SOFTWARE PROJECT COST ESTIMATION RISK INDICATORS IDENTIFICATION AND EVALUATION MODEL

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ABSTRACT: In this research an innovative technique has been introduced to evaluate the software project development cost. In this technique we used simple fuzzy rule base to create the fuzzy inference system to predict the estimated cost risk. Due to rapid change of the hardware and software technology previous research are needed to be reviewed including agile methods and innovative ideas are required in the software development industry. Proposed model is very fruitful for current dynamic development environment.

KEYWORDS: Cost Estimation, Cost Risk, Fuzzificaion, Agile Methods, Fuzzy Inference System, Rule Base, and Risk Indicators.

INTRODUCTION: Cost estimation is a process that is well suited to risk analysis techniques. It addresses its uncertainties which are inherent. In the beginning of 1970s, software cost engineers had devoted attention to this topic. In this reference, the Association for the Advancement of Cost Engineering gave the AACE International's Professional Practice Guide to Risk (Curran). It is a three volume set of 2,230 pages which contains 360 articles related to cost estimation risk analysis. Cost estimation risk analysis is an emerging area of interest across the length and breadth of the construction industry. With the institutional perspective, the Corps is moving in a direction of doing and requiring risk analysis in entire its programs. Such trend is not possible to be reversed anytime. The risk analysis of cost estimation is not required; it might happen in the future. It enables the agency to start the options and requirements for using risk analysis. All methods which best meet the needs of the agency can be get ready and implemented into idea for development of future cost estimating tools, future guidance, and training needs. So far as the cost engineers are the concerned they have already understood and addressed the uncertainty lying in the cost estimation. While addressing the uncertainties contingencies are used as primary techniques. The priority of the research is to evolve the risk analysis contingency methodologies. It is less clear, but more promising is the truth can render better decision making prospects. It identifies two vast categories of benefits from cost estimation risk analysis. It gives an aspect of improved accuracy of cost estimation and evolved decision making. [**1**][**2**][**3**][**4**][**5**][**6**]

RESEARCH OBJECTIVE: Nowadays in software development area hardware and software technologies are changing rapidly, therefore the established rules and techniques in software engineering fields are needed review or re-establishment. Software cost estimation is one of the crucial issues in the field of software engineering.

LITERATURE REVIEW: In this area background and concerned work of risk assessment and estimation models are being presented. Academicians, scientist and researchers in the field of software engineering have evolved many models as per their requirements [**7**]. Gupta and Sadiq [**8**] have developed a SRAEM to foresay possibilities of software projects with appropriate correctness. SRAEM model not only evaluates the risk but also estimates the risk of software. Here, the risk is being estimated using risk exposure and specific software metrics of risk management. It is based on critical requirements stability risk metrics (MCRSRM) [**9**][**10**][**11**]. This software metrics is used when changes occur in requirements like addition, subtraction and update. Gupta et al. [**12**] evolved a software estimation tool which is based on software engineering metrics model. In literature, there are a few published models that estimated the risk of software projects. In Kashlaf and Hashim [**13**] evolved a model to manage software risks. Soft risk prototype is a nice tool which manages software development risks. Java language has been chosen for the development. Software engineering risk model (SERIM) focuses on three risk elements: (i) technical risk, (ii) cost risk, and (iii) schedule risk. In the list of risk assessment models there is another model known as software risk assessment model (SRAM) [**14**], which considers the nine critical risk elements (i) complexity of the software (ii) staff involved in the projects (iii) targeted reliability (iv) product requirement (v) method of estimation (vi) method of monitoring (vii) development process adopted (viii) usability of software (ix) tools. The above models do not take the sources of uncertainty, like measurement error, model error and assumption errors. Existing models have been taken for the prioritization as a single step of risk estimation. It does not specify how prioritization would be done. In [**15**] we also proposed the architecture of an esrcTool to evaluate the software risk and cost. As on systematic review of software risk assessment and estimation model [**16**], it is an extension of the work of Georgieve et al. [**17**], here we find 11 primary findings which are associated to software risk and cost estimation and its description is given in Table 1. The outcome of previous work indicates that *SRAEM* [**8**] and *SRAEP using model based approach* [**18**] is the latest risk assessment model in the literature [**16**][**17**].

PROPOSED SOFTWARE COST RISK EVALUATION MODEL: This proposed model is based on the fuzzy logic theory. We notice that some parameters are represented in qualitative manners. Software risk parameter is also a parameter which holds the qualitative value. Sometimes whenever multiple parameters which holds qualitative value, we find that it is difficult to relate them and collective result for prediction, in such scenario fuzzy logic is very effective tool to handle (Figure 1).

Figure 1. Software cost estimation risk evaluation using fuzzy infrence system

Table 1. Software Cost Risk Indicators		
S.N.	**Risk Indicators**	**Abbreviation**
1	Planned value	PV
2	Actual cost	AC
3.	Earned value	EV
4.	Cost variance	CV
5	Schedule Variance	SV
6	Schedule Performance Index	SPI
7	Cost Performance Index	CPI
8	Percentage of projects completed on time	PPCOT
9	Percentage of Cancelled Projects	PCP
10	Project Resource Utilization	PRU
11	Cost of managing processes	CMP
12	Return on investment	ROI

Software cost risk indicators have been identified through literature review and online case studies. Total 12 indicators are found which affects the software cost. In this research qualitative values are collected and as per the different development conditions rule base/ knowledge base were created. In this research 10 rules have been created and these rule bases are applied in inference system to evaluate the cost risk based on the qualitative value of cost risk indicators. Table 1 shows the list of software cost risk indicators. We can see in given Figure 2, this is triangular function for the fuzzification / de-fuzzification process. In this process we used three triangles for Low (L), Medium (M) and High (H) input output qualitative value and finally we evaluate its quantitative value with the help of its membership function value. Horizontal line of the triangle represent the input value and vertical line of the triangle represent the membership function value, by combining these value crisp value of the particular input can be evaluated. The different condition of the rule base used to represent in if () then else condition. Aggregations of these rules are done by different aggregation methods like min, max and centroid. Figure 3, shows the rule viewer where we can fix the value of each risk indicators by the vertical moving line over the triangle.

Table 2. Software Cost Estimation Risk Indicators Rule Base													
S.N.	**PV**	**AC**	**EV**	**CV**	**SV**	**SPI**	**CPI**	**PPCOT**	**PCP**	**PRU**	**CMP**	**ROI**	**Cost Risk(CR)**
1	L	H	H	H	M	H	H	H	L	H	H	M	M
2	H	H	M	L	H	H	H	M	M	L	L	L	H
3	M	L	L	L	M	L	H	M	L	L	M	M	H
4	L	L	H	H	H	M	M	M	H	H	H	H	L
5	H	H	M	M	M	M	H	H	H	L	L	L	M
6	M	M	L	L	H	M	L	M	M	L	L	M	M
7	L	L	L	L	M	M	M	M	H	H	M	M	H
8	L	L	M	M	M	H	H	H	H	H	H	H	H
9	H	H	H	H	H	M	M	M	L	L	L	L	M
10	H	H	M	M	L	L	H	H	L	L	H	H	L

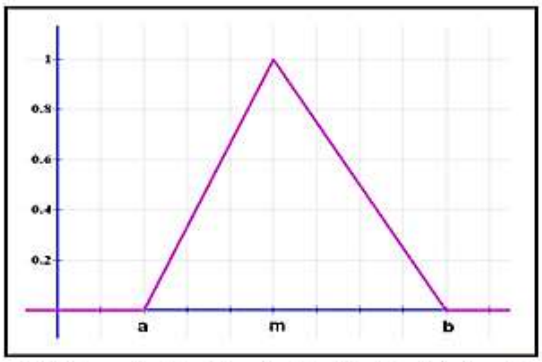

Figure 2. Triangular function for fuzzification/Defuzzification

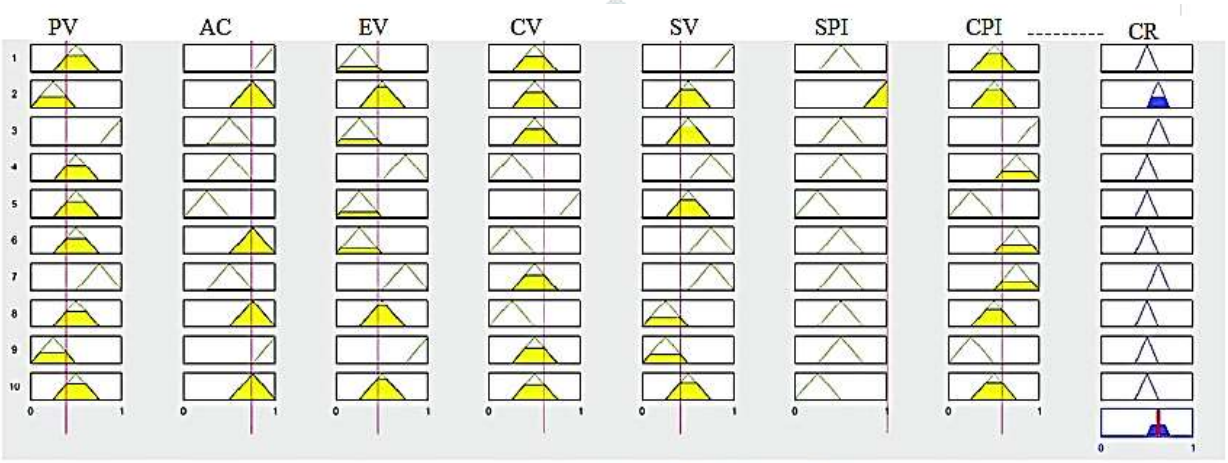

Figure 3. Software Cost Estimation Risk Evaluation Rule Viewer

CONCLUSION AND FUTURE RESEARCH: In this research 12 software cost risk indicators have been identified and 10 rules are applied to predict the software cost risk. This fuzzy inference system based rule evaluator will not be obsolete by the changing of hardware/ software technology as time passes. This model is very appropriate to adopt the dynamic development environment. The sensitivity of the software cost indicators are needed to assess through some AI based tools. Further few more risk indicators can be identified and rule cases can be enhanced for more accuracy of the proposed model.

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