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COMPARISON AND ANALYSIS OF IT PROJECT RISK ASSESSMENT MODEL METHODS: PROPOSED ENTROPY RISK ASSESSMENT METHOD WITH MANUAL CALCULATION METHOD AND FUZZY TECHNIQUE BASED RISK ASSESSMENT

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Abstract— **Software Development of projects encounter varied risks which influence project success adversely. Current status of projects indicates crucial need of an effective risk assessment model and methods which can identify and assess risks better. A software project risk assessment model based on three approaches viz. manual calculation, fuzzy method and entropy based is proposed. An earlier paper on entropy method indicates its merits and proposed this method for effective risk assessment. In this paper a comparison of the results of risk assessment via above three methods is made and analyses of the results indicating their significances. These three methods were implemented through spreadsheets and program algorithm implementations and thus the results obtained and analyzed.**

The risk assessment model and all the three methods can be helpful to the software development project managers and their teams, since the entropy method can give them ease of usage & implementation, fast calculations, accuracy of results of their software development project risk assessment effectively.

Keywords— **Software Development Project Risk Assessment Model Methods Comparison, Entropy Method for Risk Assessment Model, Fuzzy Method for Risk Assessment Model, Manual Calculation Method for Risk Assessment Model**

I. INTRODUCTION

The Software Project Risk Assessment Model was studies with literature review indicating gap showing the need of an effective risk assessment model. Preliminary surveys conducted to understand the IT practitioner's views on risk factors and risk assessment aspects relevant to risk assessment. The literature review included thorough study of risk management frameworks, risk taxonomies and risk management standards like PMI PMBOK® IT project Risk management processes [1-10]. Detailed study and analysis of different techniques of software development project risk management techniques like Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Monte Carlo Simulation (MCS), Fuzzy Technique probed in creating mechanism to find suitable technique for better risk assessment [11-12].

The practitioner's perceptive survey of their views on imperative risk factors & assessment helped in contributing to the risk assessment model created in this research. The limitations of above techniques and literature review furthered us to study entropy techniques impactful application to risk assessment model [13-15, 25].

Each of the above inputs have contributed and decisively facilitated us to create an effective risk assessment model including the cost based and non-cost based risk factors & risk assessment [16-21].

The proposed method of risk assessment is Entropy Method. Other two methods created in model are manual calculation and fuzzy method. A comparison of proposed Entropy based risk assessment model with existing ones has been studies in

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this paper. The results of the dataset are analyzed, evaluated and compared with these methods.
The rest of the paper is organized as follows. Proposed comparison of risk assessment model methods are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROPOSED COMPARISION OF RISK ASSESSMENT MODEL METHODS –

Comparison of proposed Entropy Based Risk Assessment Method for Risk model with existing Manual Calculation of Risk Assessment and Fuzzy Based Method of Risk Assessment Model is done, by implementing the methods through computer calculations, programs. These methods work on risk assessment model which uses the cost based Risk Model created by us during this research work[1-25].
The models are populated with data & results are calculated, then these metrics on the result give useful insights on the performance of the models.
1. Process & Steps of Model Evaluation:
Methodology used to evaluate the models:
1.1 Data collection : It uses the cocomo-sdr public datasets
1.2 Risk Assessment Model Evaluation: Model is created based on the standards, rules, references used by expert cocomo, cocomo2, and referred to relevant important research findings of Tim Menzis.
1.3 Data Analysis : The project's risk data points are evaluated through each method and results, obtained, evaluated and analysed with appropriate metrics.
1.3.1 Obtained Results of Proposed Entropy based Risk Model, Entropy Based Risk Model implemented with by creating .m, .fig files, matlab program source code created in this research study is based on algorithm of our research publication
1.3.2 Fuzzy Based Risk Model implemented with by creating FIS files, matlab Fuzzy Inference System program source code is created in this research study
1.3.3 Obtained Results of Existing Manual Risk Model – By implementing Risk Model using spreadsheets in MS Excel.
All methods are executed & implemented with the IT project's risk related data. They show how these models help in improving in depth the strength of RISK ASSESSMENT Level[1-25].

1.1 IT Project Risk Management related Data collection:

IT Project risk management related Dataset is used for testing the IT Project Risk assessment models. The datasets is public dataset with 12 data points i.e. no. of projects.

1.2 Model Evaluation:

The evaluation of manual calculation method, Fuzzy method, and Entropy based method of Risk Models consists of 3 main processes:
1.1.1 Make a risk assessment using manual calculation method MAN_CALC
1.1.2 Make a risk assessment using Fuzzy method Fz_Calc
1.1.3 Make a risk Assessment using Entropy based method Entropy
1.1.4 Calculate, analyze co-relation coefficient, coefficient of determination R^2
Once the above all processes are implemented with project data, data analysis step is followed with.

1.3 Data Analysis:

Data Analysis is to compare the risk assessment results of manual calculation method, Fuzzy method, Entropy based method methodologies respectively.

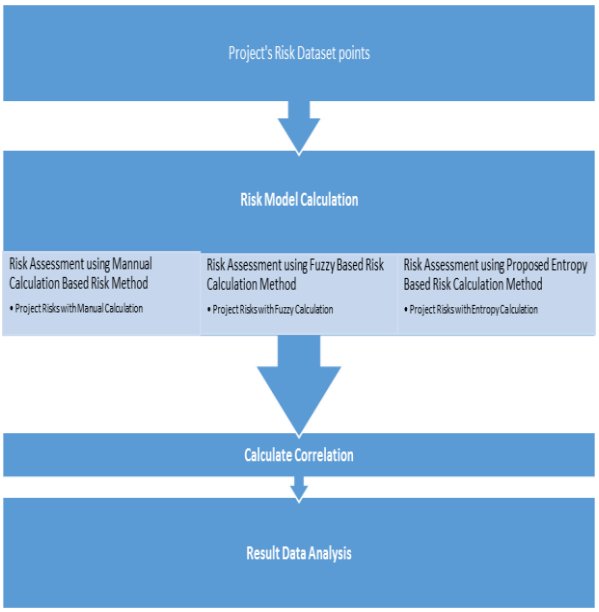

Fig1. Risk Model Evaluation Steps

III. EXPERIMENT AND RESULT

A. *Risk Assessment Model Manual Calculation Based Method Evaluation*

Risk Assessment using manual calculation methodology is based on the Risk Model created which is based on cocomo2 methodology, our derived reference model's cost based risk factors & model as mentioned from above model prescribed by this research study which has been based taking literature references from earlier expert risk models.

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The output of "Manual Method of Risk Model" emerges as Project Risks which consists of various risk values of schedule risk, product risk, platform risk, personnel risk, process risk and reuse risk.

Analysis:

From data set of 15 project points, MAN_CALC determined that out of 12 projects 9 were categories as low risk and 3 were medium risk projects.

Table - 1 provides **partial list** of **risk assessment results** using **MAN_CALC** for project **data set**.

Table - 1 Manual Calculation:

Proj_ID	Size (KSLOC)	Actual Effort (person-mo)	Risk_Level	Project Risk
1	3000	1.2	LOW_RISK	62.6929
2	2000	2	LOW_RISK	69.0494
3	4250	4.5	LOW_RISK	76.2454
4	10000	3	LOW_RISK	63.9438
5	15000	4	LOW_RISK	87.4967
6	40530	22	MODERATE_RISK	107.1441
7	4050	2	MODERATE_RISK	114.5001
8	31845	5	LOW_RISK	90.8471
9	114280	18	MODERATE_RISK	169.2621
10	23106	4	LOW_RISK	84.0309
11	1369	1	LOW_RISK	36.83874
12	1611	2.1	LOW_RISK	33.51586

B. *Risk Assessment Model Fuzzy Based Method Evaluation*

Risk Assessment using Fuzzy calculation methodology is based on the Risk Model created which is based on Fuzzy Inference System methodology, our derived reference model's cost based risk factors & model as mentioned from above model prescribed by this research study which has been based taking literature references from earlier expert risk models. The Fuzzy Inference System (FIS) is implemented based on Risk Model & risk factors from this research study, risk rules of risk factors & corresponding risk levels from the project data points mapped from expert cocomo, cocmo2 based risk model created in this research study. Fuzzy Inference system in matlab environment is used to create, run, and evaluate the project risks with fuzzy method.

The output of "Fuzzy Method of Risk Model" emerges as Project Risks which consists of various risk values of schedule risk, product risk, platform risk, personnel risk, process risk and reuse risk.

Analysis:

From data set of 15 project points, Fuzzy_CALC determined that out of 12 projects all 12 were categorized as moderate risk projects.

Table - 2 provides **partial list** of **risk assessment results** using **MAN_CALC** for project **data set**.

Table - 2 Fuzzy Calculations:

Size (KSLOC)	Actual Effort (person mo)	Risk_Level	Project Risk
3000	1.2	MODERATE_RISK	312.8239
2000	2	MODERATE_RISK	313.3057
4250	4.5	MODERATE_RISK	311.9874
10000	3	MODERATE_RISK	304.5382
15000	4	MODERATE_RISK	301.2694
40530	22	MODERATE_RISK	295.9016
4050	2	MODERATE_RISK	312.1404
31845	5	MODERATE_RISK	296.6062
114280	18	MODERATE_RISK	301.2412
23106	4	MODERATE_RISK	296.1487
1369	1	MODERATE_RISK	313.531
1611	2.1	MODERATE_RISK	313.3699

C. *Risk Assessment Model Entropy Calculation Based Method Evaluation*

Risk Assessment using proposed Entropy calculation methodology is based on the Risk Model created which is based on cocomo2 methodology, our derived reference model's cost based risk factors & model as mentioned from above model prescribed by this research study which has been based taking literature references from earlier expert risk models, and Shannon's entropy.

We have created, run, evaluated, implemented Entropy based Computer Calculator i.e. program.

Entropy Based Method of Risk Model is implemented in matlab with .fig file GUI and .m code files. It reads project's risk attribute data from excel files, calculates risk factor wise & From data set of 15 project points, MAN_CALC determined that out of 12 projects, 6 were categorized as moderate risk projects, 1 project of high risk, 2 projects of very high risks, 3 projects of extremely high risks.

Project wise risks, and stores the risk values to excel file.

The output of "Manual Method of Risk Model" emerges as Project Risks [13-15, 24].

Analysis:

Table - 3 provides **partial list** of **risk assessment results** using **MAN_CALC** for project **data set**.

Size (KSLOC)	Actual Effort (person-mo)	Risk_Level	Project Risk
3000	1.2	MODERATE_RISK	347.6628733
2000	2	MODERATE_RISK	213.4085597
4250	4.5	MODERATE_RISK	401.5746104
10000	3	HIGH_RISK	840.712854
15000	4	VERYHIGH_RISK	1296.943345

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40530	**22**	**EXTREMLYHIGHRISK**	**3278.370157**
4050	**2**	**MODERATE_RISK**	**337.1394294**
31845	**5**	**EXTREMLYHIGHRISK**	**2618.077412**
114280	**18**	**EXTREMLYHIGHRISK**	**9327.436998**
23106	**4**	**VERYHIGH_RISK**	**1916.449445**
1369	**1**	**MODERATE_RISK**	**142.6171653**
1611	**2.1**	**MODERATE_RISK**	**214.9505251**

Data Analysis:
Comparison of Three Methods Entropy, Fuzzy Based and Manual Calculation Method of Risk Assessment Model

Risk Model			Mannual Calculation		Fuzzy Calculation		Entropy Calculation	
Proj_ID	Size	Actual Effort	Project Risk	Risk_Level	Risk_Level	Project Risk	Risk_Level	Project Risk
	(KSLOC)	(person-mo)						
1	3000	1.2	62.6929	LOW_RISK	312.8239	MODERATE_RISK	347.66287	MODERATE_RISK
2	2000	2	69.0494	LOW_RISK	313.3057	MODERATE_RISK	213.40856	MODERATE_RISK
3	4250	4.5	76.2454	LOW_RISK	311.9874	MODERATE_RISK	401.57461	MODERATE_RISK
4	10000	3	63.9438	LOW_RISK	304.5382	MODERATE_RISK	840.71285	HIGH_RISK
5	15000	4	87.4967	LOW_RISK	301.2694	MODERATE_RISK	1296.9433	VERYHIGH_RISK
6	40530	22	107.1441	MODERATE_RISK	295.9016	MODERATE_RISK	3278.3702	EXTREMLYHIGHRISK
7	4050	2	114.5001	MODERATE_RISK	312.1404	MODERATE_RISK	337.13943	MODERATE_RISK
8	31845	5	90.8471	LOW_RISK	296.6062	MODERATE_RISK	2618.0774	EXTREMLYHIGHRISK
9	114280	18	169.2621	MODERATE_RISK	301.2412	MODERATE_RISK	9327.437	EXTREMLYHIGHRISK
10	23106	4	84.0309	LOW_RISK	296.1487	MODERATE_RISK	1916.4494	VERYHIGH_RISK
11	1369	1	36.83874	LOW_RISK	313.531	MODERATE_RISK	142.61717	MODERATE_RISK
12	1611	2.1	33.51586	LOW_RISK	313.3699	MODERATE_RISK	214.95053	MODERATE_RISK

Fig. 2. Comparison of Mannual, Fuzzy and Entropy based methods of Risk Assessment Model Diagram

Analysis with Graph:

Calculation Project Risk	Fuzzy Calculation Project Risk	Calculation Project Risk
62.6929	312.8239	347.6629
69.0494	313.3057	213.4086
76.2454	311.9874	401.5746
63.9438	304.5382	840.7129
87.4967	301.2694	1296.943
107.1441	295.9016	3278.37
114.5001	312.1404	337.1394
90.8471	296.6062	2618.077
169.2621	301.2412	9327.437
84.0309	296.1487	1916.449
36.83874	313.531	142.6172
33.51586	313.3699	214.9505

Fig. 3. Analysis of Graph Diagram

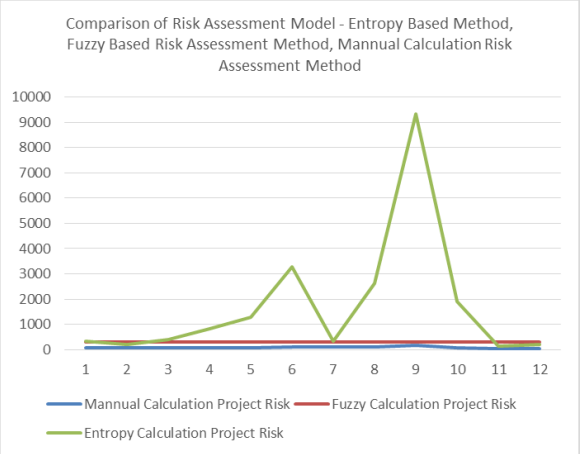

Fig. 4. Comparison of Mannual, Fuzzy and Entropy based methods of Risk Assessment Model Graphical representation Diagram

Here models are evaluated and validated with data. The two metrics used to specify that the correlation coefficient as well as R square strong positive values indicate that Entropy is a better, easier, accurate method for risk assessment.

1.1.4 Calculate Correlation Coefficient & R^2

The correlation coefficient gives the degree of correlation between project risks and other project parameters. It also gives information about sensitivity of project risks to the variations in these parameters.
Here, correlation coefficient is calculated between project risk with software size and with actual project effort.
Software Size in a software development project is having a proportional relationship with project risk;
Larger software size means Higher project Risk. Project risk due to project effort problems.
Table 4 shows correlation between Project Risk versus software size, actual effort based on Manual Method, Fuzzy Method and the Entropy based Method for dataset.
Correlation chart diagram for risk against software size for dataset is in fig below

Table – 4 Risk Correlations with Size
And Actual Effort with dataset

corr (dst1)	Size	Actual_Effort
	(KSLOC)	(person-mo)
MAN_CALC	0.84023	0.6984756
Fz_PPMDL	-0.556258	-0.5978806
Entropy	0.999925	0.777403

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Table - 5 R^2 with Size and Actual Effort with dataset

corr (dst1)	Size - Y dependent	Actual_Effort
x independent	(KSLOC)	(person-mo)
MAN_CALC	0.7059864	0.4878681
Fz_PPMDL	0.309423	0.3574612
Entropy	0.99985	0.604355

1.3 ANALYSIS: ANALYSIS ON COMPARISON OF ENTROPY BASED METHOD OF RISK ASSESSMENT WITH MANUAL CALCULATION METHOD AND FUZZY CALCULATION METHOD WITH RISK MODEL RESULTS EVALUATION

Risk Assessment with Entropy Based Method shows more in-depth risk values and risk levels in terms of moderate, high, very high, extremely high levels of project risks compared with the Manual Calculation and Fuzzy Method in fig.
The correlation calculation for the two risk assessment approaches to data sets shows that Entropy Based risk assessment results are producing a higher correlation with software size and actual effort compared to the results from Manual Calculation Method and Fuzzy Method of Risk Assessment Model.
The correlation calculation for the three risk assessment approaches to data sets shows that Entropy Based risk assessment results are producing a higher correlation with software size and actual effort compared to the results from Manual Calculation Method and Fuzzy Method of Risk Assessment Model.

IV. CONCLUSION

Thus it can be said that Entropy Based Risk Assessment method of the Risk Model provides a better and more sensitive risk assessment result compared to the existing methods of manual calculation method as well as fuzzy method, and thus provides more valuable information to the project manager for planning purposes.

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