SOFTWARE QUALITY: DUAL EXPERTS OPINION AND CONDITIONAL BASED AGGREGATION METHOD

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ABSTRACT

The software reliability is the significant factor to find out software failures in software development Life Cycle. The one more factor considered is the quality of software measurement process. These two factors are mostly considered for the possibility of execution of the software without failures in a software development life cycle. The software reliability and software quality cannot be predicted accurately because of its unsuccessful detection of failures in certain scenarios. This paper mainly focuses on improving the software engineering metrics using an expert opinion and in order to resolve the software failures. On choosing the software engineering measures there are different types of problem that are been occurred in that in this paper we have taken two main issues. The first issue is number of measures that are utilized in estimating software quality and these software measures are chosen with the help of expert opinion. However, the experts are humans so they may have less adequate knowledge about different software evaluations. The Problem is resolved by taking consideration with first level and second level of experts' opinion for selecting the best measures for software quality. The second issue is of data aggregation function which is not suitable for large number of data aggregations, here in this paper we select a prioritized opinion for data aggregation. The prioritization is based on number of experts involved in each life-cycle phase of software development with time duration to give the opinion. Finally the experiments results are shown for the software quality improvisation by the proposed framework.

Keyword - Software Metrics, Software Quality, Data Aggregation, Software engineering, Experts' opinion.

1. INTRODUCTION

The software quality measurement plays an important role in software engineering area to ensure the quality of software. The software quality can be described as the ability of entire characteristics and features of software system that satisfies the client requirements. For instance, software's will be utilized with a particular specification [4]. The Software engineering concepts are included with many approaches and are utilized to estimate the software quality. The approach utilizes a historical datasets to estimate software qualities. The estimation of software is been identified by its size and tasks. The expert's opinions are also used in estimating the software quality. The experts' opinions are gathered based on their idea and knowledge which are supported to obtain a good estimation value. The proposed work mainly focuses on software life cycle phases with estimation of Experts' opinion which are collected from the various experts. Expert's opinions are defined as the opinion given by an individual those who have the subject knowledge. Software reliability model are intended to measure the probability of software collapse that are discussed in [7], [1], and [3]. The most of these models mainly do observations on software failures that happen during testing or operating of that system. In some cases, it may not be feasible to analyze or find an infinite number of failures. In order to eliminate these problems two factors are been considered and been utilized in measuring reliability of software. The software engineering measures are fully utilized with the above exposed characteristics. Thus, a final conclusion is stated as "reliability of software is resolved by software engineering measures". Thus an organization will depend on a set of software measures to evaluate a product reliability level and also a question is raised as how these measures are helping to improvise the software quality level?,. Nowadays present software engineering measures are been prearranged with their capability to predict the reliability of software in software filed.

2. RELATED WORK

The opinion of experts will be very useful in estimating the following measures such as the experimental data couldn't be available all time to all in software life cycle areas, the estimation of software complexity can be utilized to understand the problems with very well or poor known manner [1]. In these both estimation measures can be viewed as real motivation why expert's results are widely utilized as a method to software estimation. In general, the learning was performed in a business partition of an average size group (e.g. 2000 employees) are focused on the spoken software development for international and domestic markets. An excellence traditions, commitment and quality, running process, performance improvisation, identified sequence of well practices, and it's fully provided by the company.

In the organization practices, the cost estimation study is to calculate the catalyst results for modify their estimation. It explains that for all non-structured opinion of Experts is a highly inconsistent also it has express to economic result have not proper reliability. Alternatively, suppose if the company to mislaying the business, while the estimation is large and money as less. The Cambria University in Carnegie Mellon and Portugal in US (United States) has performed as section of the necessity for the program at M. (SE) Master of Software Engineering is combining together. An Unreliable estimation and Non-Structure estimation approaches by enduring by way of analysis required to establish. So, to utilized expert's opinion elicitation methods are studied to overcome the related data lack in the software engineering literature.

The applications of a restricted number of opinions of Experts were identified in software engineering. The length of a program of subjective estimation has to suggest by [2]. In [4] tools and software engineering approaches utilizing subject review as method evaluated. Software process and rank to find are the key factors of success for improvement on opinion of Expert's by [4]. In [5] the successive project using subjective factors is calculated also it contains project success indicators of subjective factors and project features. The actual industrial projects of subjective factors are to be elicited. The relationship between project features and project success indicators are matched by authors in to five point calculation methods. In [1], [2] a cost estimation of efforts by combining the Expert's Field is executed. Depend upon the parameters of the cost efficiency model was estimate the expert's opinion. In the opinion of Expert's inputs has to decrease the indecision over the questionnaires and the elicitation process bias. Opinion of Expert's of exact applications in the measures of software engineering is obtained in these papers.

3. PROPOSED METHODOLOGY

The proposed research work deals with software engineering metrics based on expert opinion. This research methodology uses the expert opinion measures to overcome the ambiguity and vagueness that are happen at the time of human decision making. Thus these selected metrics are very helpful in investigation of the system function and to obtain the desired goal.

3.1 CONDITIONAL BASED AGGREGATION EQUATIONS FOR SOFTWARE ENGINEERING MEASURES

Previously the translation of dispatch certain level criteria phases into actual estimated values are final; these values should to be aggregated by means of an aggregation equation. The basic of an aggregation equation is chosen for this research, and which carries as a relation, and is linear additive equation with equivalent influences. in this aggregation method, which is defined as "base equation" of this research paper, each level criterion is being assigned an equal weight and the real values are joined uniformly using a proposal of the category is defined in equation (1). A real value between the range of 0 and 1 is determined for every measure per life-cycle and per expert phase. Per phase module of the study means to a previous statement which is described the fact that significance to reliability condition criterion might differ per phase. The level of criteria for other criteria is assumed that are separate of the software development stage. By using this aggregation equation, the measure rate for an offered expert and phase Rate (p,q,φ) is:

$$Rate(p,q,\varphi) = \sum_{k\ \varepsilon\ Scr} \mathrm{r(p,q,k)wk} + \mathrm{r\varphi(p,q)w\varphi}$$

Equation 1

Where, Rate (p, q, φ) is rate of measure p is given by the qth expert in phase φ. p is a Measure index. The range is from 1 to the number of measures under revise. q is an Expert index. The range is from 1 to N, where, N is the number of experts. k is level criterion index. S_{cr} is the set {Cost, Benefit, Credibility, Repeatability, Experience, and Validation}. φ is a development phase index. The range is from 1 to 4. A value of 1 stands for the requirements' phase, 2 for the design phase, 3 for the implementation phase, and 4 for the testing phase. r(p,q,k) is the real value equivalent of the kth level criterion level for measure p given by the qth expert. r_{φ}(p, q) is the real value equivalent of the relevance to reliability level criterion for the pth measure in the φth phase given by the qth expert. wk is the weight for each level criterion in set S_{cr} and w_{φ} is the weight of the importance to reliability level criterion for φth phase. So, the overall rates for a specific measure p in a given phase φ is given by:

$$\mathrm{Rate}(\mathrm{p},\mathrm{q}) = \frac{1}{\mathrm{N}} \sum_{q=1}^{N} \mathrm{Rate}\ (\mathrm{p},\mathrm{q},\varphi)$$

Equation 2

Where, N is total number of valid experts' inputs and Rate (p, φ) is a combined rate over all experts for a specific measure p during a given phase φ.

Cost		Experience		Level	Benefits	Credibility	Repeatability	Validation	Relevance to Reliability
Level	Value	Level	Value						
W	1	W	1	A	1	1	1	1	1
M	0.9	M	0.55	B	0.9	0.9	0.85	0.85	0.9
Q	0.75	L	0.2	C	0.6	0.7	0.45	0.4	0.8
Y	0.3	E	0.15	D	0.3	0.6	0.25	0.25	0.75
T	0	N	0	E	0.1	0.35	0	0	0.2
				F	0	0			0

Table 3.1 Selection on Criteria level values

In certainty, the data analysis approach differs from the one given in equation (1) and (2) because, as expected many cells in the experts' questionnaires were left blank are shown in table 3.1. Hence, equation (1) and (2) could not be used directly. To overcome this space, UMD joined all experts' inputs together before performing any further analysis using the following equations:

$$R(p,k) = \frac{1}{N(p,k)} \sum_{q \in s(p,k)} \mathrm{r}(\mathrm{p},\mathrm{q},\mathrm{k})$$

Equation 3

$$\mathrm{R\varphi}(\mathrm{p}) = \frac{1}{N_{\varphi}(p)} \sum_{q \epsilon_{\varphi}(p)} \mathrm{r}_{\varphi}(\mathrm{p},\mathrm{q})$$

Equation 4

Where, R(p, k) is the combined real value equivalent for the kth level criterion of measure p. r(p, q, k) is the combined real value equivalent for the k^{th} level criterion of measure p given by the q^{th} expert. S(p, k) is the set of valid inputs for the k^{th} level criterion of the p^{th} measure. N(p, k) is the number of elements in set S(p, k). k is level criterion index k є {Cost, Benefits, Credibility, Repeatability, Experience and Validation}. $R_{\varphi}(p)$ is the combined level of level criterion Relevance to Reliability for the p^{th} measure in phase φ. $r_{\varphi}(p, q)$ is the level of the level criterion Relevance to Reliability for the p^{th} measure provided by the q^{th} expert in the φ^{th} phase. Sφ(p) is the set of valid inputs for Relevance to Reliability for the p^{th} measure in the φ^{th} phase and $N_{\varphi}(p)$ is the number of elements in set $S_{\varphi}(p)$.

After processing the data using equation (3) and (4), two types of joined inputs are obtained. Once combined (over all experts involved in analysis phase) real-value-equivalent level for all level criteria of a measure with the exclusion of relevance to reliability; others combined the real-value-equivalent level of a measure's relevance to reliability level criterion. To obtain the overall rate of a specific measure p in a specific phase φ, the following equation is used:

$$Rate(p,\varphi) = \sum_{k} \mathrm{R}(\mathrm{p},\mathrm{k})\mathrm{w}(\mathrm{k}) + \mathrm{R\varphi}(\mathrm{p})\mathrm{w\varphi}$$

Equation 5

Where, Rate(p , φ) is the overall rank for measure p in phase φ. w(k) is the Weight for level criterion k. wφ is the Weight for the Relevance to Reliability level criterion in phase φ. k is the Measures index and it also refer to notations for equation (3) and (4). φ is the Phase index and it refer to notations for equation (1) Weights in equation (5) should be verify equation (6) for φ = 1,2,3,4, respectively.

$$\sum_{k} \mathrm{w(k)} + \mathrm{w\varphi} = 1$$

Equation 6

In the position (base) case, all weights are equal, (ie). $w(k) = w_{\varphi} = {}^{1}/_{7}$ for any k є S_{Cr} and any phase φ.

3.2 AGGREGATE DISTANCE FUNCTIONS

Aggregate functions whose parameters are Euclidean distances from a point to a set of landmarks have interesting foci [9]. It uses the properties of these loci in the design of P-CANN. The loci of the points in space with the same sum aggregate distance form a closed shape. The landmarks form the foci of this shape. The resulting shape for sum is smooth; i.e., it is differentiable. Similarly, the loci of the points in space with the same max aggregate distance form a closed shape. The landmarks form the foci of this shape. For *N* foci and for an aggregate distance *d*, the resulting shape is the intersection of *N* circles with radii *d*. The centers of these circles are the foci. Nevertheless, the loci of the points in space with the same min aggregate distance form a shape that is not necessarily closed. The landmarks form the foci of this shape. The resulting shape may contain holes and it may be non continuous. Typically, for *N* foci and for an aggregate distance *d*, the resulting shape is the union of *N* circles with radii *d*. The centers of these circles are the foci. These loci form a family of concentric curves. The number and location of the landmarks as well as the aggregate distance function determine the shape of the family of curves. For Class A aggregate distance functions, the loci are closed and convex. Moreover, the center of the convex shape is the centroids of the aggregate distance function.

3.3 CLASSIFICATON OF SOFTWARE MEASURE

The Experts' opinion represents the approximate reasoning for human thoughts and perceptions, where classification terms can be properly concerned by the Software engineering. This section deals with the classification terms and the weights of various criteria values of Software engineering metrics are decided in the rating. It can be defined as a variable whose values are not numbers but words or sentences in natural languages. Attributes as very low, low medium, high, and very high all these weights can be evaluated by classification terms. It shown in the table 3.2 and it is expressed as numbers, while the membership functions of the five classification values are shown in the table 3.3 sequentially determine the suitable of different Software engineering metrics vs. different Experts' opinion criteria and the values can be accessed by classification terms as very poor, poor, fair, good, and very good. All these classification terms shows in the table 3.3. It can be expressed by numbers. It shows different areas of applications, as well as membership functions using their initial value and calculation.

Classifications	Very low(VL)	Low(L)	Medium(M)	High(H)	Very high (VH)
Criteria result	(0,0,0.3)	(0,0,0.5)	(0.2,0.5,0.8)	(0.5,0.7,1)	(0.7,1,1)

Table 3.2: Classification of software measures for the importance weight of each criterion.

Classifications	Very poor (VP)	Poor (P)	Fair (F)	Good (G)	Very Good (VG)
Criteria result	(0,0,0.2)	(0,0,0.4)	(0.3,0.5,0.7)	(0.6,0.8,1)	(0.8,1,1)

Table 3.3 .Classification of software measure for the software engineering metrics

3.4 DEFINITION OF EXPERT OPINION CRITERIA

Cost: it is mainly focus on possible efforts necessary to apply and utilize the measure. A developer's format was defined to reveal the variations among normal development organizations. This expert opinion criterion qualification is mainly depends on the actual one year production of this organization. This criterion of expert opinion qualified by the time of staff required to carry out the one year production measurement.

Benefit: it is described as a cost prevention, which would be incurred if the measures are not utilized. It is examined by the time of staff that would be preserved for one year output if the measures are carried out.

Credibility: the documentation provided for every measure states that this document measures some part of software. If a measure supports the particular goal, then it is considered as a credible one. This condition is computed by directness of measurements. For example, the measure determines the goal which is documented directly, else joints other algorithms and quantities to determine the documented targets.

Experience: this criterion reveals the ratio to which this measure is utilized in the industry. Then, the stage of this criterion is a method of commercial uses.

Repeatability: if the reoccurred application of the measure by various or same people outputs same outputs, then that measure is considered as repeatable. This criterion is examined by total amount of subjective decision required to do the measurement.

Validation: these conditions choose the ratio to which the measure is verified by community of software engineering. The stage mainly based on the formally validated measure or informally validated measure.

Relevance to reliability: this condition determines the related measure for estimating reliability of software. The level is a method of the no of software reliability estimation methods which include the rating of measure of the software engineering metrics Vs condition. In third phase, aggregate ratings and weights of software engineering metrics are measured. That calculated aggregated values are converted to crisp scores in the fourth phase by using minimizing and maximizing the collection of methods. In fifth phase, the 'criteria matrices' are created for every Software engineering metric and the permanent value of each such 'criteria matrix' is calculated. Finally, the metrics of software reliability are ranked based on the values of the permanent. The Software engineering metric with the maximum value of the constant is ranked at number 1, the number 2, and so on. This has linguistic terms in-built scales and corresponding value in membership functions for assigning weights to Experts' opinion criterion and ratings of Software engineering metrics by the Experts. Each Experts' has only to allocate ratings and weights to each Experts' opinion criterion and Software engineering metric, respectively, and choosing suitable linguistic term which is already exist in tabular format in the software and other operations(mathematical process) like estimating aggregated ratings and weights, the transformation of linguistic terms to crisp scores, criteria matrix creation and determination of permanent, etc. and as defined in phases 3 to 5 in the above paragraph are automatically performed by the software.

The complex thoughts and perceptions of humans can be quantified by software engineering experts who can represent the linguistic terms of human by giving approximate values. This paper, the linguistic terms and the weights of various criteria values of Software engineering metrics are decided in the rating. It can be defined as a variable whose values are not numbers but words or sentences in natural languages. Attributes as very low, low medium, high, and very high weights can be determined by linguistic terms. It shown in the table 3.2 and it is expressed as numbers, while the five linguistic values membership functions are shown in the table 3.3. Sequentially determine the suitable of different Software engineering metrics vs. different Experts' opinion criteria and the values can only be accessed by linguistic terms as very poor, poor, fair, good, and very good. All these linguistic terms shows in the table 3.3. It can be expressed by numbers. It shows different areas of applications, as well as membership functions using their initial value and calculation.

4. IDENTIFICATION OF SOFTWARE ENGINEERING METRICS

There are five phases of software development such as problem analysis, requirements, design, implementation, and testing. Each phases consist of many factors, it should be differentiated the software development process and also used to guide various quality levels of the software product. The 78 software metrics are identifies by Lawrence Livermore National Laboratory (LLNL) and this software metrics are related both directly and indirectly to the software reliability. Using structural consideration the set of 78 software metrics which is reduce to 30 depends on semantic considerations. In software engineering metrics can be identified by the reliability of software product.

4.1 EXPERT DISCOVERY AND SELECTION

In earlier software literature, the data consist of Expert opinion of the pre-selected metrics is impossible, because lack of maturities in this field. Likewise the data mining of software engineering confirm databases are infeasible [9]. Therefore the problem of collecting the expert's opinion data is reliance on expert opinion of optimal approach. The first step is experts team should be formed and in that team experts have experiences on wide variety and it consist of laboratories, universities/consulting or government agencies demonstrated by publication, hands on experience and the area of managing research will be related to under study of issues and also uses these thesis of flexible enough to address the issues. Several experts are related in both academic and industries. The edge of technological advances is the better approach into issue of cost and benefit. It contains the member of industry but the academic are contain better knowledge to measures in experimental development. In this research, it selects five experts. These five experts are more then 20 year's familiar in software reliability testing and software reliability evaluation, etc.

4.2. SELECTION OF EXPERT SECOND LEVEL OPINION

The expert criterion has collective several attributes to be compared with software engineering metrics. E.g. of such attributes are: cost, credibility, repeatability (the repeated application f a measure offers identical outputs), etc. The software measurement can be improved by finding the attributes of software engineering metrics. For example IEEE standard 982.2 [5] identified additional Expert opinion criteria such as profits and experience characteristics of every metrics in software engineering. These criteria reproduce the industrial considerations. The learning of [1], there is eight criteria can be measured such as directness, validation, benefit, repeatability, cost, timeliness, credibility and experience. Each and every opinion criteria are related to some particular measurement of aspects, also it consist of objectives of the studies. The literature can be used to gain experience, reliability can be characterized used to finding the single measure of problem, the criteria as following aspects must be covered: (1) Measurement's cost effectiveness (cost and benefit). It determines the software development process will be utilized in a 'real' measure whether or not. (2) Measurement's quality (whether it is repeatable, reliable, formally validated, and usually utilized in the industry). It will find whether measure is incredible. (3) Measures related to reliability (the direct aim of the study). Given table 3.1 defines details about selection on expert opinion criteria level. Hence it required set of criteria can be developed and expert opining for corresponding levels in software engineering metrics. In this section, describes the software engineering problem based on the multi-criteria decision analysis and variable set theory. In proposed work various methods are used to combine opinion of experts such that mean, min, median, mixed and max operators [2]. The aggregation method [8, 9, and 6] is generally used for average operations. In this paper, aggregate the assessment of experts are used to mean operator.

5. AN ILLUSTRATIVE EXAMPLE

Software engineering measures presented in this section, called expert opinion, is provided with an example. Distance-Based Approximation method [5] is used to develop an optimal selection of software reliability in growing computer software. These selections are based on 12 software reliability model selection criteria. Optimal software reliability growth model selection (OSRGMS) is the application selected. In this software user starts working on the application by double clicking on its icon in Microsoft Window environment. 16 software reliability growth models are available and select one or many SRGM's out of 16 SRGM's, then after providing failure data in required format. The user chooses one or many model selection criteria on which 12 are already predefined in selection criteria. The user is able to select the parameter estimations technique and optimization method. The quantitative values of the parameters are displayed in the application and the selection criteria of selected software reliability growth models. This application presents, the final result of expert opinion different software reliability growth model is ascending or descending order along with intermediate results against each step of methodology. OSRGMS is attractive candidate for experimental setup since it is user friendly GUI based application and also easy to use by experts from various areas such as industry and academic, etc. and it is does not use any requires for extensive technical knowledge. Then apply our technique with this paper from premiere conferences in software engineering field: the International Conference on Software Engineering (ICSE) and Foundations of Software Engineering (FSE).

The following figure 5.1 shows the plot between number of projects and scores. The quality of each project is represented by the scores issued by expert opinions. The score level gets increased when experts cross checks number of projects. The projects are examined to meet the system requirements.

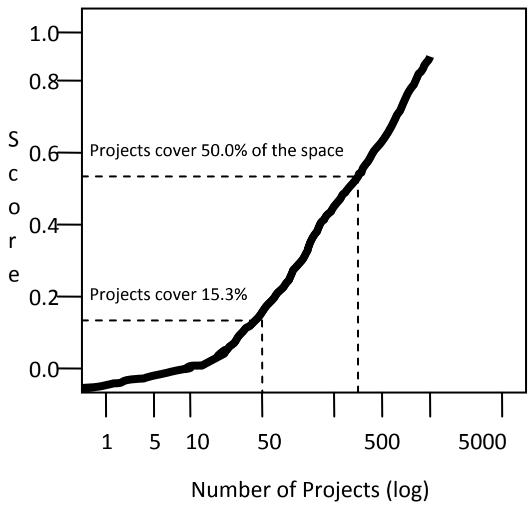

Fig. 5.1 Projects Vs Scores

The experiments performed affect from usual class of problems found in this type of study: limited sample size and emailed questionnaires are not guaranteed an overall random sampling. The result should be varied to consist of same issues in software another discipline with other studies addressing [4], [9], and [1].

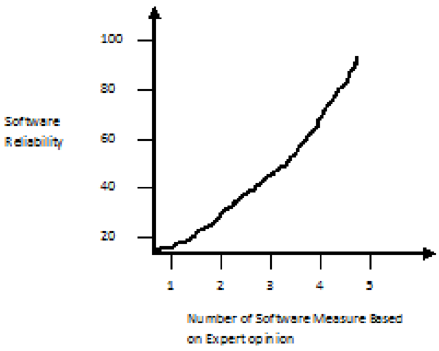

Fig. 5.2 Software Measures Vs Reliability

The above figure shows the performance between numbers of measures yielded from the opinions of software experts. The rate of reliability of software quality of is increased when the number of measures is increased. The software can be perfectly checked for its quality when more number of measures is employed. Thus software reliability is directly proportional to the number of software measures.

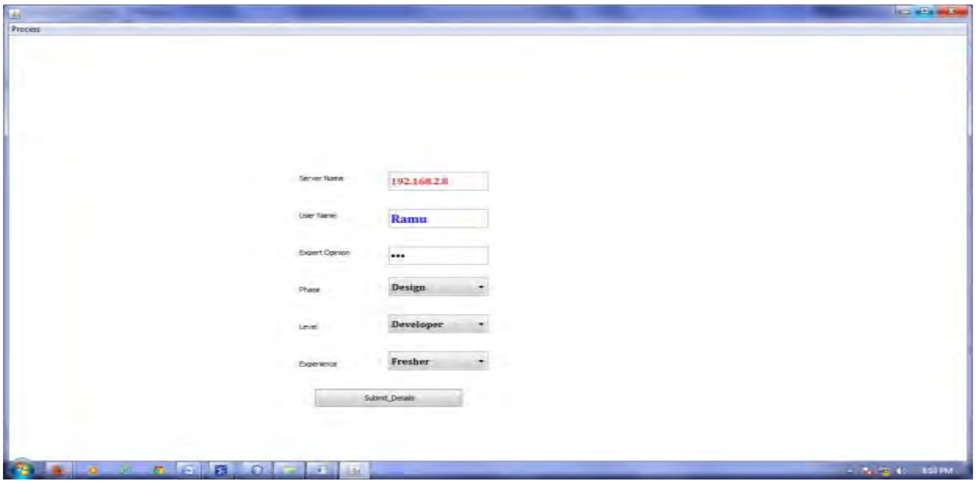

Fig 5.3. Experts Opinion Recommend Window

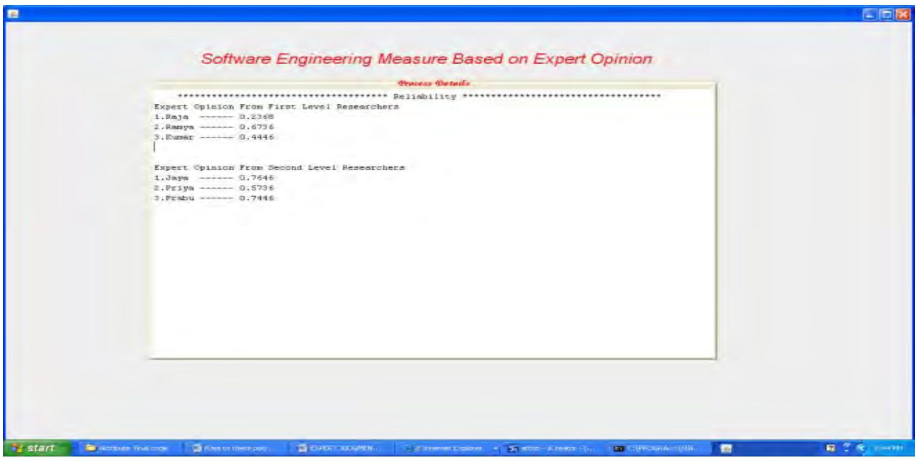

Fig 5.4. Measure Weight from the expert's opinions

6. RESULT & DISCUSSION

The software engineering metrics has provided expert opinion for their impact on software reliability. Thus it represents a highest rank of MTTF with score value of three criteria which is of repeatability, cost, and relevance of reliability. The software engineering metrics is followed by FD and it also ranked at 2 and 3 which are top three in software engineering metrics. The software engineering metrics RC has lowest expert opinion as a result cost criterion of metrics also scores very low. It shows the comparison of the expert opinion in software engineering metrics to obtain variables based on matrix method with other available methods. It is clear that the results obtained from variable based matrix methodology and consistent based results as a statistical analysis and is used by other researchers. It is very easy to obtain result by using this methodology due to its small deviation leads to larger difference in value of expert opinion in software engineering metrics. The following table 6.1 shows the relationship between various parameters with its software reliability. The rate of software reliability directly depends on the value of cost, benefit, repeatability, creditability, validation and experience.

Criteria	Cost	Benefit	Repeatability	Creditability	Validation	Experience	Relevance to reliability
Wt	0.28 ,0.5 4, 0.82	0.52,0.78, 0.96	0.22,0.5, 0.78	0.04,0.22, 0.48	0.08,0.38, 0.62	0.12,0.36, 0.64	0.28,0.54, 0.82

Table 6.1 Aggregated weights (Wt) of different criteria's.

The table 6.2 shows the influence of various software measurement parameters in calculating the reliability of software quality. The cost, benefit, repeatability, creditability, validation and experience parameters are analyzed under various categories and the result are been tabulated.

The main scope of this paper is to decide whether the proposed approach can be potentially suitable for the software Engineering from the expert developmental view. Several questions are raised to determine or to achieve the knowledge of what kind of expert system. The important drawback in developing expert system for software engineering is still not clearly defined. In this research work, knowledge details are collected from multiple experts those who have greater experience in that field. The entire methods have been evaluated for computer software that is created for an optimal selection of software consistency and growth models as detailed. Also it focuses on experimental analysis and validation by this comparison.

Criteria	Cost	Benefit	Repeatability	Creditability	Validation	Experience	Relevance to reliability
MTTF	0.3,0.5, 0.7	0.68,0.8 8, 1	0.64,0.84,1	0.64,0.84,1	0.3,0.5, 0.7	0.48,0.68,0.8 8	0.64,0.84, 1
CH	0.5	0.67931	0.67931	0.4	0.6	0.45	0.6800
CC	0.81309 5	0.5	0.371552	0.846296	0.6	0.730172	0.7056
FD	0.84629 6	0.6	0.371552	0.65	0.65	0.781034	0.8188

Table 6.2 Aggregated Rating (Rit) of software Engineering Metrics

7. CONCLUSION AND FUTURE WORK

The main goal of this paper is to predict software measures with different Expert level opinion and data aggregation. From the implemented results best software measures are been obtained by the proposed framework which is of a level based expert's opinion. Therefore, the expert opinion (i.e. of software measures) are well-structured by the proposed framework and are defined as conditional based aggregation method. Hear the experts' opinions are ordered by a weighted value that is obtained from the performance of each expert's individual performance. Thus software quality is been increased to a maximum rate, recommended by software measures. However the proposed work investigates software metric selection in a static way since the system should be constancy depend on experts' opinion. In order to make improvement in the proposed system a machine learning approaches can be included as a future work to make the system automatic.

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