Fuzzy Logic based Monitoring Framework for Software Projects

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ABSTRACT: *The Software Industry in Pakistan plays a prominent role in the Pakistan Economy. As per a report given by PSEB in the year 2008, they generated revenue of about 10 Billion Revenue per annum. However, the research indicates that only a little percentage of Pakistan software development companies has implemented formal software monitoring and software process assessment methods. One such study emphasizes that the Pakistan software companies are engage in formal Software Process Improvement or software monitoring assessments because of the high cost and high resources involved.*

Fuzzy logic always used to differentiate true or false clearly. As if we can say that the major factor that plays an important role to fails the project we can say that there is little bit misunderstanding in requirement engineering and requirement management and this thing always highlighted and most of the forums many of the authors documented in their papers. Another factor that involves in project failure that will be design strategies and testing process.

Key words: Software Process Improvement (SPI), Pakistani Software Industry, Pakistan Software Export Board (PSEB), Small Medium Enterprise (SMEs), Extended Maturity Questionnaire (EMQ)

1. Introduction

In these days Pakistan software industry facing major problem due to the lack of assessment and monitoring activities that monitoring activities performed in big organizations but not in small to medium organizations, And those companies with the help of these activities then will be eligible to follow the international standard organization ISO 9001 and capability Maturity Model Integration CMMI, with the help of these standards then can reduce the total budget, labor and the main objective of these activities that they can also reduce time.

When we talk about the small companies we can say and this is fact that these organizations or companies give less time and importance to these activities. We can say that in these companies one employee plays many roles but his specialty is only in one field. A Developer his core responsibility and specialty is only development but in small organization at the same time he plays the duties of quality assurance, Software Engineer , programmer and similarly web designer. For those companies who involves in these activities definitely they this thing not only destroy the quality of the organization work but it also disturb the whole project. The main thing that we note that why the small organizations avoid to follow the international standards because the expensive compliance effort in time quality, money and effort too. In below mentioned some main points that we are highlighted.

The existing Artificial Intelligence approaches and techniques have been adopted from other disciplines by software community to deal with software requirements. The main issue in adoption of these techniques is deciding; when to use which technique/approach and how? As stated earlier, the nature of software requirements makes certain challenges for monitoring techniques; therefore, software engineering specific general purpose framework is required. By general purpose we mean that it will be adaptable for most of the market driven software systems.

The objective of this work is the development of a framework for monitoring and easy assessment of their level of maturity in software development. The suggested framework would serve as an upper layer technique of other existing techniques. It has been observed as showing maximum benefits with lowest computational overhead. It is flexible enough to be used for minor, average and even large integer of requests. Its processes could be made computerized at maximum level but still reflect user inputs. From user perspective, it is easily comprehensible i.e., take a list of desires and produces output in a series of releases created on their priority area.

In order to succeed our objective we have presented our work in four main sections. First is to present the actual need of monitoring in requirement engineering and other engineering fields by

giving the benefits with it and pitfalls without it. The purpose of highlighting its importance also advocates familiarizing this activity in every requirements engineering model. The second involvement is to discover the key modules of this process. One of these main modules is recognition of main stakeholders along with their view weights.

The key contribution of our work to reach our main objective is the idea of emerging a cohesive, upper layer framework that is specific regarding software process improvement framework fields and generic with respect to problems domain i.e., suitable for any kind and length of software requirements. A systematic review of existing ordering approaches, methods and tools will also be presented as a key contribution. They will be examined critically and a comparative analysis will be provided. Each technique's strengths and weaknesses shall be discussed. The understanding of these techniques will be very helpful in designing of a new approach, technique or tool. At the end, we will present our developed framework. The developed framework shall be applied on a real work for a company being newly introduced to Capability Maturity Model Integration (CMMI), for quick self assessment. Our framework can be accessed freely as an online tool to support organizations continuous and regular assessment.

2. Literature Review

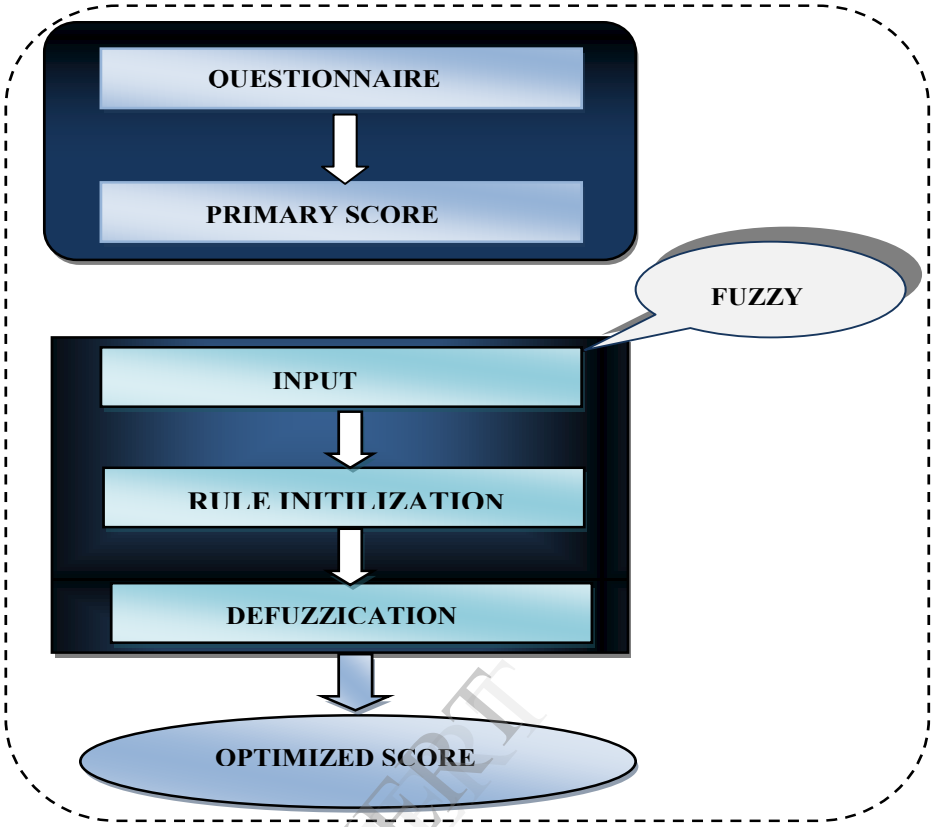
While reviewing the literature we learnt that there are number of studies that have been conducted to investigate the issues related to Software Process Improvement.

Lotfi A. Zadeh (Zadeh 1965) introduced his work with the subject "Fuzzy Sets" that defined new fuzzy set theory and especially the fuzzy set theory mathematics and new terms related to the fuzzy logic and near to the fuzzy logic. Also Zadeh proposed a new technique that can be help full in creation of membership functions that can operate the range of the only real numbers. One of the important and famous work that proposed by the Zadeh that was new operations that can help to solve the calculus problems. **Fox (1981)** he presented his one of the famous and most important argument that we can say that classic logic and fuzzy logic we can't see the competitive to each other but mostly complementary from each other. He also responded that Hacks' claims that are only a reason of lack of clarity in his words like semantics, so that's the reason that fuzzy logic statements may can be easily translatable into phrases and this idea taken from classical logic. Fox also gave some solid reasons that he has objections in few points, that's there are only three fields where fuzzy logic can be helpful and those three areas are "requisite" that's describes real worlds relationship between each other and this thing was inherited from fuzzy logic. Second "prescriptive" as some data extracts from fuzzy so that's why fuzzy calculus for this problem. Third "descriptive" some systems are inherited from fuzzy so inference here. **Wang and Mendel (1992)** introduced a new way to extract fuzzy rules from different data like numeric data. One of the most power full work from wang and mendel that with the help of this technique that developed both wang anf mendel we can combine both mathematical and semantic information in a common developed framework and named of this is a fuzzy rule base. The developed framework or rule base contains of two different type of fuzzy rules: and these rule base one will be developed from different experts that have the knowledge of the domain and other generated after using the special method and that will called numerical data. **Jacques Lonchamp et.Al (1993)** proposed A technique that were nearly relevant to the organized abstract and terminological framework that will be help in Software Process Engineering. This framework was describes the previous work in clarification and also specify the shortcomings in this field. So that's why this framework was also some issues like its more focus on the general only on the meta process model and we clearly knows that this meta process model contains or deals only process modeling. Similarly for this reason it only deals with the enforcement oriented process modeling.

3. Proposed Framework

Our proposed framework is a collection of questionnaire and on the basis of questionnaire primary score will be generated through our developed online tool. That tool not only specify the primary score but it also generated a detailed report and that report will be on the basis of different organization members. When we talk about the fuzzy logic tool we can say that if and else rules applied with the help of our developed tool and on the basis of this score that were generated from questionnaire give to the framework. Below mentioned diagram indicates all about the specified framework and step by step processing. It helped us to identify the weak areas of an organization

and propose what approach or action will lead to improvement. Five small software organizations with respective points from every process area are given in table 2.



Proposed Framework (Figure1)

Questionnaire

EMQ was taken as the tool for data collection as we knew that it is simple, easy to handle. We designed a 5 scale EMQ with 5 answers,

- Achieved
- Partially Achieved
- Does Not Apply
- No
- Don‟t Know.

EMQ‟s were given to a minimum of four persons in each organization; sufficient time was given to finish the questionnaire. Then they filled in and answered questionnaire form was collected back to them. Questionnaires were given to mainly Software developers and team leaders and project manager / project leader. Based on the individual answers about each process area, marks were allotted and a final score was calculated for each process area from the four questionnaires. Similarly, all process area scores were calculated and finally they were summed up for a final score of the corresponding organization.

Primary Score

The primary scores were processed with the help of fuzzy logic. After obtaining primary score it is assumed that some Organizations which are good in some process areas, average performance in few areas and show poor performance in remaining. It is also observed that two organizations stand in same level in some process areas. In such a situation it is very difficult to find the best organization. This type of ambiguity was eliminated applying fuzzy logic technique.

Capability Maturity Level of each organization is shown in the graph 1, 2 these graph depicts the final result of each organization after the implementation of framework. Primary score is shown in table-2.

Fuzzy Inputs

The term "fuzzy logic" introduces by Zadeh is used to handle situations where precise answers cannot be determined. Fuzzy logic is a form of algebra which is based on the two values true and false, for the purpose of decision making with imprecise data. Fuzzy logic uses the whole interval between 0 (false) and 1(True) to describe human reasoning. As a result, fuzzy logic is being applied in various real world problems. Zadeh explained that the purpose of fuzzy logic is to provide a variety of concepts and techniques for representing and inferring from knowledge that is imprecise, uncertain or lacking reliability.

Rule Initialization

If-then rules specify the relationship between input and output. Our rules totally depend on the results that received from questionnaire that were filled from different organizations employees. Furthermore we can say that if a rule has contains one part like if x is 1 and y is 2 then z is 3. The fuzzy logical operators are always applied to evaluate the results obtained from our proposed framework.

4. Case Study and Discussion of the results obtained

The assessments were conducted in order to validate the framework. The questionnaire was distributed to four Pakistani software organizations. For experimental purpose, the organizations are coded

„A", „B","C", and "D". We just demanded to the organizations that they send us the major sources of data in organization such as plans, models and relevant documents before responding to the questionnaire, in order to reduce the tendency to overestimate or underestimate their Organization, while filling the questionnaire. Since we have given the same set of questionnaire to different persons in an organization, we used an average of all the responses received from the particular organization.

The results were given in table 3 & 4. They show organization A has higher scores and has the higher success rate to attain CMMI level. Organization B has score nearer to organization A and it is capable of attaining the CMMI maturity level early than other 2 organization. Further assessment of organization C by the authors indicated that the organization can attain CMMI level with a little more effort.

Group Analysis

V. H. – Very High
V. L. – Very Low

Organization	PM	ENG	PRO M	SUP	Total
A	17.594 V.H	16.536 V.H	12.296 L	14.37 H	60.796
B	14.52 H	17.364 V.H	12.244 H	14.996 H	59.124
C	12.424 H	13.736 H	16.204 V.H	16.25 V.H	58.614
D	11.176 L	13.108 H	13.424 H	9.992 V.L	47.7

Table: 1 Organizations Response

After receiving response from different organizations and it was clearly come to know that they were giving little bit attention on process improvement phases. Similarly they also accept that they were neglecting totally Capability Maturity Model Integrations rules and instructions. These organizations were influenced by the knowledge and capability of senior most personalities in the organization.

4.1 Industry Trends

Grand Total (Intermediate Score)

ORGANIZATION NAME	PROJECT MANAGEMENT	ENGINEERING	PROCESS MANAGEMENT	SUPPORT
Rose Software technology park	87.97	82.68	61.48	**71.85**
Netsolace Information technology	72.6	86.82	61.22	**74.98**
Rawalz Software	62.12	68.68	81.02	**81.25**
Intellegentsia Software	55.88	65.54	67.12	**49.96**

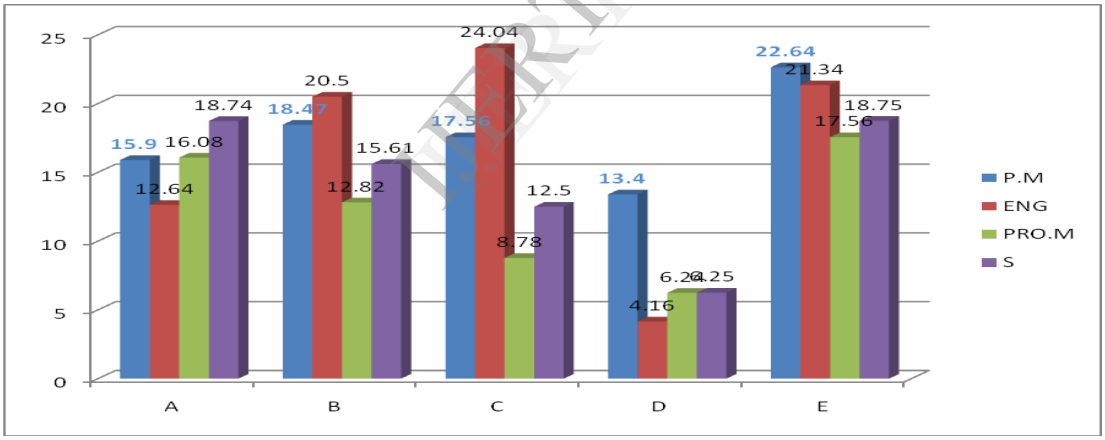
Table: 2 Intermediate Score

ROSE SOFTWARE TECHNOLOGY PARK

	P.M	ENG	PRO.M	SP
01	15.9	12.64	16.08	18.74
02	18.47	20.5	12.82	15.61
03	17.56	24.04	8.78	12.5
04	13.4	4.16	6.24	6.25
05	22.64	21.34	17.56	18.75

Table: 3 Rose Software Technology Park

Graphical Representation



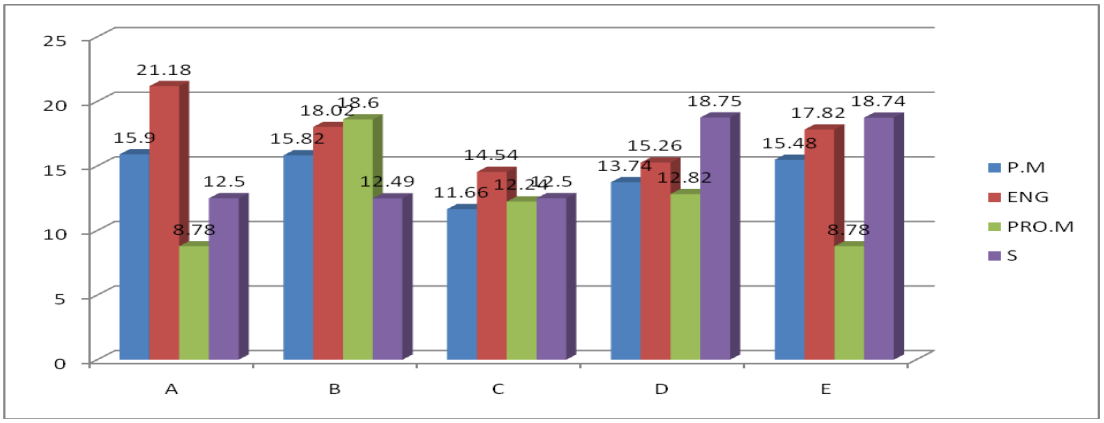
Graph: 1 Rose Software Technology Park

NETSOLACE INFORMATION TECHNOLOGY

	P.M	ENG	PRO.M	S
01	15.9	21.18	8.78	12.5
02	15.82	18.02	18.6	12.49
03	11.66	14.54	12.24	12.5
04	13.74	15.26	12.82	18.75
05	15.48	17.82	8.78	18.74

Table: 4 Netsolace Information Technology

Graphical Representation



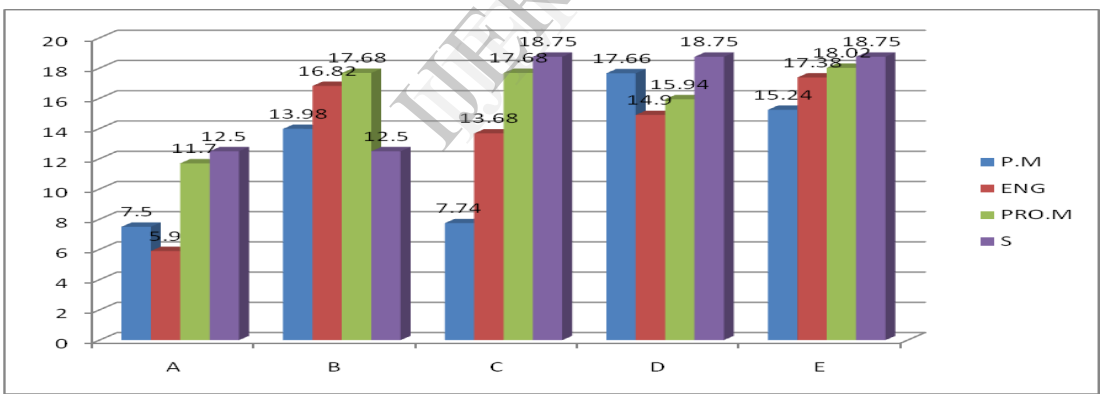
Graph: 2 Netsolace Information Technology

RAWALZ SOFTWARE

	P.M	ENG	PRO.M	S
01	7.5	5.9	11.7	12.5
02	13.98	16.82	17.68	12.5
03	7.74	13.68	17.68	18.75
04	17.66	14.9	15.94	18.75
05	15.24	17.38	18.02	18.75

Table: 5 Rawalz Software

Graphical Representation



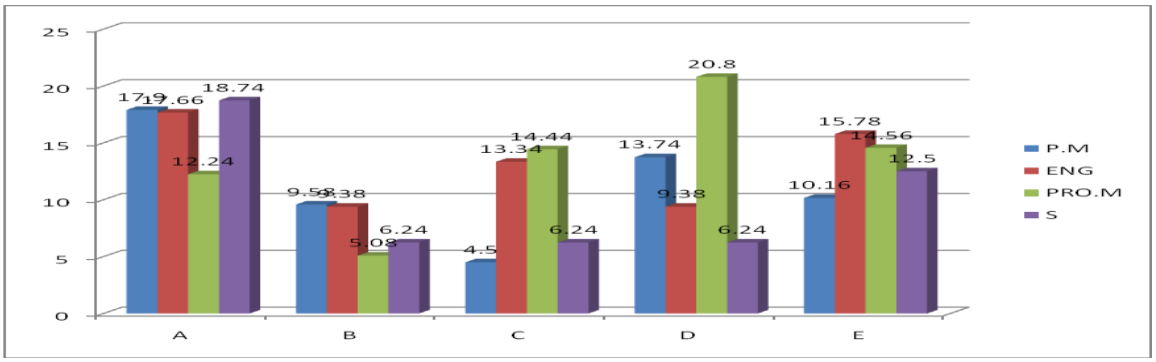
Graph:3 Rawalz Software

INTELLEGENTSIA SOFTWARE

	P.M	ENG	PRO.M	S
01	17.9	17.66	12.24	18.74
02	9.58	9.38	5.08	6.24
03	4.5	13.34	14.44	6.24
04	13.74	9.38	20.8	6.24
05	10.16	15.78	14.56	12.5

Table: 6 Intellegentsia Software

Graphical Representation



Graph:4 Intellegentsia Software

SUMMARY

A frame work was introduced for quick and fast understanding and also easy evaluation of any organization and that organization maturity level. This method is totally meant keeping in mind the smaller organizations or those organizations that are new introduced for Capability Maturity Model Integrations, for the assessment of organizations maturity. It helps to know the SSMEs, their level of maturity in each process area. This method was applied to five Small software organizations to assess their process activities. At the end we saw that our developed framework can be used for achieving purpose and for this reason a trial was applied to the organizations and it stated that 80% score indicate the good success of any organization. A higher score indicates that they are above the average level in each process area and their maturity level is high when matched to other organizations. A threshold can be located at a score of about 80% to indicate success. A higher score indicates that they are above the average level in each process area and their maturity level is high when compared to other organizations. Our Proposed framework can further be developed as an online tool so that it can better support organizations in continuous evaluation. It will help to assess their maturity level periodically. It also helps to improve organizations to attain CMMI standards.

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