A Study on Enhancing Source Code Quality by Using SIG Approach

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Abstract—This paper presents the study of three model which is used to improve maintainability process of the software system product. The Software Improvement Group (SIG) has the process of maintainability index to calculate the single number that express the maintainability of the system. The analytical Hierarchical process model is used to extract the data and metrics to assign the relative weight and the clustering technology is used to cluster the derived ISO/IEC-9126's maintainability values. The two dimensional model is used for the maintainability activity with the system property. It has activity and facts for the representation of Factor-Criteria-Metrics approach.

Index Terms— Analytics Hierarchy Process, Defect, Factor Criteria Metrics, Issue, Quality, Source code, Test code.

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1. INTRODUCTION

SOFTWARE testing is the process of evaluation a software product to detect differences between given input and expected output are correct or not and also to assess the feature of a software product. Testing assesses the quality of the Software product and it is a process that should be done after the development process. The four level of software testing are unit, integration, system and acceptance testing, these are the main testing which is done in the testing level.

The SIG model has the source code metrics are used to collect facts about a software system. The source code metrics that are used express volume, duplication, unit complexity, unit size, unit interfacing and module coupling. The measured values are combined and aggregated to provide information on properties at the level of the entire system. These system-level properties are then mapped onto the ISO/IEC 9126 standard quality characteristics that relate to maintainability, which are: analysability, changeability, stability and testability. Then after the measurements are obtained from the source code, the system-level properties are converted from metric-values into ratings. This conversion is performed through benchmarking and relies on the database that SIG possesses and curates; the database contains hundreds of systems that the system's performance in comparison with the benchmark.

The data mining technique is used towards that was to develop the extraction of metric and the data from the java source code. The extracted data has stored in the XML file and with every XML file is corresponding to the source code file. Then the relative weight is assigned to the extracted data by using of Analytic Hierarchy Process (AHP) approach. After the weight is assigned the clustering process is taken placed in the maintainable value. Here the K-means clustering methodology is used.

The two dimensional model has used collect the relevant idea and build the Factor-Criteria-Metrics (FCM) like decompositional quality. This model is the top down approach which is used in the maintainability matrix. The FCM approach is the suitable tree structure of the process refining high level facts into detailed, tactile ones which can call as atomic facts. An atomic fact is a fact that can checked without further decomposition either because its assessment is no known decomposition. To achieve in a given project setting we now need to establish the interrelation between facts and activities. Because of the tree-like structures of facts and activities it is sufficient to link atomic facts with atomic activities. Here the problem lies in the incompleteness of the depicted model, that doesn't include tools like IDE-Integrated Development Environments.

2. LITERATURE SURVEY
2.1 A Practical Model For Measuring Maintainability
Dimitrios Athanasiou [1] and Joost Visser [2] suggested that Software Improvement Group (SIG) quality model is the tool-based consultancy firm and that is specialized in the maintainability process. This model identifies the source code metric and maps their metrics to the characteristics of the ISO/IEC 9126 and that is related to the maintainability process. The SIG quality model is also known as McCall's Triangle of Quality.

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In SIG model the source code metrics were present and they are Volume, Duplication, Unit Complexity, Unit size, Unit interface and Module coupling. The properties are maps to the ISO/IEC 9126 process.

The each metric maps to the similar maintainability process. The volume is mapped to the analyzability, Duplication is mapped to the analyzability and changeability, unit complexity is mapped to the changeability and testability, unit size is mapped to the analyzability and testability, unit interface is mapped to the stability of the process and finally module coupling is mapped to the changeability and stability. Likewise the system properties maps to the maintainability process.
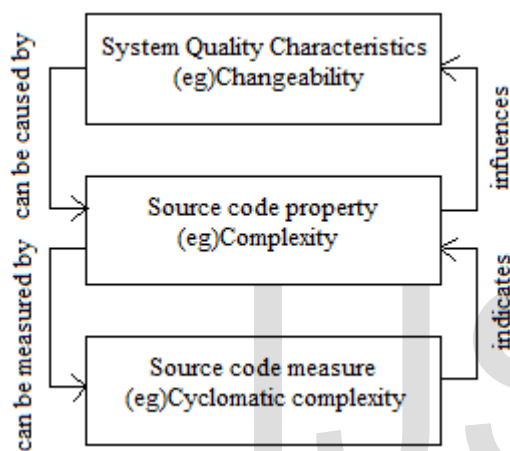

Fig. 1. Mapping of Maintainability Model

Finally, the maintainability process of analyzability, changeability, stability and testability is combine to form the Maintainability model. Were the SIG model was formed

The definition of software quality characteristics of ISO quality model provides the frame of reference and standardized terminology which facilitates communication concerning of software quality. The maintainability Index (MI) is the process which is used to measure the performance and calibrate the result with the opinion of the developers.

The maintainability model has to maps the system quality characteristics to the source code measure in two steps shown in Fig 1. Firstly the system quality characteristics can be caused by the source code properties like complexity .And the source code property can be measured by the source code measure for example cyclomatic complexity, likewise the system quality characteristics is mapped to the source code measurement.

The maintainability model can be done by the 180/IEC 9126 process. And the model has the four characteristics and they are analyzability, changeability, stability and testability. [2]

Analyzability: How easy or difficult to modify the system.
Changeability: How easy or difficult to adapt to the system.
Stability: When a system is modified then the system should be in consistent state.
Testability: When the system is modified it checks whether the system is easy or difficult to test.

2.2. A Data Mining Methodology For Evaluation Maintainability According To Iso/Iec-9126 Software Engineering-Product Quality Standard

Antonellis. P[3] suggested the data mining methodology for evaluating maintainability according to ISO/IEC-9126 software engineering product quality standard. According to ISO/IEC-9126 [ref International standard Organization and International Electrotechnical Comission] maintainability is the capability of software product to be modified. Data mining is deal with the large volume of data and to uncover hidden patterns has been proposed as a mean to support the evaluation and assessment of the maintainability scale software system.
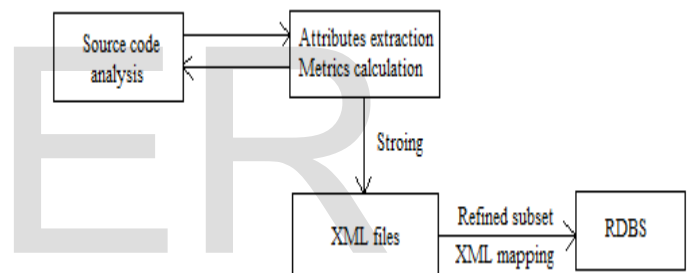

Fig 2. Architecture of data Extraction and preparation module (Image taken from [3])

The scope of this methodology is to facilities the evaluation of a software product's maintainability according to the ISO/IEC-9126 quality standard. The intuition of this process is to integrate the measurement data metrics that are extracted from the element of the system's software code. To extract the appropriate element and metric from the java source code, and the extracted element are stored in the XML files. The attributes depend on the system's programming paradigm are: names and id of packages, class names, definition files, class-files, structure blocks such as if blocks, loop blocks etc. The XML files containing extracted data refined subset of XML mapped to the Relational Database Systems (RDBS) shown in Fig 2..

The Collection of metric in order to provide the systematic approach for code evaluation based on a set of predefined rules. The selected metrics are Weighted Methods per class (WMC) provides a measure for

predicting class's maintainability and reusability, Number of public Methods (NPM) measures the size of an API provided by the packages, Data Access Metric(DAM) reflects the property of encapsulation, Coupling Between Objects(CBO) represents the number of classes coupled to a given class, Number of Polymorphic methods(NOP) is a measures of the overridden methods of an OO software system ,Depth of Inheritance Tree(DIT) provides for each class a measure of the inheritance level, Number Of Children(NOC) measures the number of the immediate descendants of the class, Lack of Cohesion in Methods(LCOM) measure class of all system methods working together in order to achive a single purpose, Afferent Coupling(Ca) measures the number of packages that depend on the packages under examination[6].

The weight is assigned to the selected metrics in order to reflect their importance on evaluating a system's maintainability according to ISO/IEC-9126 quality standard. For this the Analytic Hierarchy Process (AHP) model is used to assign the weight for the selected metrics. AHP is the decision making technique that allows the consideration of both quantitative and qualitative aspects. In system's engineering process the AHP can be the powerful tool for comparing alternative design concept. It forms the pair wise comparision matrix.

Finally, the clustering data mining techniques is applied on the derived maintainability value. For this the K-means clustering has been chosen to be implemented and performed because it is the simple clustering method. The cluster similarity is based on the distance between the object and the mean value of the input data. The methodology is evaluated on Apache Geronimo server. It is the large open source application server. Hence the time required to assess the maintainability of the software system is reduced. The methodology has been proved to be time and performance efficient. The extraction process is the time consuming part of this methodology which analyzed the 1440 classes of Apache Geronimo and stored the metric and elements in the limited amount of time.

2.3 Demystifying Maintainability

Manfred Broy[4] suggested that the demystifying maintainability which has the unique two dimensional quality model which associates maintainance activity with the system properties. Assessing maintainability has the process of reducing the cost of slow maintainability and the time consuming needed to complete the slow maintainance task .here the top-down method is used to identify the completeness. The aim is to collect all relevant element and the build the Factor-Criteria-Metrices (FCM) approach like decompositional quality model. The two dimensional

model has the activity and facts. It taken as the rows and column in the maintainability matrix shown in Fig 3.[7].

The IEEE 1219 standard maintenance process is used in the two dimensional model. The FCM approach has the suitable tree structure by stepwise refining high level facts into detailed and tactile one which is known as atomic facts. It can be assessed without further decomposition. To measure the maintainability, the interrelation between facts and activities can be made like an tree structure which is sufficient to like atomic facts with atomic activities .The aggregation between both the tree to cross check the probity of the model.
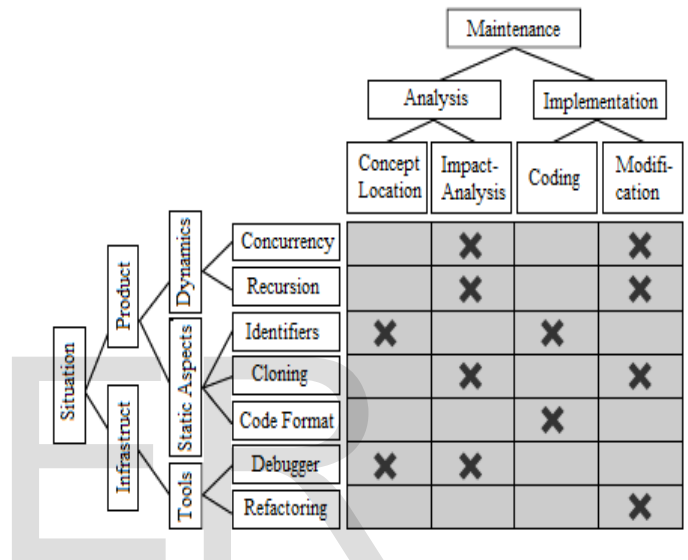

Fig 3. Maintainability Matrix (Image taken from [4])

The problem lies in the incompleteness of the depicted of the model, because that doesn't include the tool like Integrated Development Environment (IDE). For the better reflect, the different impact of various facts uses the relative weight as the element of matrix. The relative weight values is within the interval of [0,1].where the zero refers to no crash and one refers the activity affected by the corresponding facts. So the model is still incomplete and it don't claim completing is a task a single team researcher can achieve.

TABLE 1
COMPARITIVE STUDY

TITLE	TECHNIQUE USED	MERITS	DEMERITS

A practical model for measuring maintainability	Software Improvement Group (SIG) Model	The maintainability process can be maintained	The quality improvement is only for java source code
A Data Mining Methodology for Evaluation Maintainability according to ISO/IEC-9126 Software Engineering-Product Quality Standard	Analytic Hierarchy Process (AHP) model	The time consuming of extraction is good	The maintainability of the product is less
Demystifying Maintainability	Two dimensional quality model	Factor-Criteria-Metrices (FCM) approach used for the tree structure	The model is incomplete for the process

3. CONCLUSION AND FUTURE WORK

The aim of this work is to present the study of the various maintainability model. The 180/IEC-9126 maintainability standard is used for the maintainability process. The Software Improvement Group is the process of improving maintainability of the software product by the maintainability index approaches. And the data mining process of AHP approach is used to assign weight for the derived maintainability value and the k-means cluster method is used to cluster the element. During this process, mutually exclusive groups of classes, member data or methods one created according to their similarities and hence the time required to assess the maintainability of

software system is reduced. The two dimension model for maintainability has activity is facts for the process. Here the Factor-Oriented-Metrics approach is used for the process of maintainability matrix. In future work we expect to refine these model by make another model to improve the maintainability of source code quality for the other programming language like java, C and C++.

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