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Estimated Model of OO Maintainability with Metrics of Three Important Factors

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ABSTRACT

Analyzability is one of the most important factors of the Maintainability parameter which can influence any software quality requirement. Analyzability is a key factor along with Understandability and Modifiability factors of the software Maintainability. The researcher's intention in this research work is to include more number of accurate metrics to improve the accuracy of the proposed Maintainability model. The inclusion of Analyzability in the development of Maintainability model is the innovative thought which is presented here for the Object-Oriented (OO) software systems. Analyzability metric based data is also calculated for various OO class diagrams and that data is used in the identification of the number of Maintainability levels.

KEYWORDS:- Analyzability, Maintainability, Maintainability model, OO class diagram hierarchy, Maintainability levels, Analyzability metric, Important factors of Maintainability, OO Model with metrics.

1. INTRODUCTION

The typical trending topic in the real world are the existing issues to measure the software quality in a proper way to improve the productivity of the software.Any proven measure of software quality provides a great chance in improving the software quality in a remarkable manner because less number of existed quality measures which may lead to poor management of the software system [1]. In the process of improving the software quality early researchers had done some valuable studies [2, 3] and delivered usable information for the future researchers. The software quality cannot be measured directly with metrics because of its nonfunctional behavior and depends on various parameters like maintainability, usability, scalability security, portability, efficiency..etc, such quality related issues[4].

The software quality mainly depends on the software maintainability parameter because major parts of the software quality are decided by the maintainability parameter. In the real world scenario most researchers, developers and users (Customers) think that a good maintainable software system provides good results in the perspective of the software quality. The software

maintainability defined as the happened modifications accepting and changes adoption in the system to resolve the inspected faults in the system [5]. Among the different existing phases such as requirements, design, coding, testing and maintenance. The maintenance phase requires much cost and is the most difficult process to evaluate [6,7]. The proper estimation of the software maintainability parameter greatly influences the required cost, staff….etc such things, which are included with the software product development [8].

Analyzability is the most important factor of the software maintainability parameter along with the Understandability and Modifiability factors. This factor gives priority to the user's efforts spent on the software system when compared to the other two factors which were discussed earlier here. As per the ISO/IEC-9126-3 standard [9], this factor involves the resources spent towards the identification of modified parts and failure identification, with the help of software maintainer's or user's efforts. Analyzability factor prediction involves with the accurate levels that can lead in improving the software maintainability parameter in a proper manner and ultimately causes to produce the better quality posing software systems.

This research paper is organized in the following manner. Section-2 deals with this research work based in the form of literature survey by discussing various pre-developed models related to OO software maintainability and its factors. The factor's metrics required to estimate the maintainability model are illustrated in Section-3.Section-4 includes the sample data of the three important factors (Modifiability, Understandability and Analyzability) of the software maintainability parameter. The Proposed maintainability model and its related information such as statistical significance and proposed model validation aspects are presnted in Section-5. The comparison of the proposed model to the previous existed models in terms of Pearson coefficient values are exhibited in Section-6. The conclusion and future scope of this research work are shown in the Secion-7 and Section-8 respectively.

2. LITERATURE REVIEW

The software maintainability model prediction would give nearer results to the actual intended results by the user or maintainer because of the natural behavior of the non functional requirements. The maintainability parameter of the software gives more accurate results in case of more number of factors than the less number of factors. The researcher also focuses on this point and included three numbers of important factors rather than two factors. The researcher used these factors with metric valued based sample data instead of factor's model based sample data which was used earlier by so many researchers.

Genero et.al. [10, 11, 12] developed OO software Maintainability models based on their own developed sample data [13]. In these developed models Genero et.al., developed the models for only factors of maintainability not the maintainability parameter. The developed models also included most of the metrics developed by them. Kiewkanya et.al.,[14] developed various maintainability models based on their own developed metrics and sample data. These proposed models include all of the metrics. The proposed models are hard to predict because many metrics are involved in this model development. Nazir et.al. [15] also developed OO software maintainability model for only Understandability parameter based on the Genero et.al.,[13] developed sample data.

Rizvi and Khan[16] developed the OO software maintainability models by using the Genero et.al.,[13] and Kiewkanya et.al.[14] sample data. The researcher developed the models for only understandability and modifiability factors here. The proposed maintainability model also includes only these two factors. syma kumar et.al.,[17,18,19] developed OO software maintainability models based on the non-linear standards like log normal ($\log_n$) and exponential (e^x) standards based on their own sample data related to the factors of OO software maintainability. One more OO software maintainability model [20] is developed by syma kumar with the help of Genero et.al.,[13] sample data by using the exponential (e^x) standard. The advantage of these models is these include three same metrics in the development of the maintainability models.

Hanumantharao et al.,[21, 22] developed two more interesting OO software maintainability models based on the metric values of the Understandability and Modifiability factors of the maintainability parameter. Earlier most of the OO software maintainability models are developed based on the models of the factors of the maintainability parameter not the metrics of the

maintainability. Hence the new notion thought in the development of the OO software maintainability models because metrics based maintainability models can obtain more accurate results rather than the model based maintainability models. So, the researcher in this research work also followed this metric based strategy and extended this technique to three factors and want to obtain more accurate maintainability models rather than the previous researchers.

3. USABLE METRICS IN MODEL ESTIMATION

The model estimation includes another model that leads to degradation of the performance of the proposed models. So, the model development includes the metric values of the different factors that may improve the performance of the resultant model in impressive manner because these metrics can provide accurate measures rather than the models.

Hanumantharao et al.,[23,24] developed the OOM (Object Oriented Maintainability) metrics for the Understandability and Modifiability factors. The author here developed these two metrics based on the inspiration of the Frederick T. Sheldon et.al. [25] developed metrics of OO software maintainability factors.

The developed Understandability metric is in the following manner.

Individual Class Understandability is

ICU = (Number of Super Classes/2) + (Number of Sub Classes/2) + 1

Total System Understandability is

SU= $\sum_{i=1}^{n} ICU_i$ / n

ICU_i = Individual Class Understandability of the Class i.

n= Number of classes.

The developed Modifiability metric is in the following manner.

Individual Class Modifiability is

ICM = (Number of Sub Classes/2)+1

Total System Modifiability is

SM = $\sum_{i=1}^{n} ICM_i$ / n

ICM_i = Individual Class Modifiability of the Class i.

n= Number of classes.

The researcher of this research work also developed metric for the Analyzability factor [26] of the OO software maintainability which may help in the process of estimating the model for the maintainability with three factors metrics.

The developed Analyzability metric is in the following manner.

Analyzability of the Individual Class (CA) is

CA= Number of Super Classes + Number of Sub Classes + 1

Analyzability of the entire system (SA) is

SA = $\sum_{i=1}^{n} CA_i$ / n

CA_i = Analyzability of the Individual Class i.

n= Number of classes.

4.SAMPLE DATA TABLE

The sample data table used in the development of the OO software maintainability model with three important factors is placed in this section. The given sample table data includes the metric values of Understandability(Un), Modifiability(Mo) and Analyzability(Ana) factors of maintainability parameter and the level of maintainability is also included here. The metric values of the various metric are taken from the OO software class diagram inheritance hierarchies. The maintainability levels are the number of levels that exists in the individual OO software class diagram. The number of classes required in developing the OO software system are also placed in the following sample table data.

CLASS DIAGRAM	Number of Classes	Un	Mo	Ana	Main
1	2	1.5	1.25	1.5	1
2	3	2	1.5	2	2
3	3	1.67	1.33	3.8	1
4	4	2.5	1.75	2.5	3
5	4	1.75	1.37	1.75	1
6	4	2.25	1.62	3.5	2
7	4	2	1.5	3.5	2
8	5	1.8	1.4	1.8	1
9	5	2.2	1.6	3.4	2
10	5	2	1.5	3	2
11	5	2.4	1.7	3.8	2
12	5	2.6	1.8	4.2	2
13	5	2.2	1.6	3.4	2

14	5	2.4	1.6	3.4	2
15	5	2.6	1.8	4.2	2
16	5	2.5	1.8	3.8	2
17	5	2.2	1.5	3.4	2
18	5	2.8	1.9	4.6	3
19	5	2.4	1.7	4	3
20	5	2.3	1.7	3.8	2
21	7	3.18	2.13	3.84	2
22	6	2.33	1.66	3.66	2
23	6	2.5	1.75	4	2
24	7	2.42	1.71	3.71	2
25	8	2.4	1.7	5.5	3

Table-4.1: Sample data for Maintainability Model Estimation

5. PROPOSED MAINTAINABILITY MODEL ESTIMATION

5.1. Model related Statistical Significance

In the process of proving the statistical significance of the proposed model,In this research work researcher calculated the ANOVA values, model summary and required constant values for model development here.

The following table-5.1.1 indicates the required model constant values and other information like standard error and the coefficient values are placed for the three factors of the maintainability parameter (Understandability, Modifiability and Analyzability).

	B	S.Error	t	Sig.
(Constant)	0.808	1.125	0.718	0.485
Un	0.139	1.259	0.110	0.914
Mo	-0.465	2.273	-0.204	0.841
Ana	0.484	0.129	3.746	0.002

Table-5.1.1: Constant and coefficient values of Model

The researcher opted the multivariate linear regression to propose the OO software maintainability model. The proposed Maintainability model with the help of Table-5.1.1. Shown values are placed in the following equation.

Main =0.808+0.139*Un-0.465*Mo+0.484*Ana-----→ (1)

The ANOVA model values and the model summary for improving the statistical significance of the proposed model are place in the following Table-5.1.2 and table-5.1.3 respectively.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	3.357	3	1.119	9.871	.001[b]
Residual	1.587	14	0.113		
Total	4.944	17			

Table-5.1.2:ANOVA of model

R	R Square	Adjusted R Square	Std. Err.
0.824	0.679	0.610	0.33670

Table-5.1.3:Model Summary

5.2. Estimated Maintainability Model Validation

In the Table-5.2.1,The researcher includes the Actual values of Maintainability and the calculated values of Maintainability with the help of equation-1. The proposed and calculated values of Maintainability are very much nearer than the previous results.

	1	2	3	4	5	6	7
A-MAIN	1	3	2	1	2	2	2
C-MAIN	2.26	1.55	2.08	1.28	2.37	2.02	2.18

Table-5.2.1: Actual and Calculated values of Model

The Pearson Correlation coefficient values are calculated between the actual and calculated values of Maintainability and placed in the Table-5.2.2. The resultant Correlation coefficient values are 0.97 (All most 1) means calculated values are all most nearer to the actual values of Maintainability.

	A-MAIN	C-MAIN
A-MAIN	1	0.97
C-MAIN	0.97	1

Table-5.2.2:-Correlation between Actual and Calculated values of Model

6. COMPARISON WITH EXISTED MODELS

Table-6.1 illustrates the comparison of resultant Pearson Correlation Coefficient values by the present researcher's proposed values to the other previous researchers developed Correlation Coefficient values. Here the researcher presented the resultant values of Correlation Coefficient is 0.97(All most nearer to 1) far better result than any other previous resultant Correlation Coefficient value of the developed maintainability model.

Model Number	Name of the Author	Resultant Pearson Correlation Coefficient
MODEL-I	Hanumantha rao et al.,[21]	0.86
MODEL-II	Hanumantha rao et al.,[22]	0.87
MODEL-III	Preeti priyanka et.al. [present]	0.97

Table-6.1: Comparison of proposed Correlation values with previous results.

7. CONCLUSION

In this research work,the researcher mainly concentrates on the improvement of the proposed OO software system maintainability in the perspective of showing results of calculated values of maintainability. Many previous researcher used Only understandability and Modifiability factors in the development of the maintainability model but the researcher here opted the three important factors of maintainability (Analyzability factor also) in the development of maintainability model. This improvement may cause to give the accurate and more improved model of maintainability. The researcher used three factors with their metric values rather than model values of factors to improve the accuracy in better manner of the proposed maintainability model. The resultant maintainability values and correlation coefficient values with the help of this proposed model are more nearer to the actual values and the required maintainability of the intended OO software system.

8. FUTURE SCOPE

The researcher proposed one maintainability model in this research work with the help of the metric values of the three important factors (Understandability, Modifiability and Analyzability) of the Maintainability parameter. This is an entirely new idea because the previous researchers proposed maintainability models with the help of models of the factors only, not the metric values of the maintainability factors till now. In future the researcher wants to focus on inclusion of more number of factors of maintainability in the development of model to give more accurate and improved model to the future researchers and users of the OO software system. The researcher want to include other factors like reusability, testability…etc in the development of model and calculate the metric values of those factors for the OO class diagram inheritance hierarchies which is very much useful in the development of the OO software system maintainability model.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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