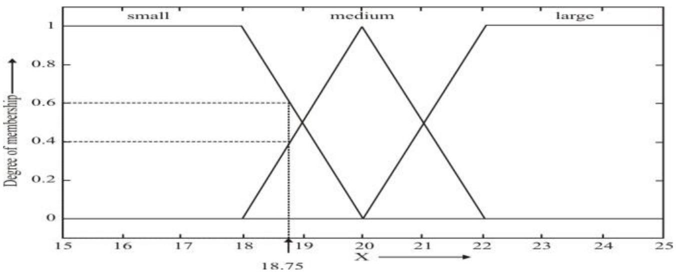

Figure 1: Fuzzy logic membership function

It shows the membership functions of three fuzzy sets viz. “small”, medium” and “large” for a fuzzy variable X. The universe of discourse is all possible values of Xs. It is X = [15;25]. At X of 18.75, the fuzzy set is a “small” with membership value of 0.6.

Thus, $\mu_{small}(18.75) = 0.6$, $\mu_{medium}(18.75) = 0.4$, AND $\mu_{large}(18.75) = 0.4$

The support of a fuzzy set A is the crisp set of all points x∈X such that $\mu A(x) > 0$. The core of a fuzzy set is of all points x∈X such that $\mu A(x) = 1$. A T norm denoted by *. It is a two place function from [0,1] x [0,1] to [0;1]. It includes fuzzy intersection, drastic product, algebraic product and bounded product as

$x * y = \min(x, y)$ and $x * y = xy$

$$x * y = \begin{cases} x : y = 1 \\ y : x = 1 \\ 0 : x, y < 1 \end{cases} \qquad 2$$

There are various types of membership function in fuzzy logic. Some standard membership functions are given here. Membership functions contain the membership values of elements in fuzzy set. Membership values can lie between 0 and 1.

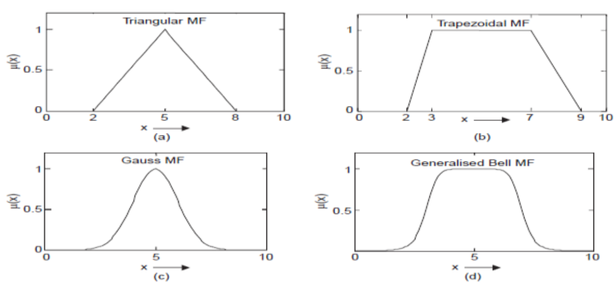

Figure 2: Fuzzy logic membership functions

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IV FUZZY DECISION MAKING SYSTEMS

Fuzzy inference systems (FIS) are rule-based systems. It is based on fuzzy set theory and fuzzy logic. FIS are mappings from an input space to an output space. FIS allows constructing structures which are used to generate responses (outputs) for certain stimulations (inputs). Response of FIS is based on stored knowledge (relationships between responses and stimulations). Knowledge is stored in the form of a rule base. Rule base is a set of rules. Rule base expresses relations between inputs of system and its expected outputs. Knowledge is obtained by eliciting information from specialists. These systems are usually known as fuzzy expert systems. Another common denomination for FIS is fuzzy knowledge-based systems. It is also called as data-driven fuzzy systems.

A fuzzy decision making system (FDMS) is comprised of four main components: a fuzzification interface, a knowledge base, decision making logic, and a defuzzification interface [7 ,4]. In essence, a FDMS is a fuzzy expert system (FES). Fuzzy expert systems are oriented towards numerical processing where conventional expert systems are mainly symbolic reasoning engines [1,8,9]. Fig. 3 provides a framework for the interrelationships between the components that constitute a fuzzy decision making system (FDMS).The four components are explained as in the following:

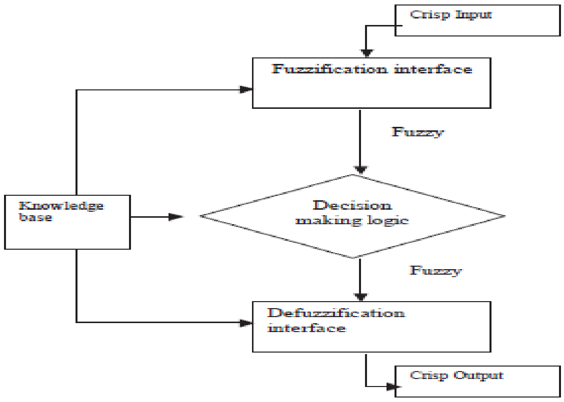

Figure 3: A Frame work for fuzzy decision making (FDMS)

1. The fuzzification interface: It measures the values of the input variables on their membership functions to determine the degree of truth for each rule premise.

2. The knowledge base: It comprises experts' knowledge of the application domain and the decision rules that govern the relationships between inputs and outputs. The membership functions of inputs and outputs are designed by experts based on their knowledge of the system and experience.

3. The decision making logic (DML): It is similar to simulating human decision making in inferring fuzzy control actions based on the rules of inference in fuzzy logic. The evaluation of a rule is based on computing the truth value of its premise part and applying it to its conclusion part. This results in assigning one fuzzy subset to each output variable of the rule. In Min Inference the entire strength of the rule is considered as the minimum membership value of the input variables' membership values [8].A rule is said to be fire, if the degree of truth of the premise part of the rule is not zero.

4. The defuzzification interface: It converts a fuzzy control action (a fuzzy output) into a nonfuzzy control action (a crisp output). The most common used method in defuzzification is the center of area method (COA). The COA method computes the crisp value as the weighted average of a fuzzy set.

V MODEL BUILDING

Once identified the objective of the model, it is possible to begin to define the rules that compose the model. These rules are very subjective and vary a lot from researches to researches and from area to area. Therefore, this model is composed of logic where most of the researchers could agree upon as well as through my own experience & study.

This model composes the proposed algorithm and was programmed using the MATLAB software, where Fuzzy Logic techniques were implemented. To understand the model it is important to define what the following terms mean:

Project Time Delay: – This term refers to the time that the project will be delayed due to the inherent risks in the project contributing to a project failure. This term has a very close relationship to the project failure.

Project Time Delay Gradient: – This term refers to the impact that a project delay will have upon a given project. This term has a very close relationship to the impact of a project failure.

Project Management Efficiency: – This term refers to how desirable a project is based upon how high the failure is and how high is the impact of this failure.

PME (Project management) efficiency is a vogue or uncertain quantity. Fuzzy logic is initially introduced to deal with the fuzzy or ill-defined problem. To use fuzzy decision making for the project management efficiency (PME) the following procedure is proposed.

○ Identify the inputs and outputs variables

○ Find the factors the affect the PME. According to this work approach, the major factor that is contributing to the PME is PTD i.e. project time delay and corresponding priority PTDG (Project time delay gradient).

○ Assign membership functions to the variables (fuzzy subsets).

○ Build a rule base.

○ Determine decision rules: Expert knowledge experience and various sources in the literature are used here for the development of IF-THAN rule that governs the relationships between inputs and the output

▪ The first function that our fuzzy system is to perform is that of fuzzification. These to do this, we must define what is Low, Medium, High and Very High, in terms of various variables like PTD,PTDG and PME..

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- To define this commonly used techniques one proposed by Wang and Mendel Approach. In this approach the input and output variable are divided into various regions using some clustering technique namely fuzzy C-means clustering (FCM) and these are represented below.

Variable	INPUTS		OUTPUT (PME)
	PTD (Project Time Delay) (0-100)	PTDG (Project Time Delay Gradient) (0-100)	(Project Management Efficiency) (0-100)
LOW (L)	0-30	0-25	0-20
MEDIUM (M)	20-50	20-45	15-55
HIGH (H)	45-75	40-70	45-80
VERY HIGH (V_H)	65-100	65-100	75-100

Table 1: Input /Output Variable Representation

The model build using fuzzy logic tool box is represented below:

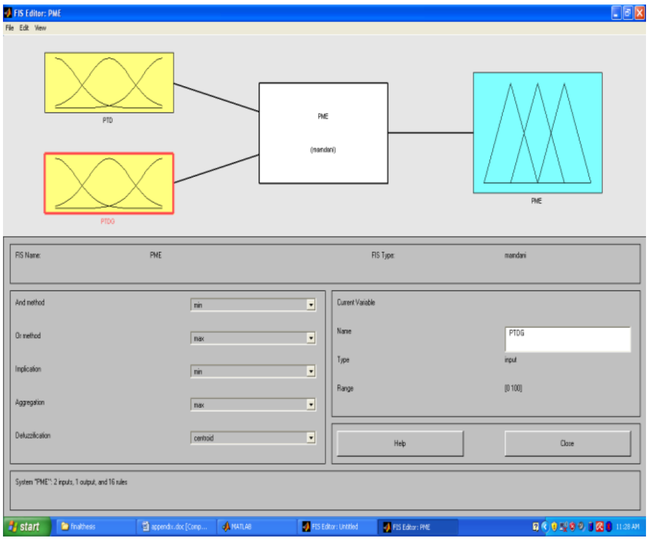

Figure 4: MAMDANI based fuzzy inference system PME

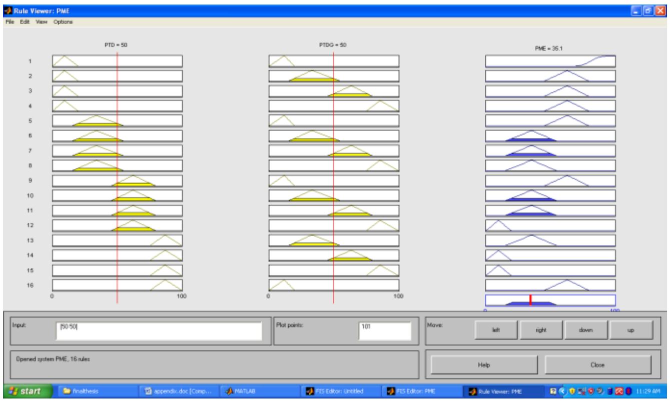

Figure 5: Rule viewer

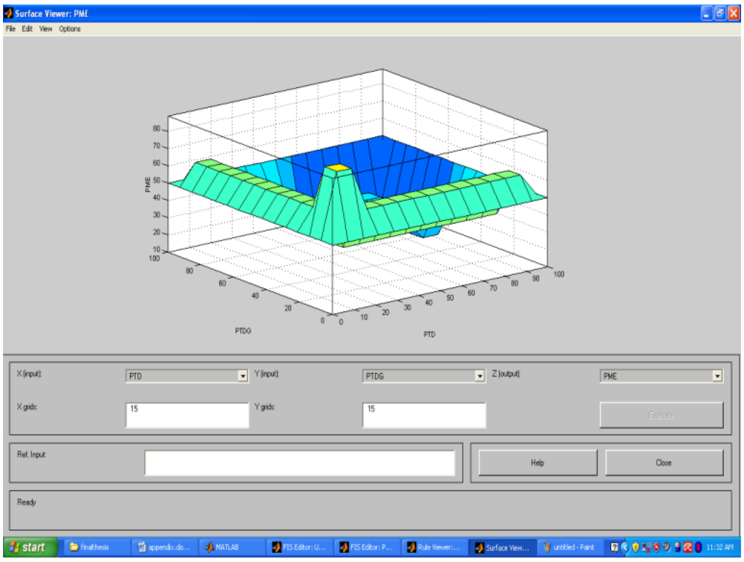

Figure 6: Surface viewer

VI SCENARIO

A scenario have been introduced to represent the developed Fuzzy rule base Model and evaluated using Matlab scripts, Rule viewer and 3Dgraphs for the Project Time Delay (PTD) and Project Time Delay Gradient(PTDG) to determine the Project Management Efficiency (PME).

S.No.	INPUTS		OUTPUT (PME)
	PTD (Project Time Delay)	PTDG (Project Time Delay Gradient)	(Project Management Efficiency)
1.	10.8	11	89.3
2.	35.3	32.5	35.2
3.	59.7	59.8	35.2
4.	87	85.4	10

Table 2: Input/Output Values Representation

VII CONCLUSION AND SUGGESTIONS

The results of first four scenarios are compatible as per reasoning to know the project management efficiency. It is safe to assume that the developed model is working correctly.

These results show that it is easy to choose between a project that is of low, medium and high project management efficiency, rather it becomes difficult to choose the projects that have high project management efficiency. This can never be eliminated but it can be fine, tuned by adding more variables to the analysis. In terms of reasoning and hypothetical data, the algorithm is working correctly, but in order to test the integrity of the algorithm, it should be applied to test the projects (in the fields), past and present, failed and successful.

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The work presented in this paper opens up a realm of possibilities where future researchers can develop more powerful, user friendly software.

The factor project quality can also be considered and converted into fuzzy logic.

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