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Role of Tailorability to Access Software Product Line Orthogonal Variability Model Maintainability

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Abstract: Software product line is defined as a set of similar software systems that sharejoint and managed set of features to satisfy the specific need of a particular market segment and these are developed from core assets in a prescribedway[1]. All the systems that come in product line have commonalities and variability. Anincreasing trend in software development is the requirement to develop new multiple and similar products at same time instead of single individual product. There may be quite a lot of reasons behind this. For continue the function of any product and developit as needed, it is important to look upon all the quality attributes that may affect it in future. There can be two types of quality attributes: internal and external. We can directly measure the internal quality attributes on the basis of product features such as size, length or complexity. Whereas there are external attributes like efficiency, reliability and maintainability. The maintainability which can be measuredrelating to how software relates with its environment and consequently, can be measured one time the software systems fully developed and deployed. Maintainability is one of these external quality attributes that is much valued at the present time. Maintainability is according to ISO/IEC 9126 standard means "the capability of software product to be modified.In current research we predict how the tailorability will predict OVM product line maintainability by using of developed metrics.

Keywords: Software Product Line, Orthogonal Variability Model, Tailorability, Maintainability, Empirical evaluation.

I. INTRODUCTION

As defined by Clements, Software product line is "*A set of similar software systems that share a common and managed set of features to satisfying the specific needs of a particular market segment*"[1]. Rather than developing a single product, the growing tendency in software engineering is to develop several product and similar products at one time. Software product line engineering (SPLE) offers a solution to eradicate this particular type of problem. Line means a set of products those are linked and share commonalties like data structure, software components, some features and architecture etc.[3]. Software product line(SPL) is a set of similar software systems that share a common, managed set of features to satisfy the specific needs of a particular market section that are developed from common set of core assets in prescribed way[2].Software product line has two phases: domain engineering and application engineering. In domain engineering,shared software artifacts are designed and developed for reuse. In application engineering, the particular products are derived by reusing a set of afore mentioned domain artifacts[4].Relating to the newest software quality model which is proposed by an ISO i.e. ISO/IEC 9126 model, Maintainability is the characteristic that is ability of software product to be amended. Maintainability is one of the external quality attributes. Others are Functionality, Efficiency, Portability, Reliability and Usability. All these characteristics have their own sub characteristics[1]. Maintainability is such ansignificant quality attribute and management of this is still a problematic area. Maintainability is concerned with assessing how well the model is analyzable or changeable. The level of maintainability acts as a major determinant of the success or failure of the product line.

Although various attempts have been done in the domain of software measurement for improving product quality, but most of them practices the goal of evaluations in late stages by using quantitative measurements by nature. Measuring quality at early phase of development is the key area to develop high quality software product line.

In a nutshell, the major contributions of this paper are:

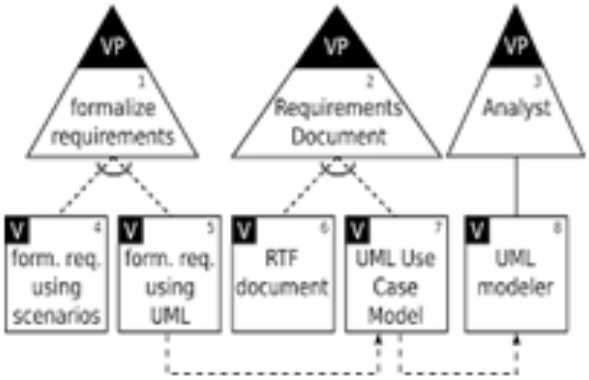
a) To describe the benefits of assessing maintainability quality attribute in reference to SPL orthogonal variability models.
b) Development of new metrics to assess SPL orthogonal variability models maintainability.
c) To empirically validate the developed metrics to assess OVM Maintainability.

The remaining paper is organized as follows: Section II describe the OVM model. Maintainability and its sub characteristic introduced in Section III; and also contains literature review over existing metrics. Section IV describes design and experimental set up. Section V explains analysis techniques and Section VI Results and Conclusion.

II. OVM

Orthogonal variability model is one of the best methodologies for modeling the variability in SPL. OVM is a proposal for documenting software product line variability[5]. In OVM, only variability of product line can be documented. In this model VP (Variation Point) that documents a variable item and V(Variant) documents the possible instances of that variable item. All the variation points are related to at least one variant and each variant (V) is related tone VP. Both VPs and Vs. can be either mandatory or optional. A mandatory VP must always be bound i.e. all the products of the product line must have this VP and its Vs must always be chosen. An optional VP does not have to be bound, it may be chosen to specific products. Always that a VP, mandatory or optional, is bound, its mandatory Vs must be chosen to a specific product. Always that a VP, mandatory or optional is bound, its mandatory Vs must be chosen and is optional Vs can, but do not have to be chosen[6].

The following diagram shows the example of OVM Product line:(Ref from website).



OVM product Line of Requirements Formulation

III. MAINTAINABILITY AND ITS SUB CHARACTERISTIC ANALYZABILITY

According to ISO the term quality can be defined as "the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs.[1] For continue the function of any Product and evolve as needed, it is imperative to look upon all the quality attributed that may affect it in future. Quality attribute can be categorized into two categories: internal and external. It is an indirect measurement based on internal quality attributes is devised. The reason being that internal quality attributes are suitable determinants for external quality attributes. One of these external quality attributes that is much valued at the present time is maintainability.. Maintainability is one of such external quality attributes is concerned with evaluating how well the developed software models can be understood changed and analyzed[8]. Research in the field of empirical software engineering has already shown that internal quality attributes can be appropriate determinants of external quality attributes [9,10].

Observing that the potential future significance of maintainability standards, it seems reasonable enough to study and analyze measures to assess maintainability quality attributes in reference to OVM product line. This assessment will lead to increased maintainability eventually leading to increase productivity, usage, adoption, satisfaction of user, and reduced development time and cost.

IV. EXPERIMENT DESIGN AND SETUP

A) VARIABLES

1. Independent Variables:

In our research we will develop our own independent variables. To which we categorize as independent because within the cause- effect relationship which is our major concern, they will represent the cause, i.e. we want to study if these metrics are or are not correlated with maintainability of software product line OVM.

2. Dependent Variables:

In our experiments the dependent variable will sub characteristics of maintainability i.e. analyzability.

B) OBJECTS OF STUDY:

The models included in our experiment are changed from feature models. Some of feature models picked form Software Product Line Online Tools (SPLOT) and we changed then into OVM by own. Total 14 models were selected keeping in mind their understandability by the subjects of study. The language for the models is used English only.

C) VALIDATION OF DATA

Once we collected data, to ascertain the degree of consent among the subjects we employed the Cronbach'sAlpha[11]. This analysis is important as the subject should reach a certain level of agreement else convincing conclusions cannot be drawn. That's why we used Cronbach's Alpha to retrieve the level of resemblance among the qualitative behavior of the participants. Results are shown in table 1.obtained from test.

Table1. Cronbach's Alpha For Degree Of Resemblance Between The Opinions Of The Participants

No of Items	Tailorability
14	.815

As seen in above table that the degree of similarity of all the participants is above than 8. It indicates that there exists a reasonable agreement between participants. As a result this reliability analysis, we conclude that it is reliable for further analysis.

Data Analysis

All the OVM models which we used in our experiment are from different domain and thus form satisfactory set of objects of study. They are also differs in metric values. The data collected empirically is also quantitatively reasonable. The quantity of data validates this. We have 2100data points as participants' opinion (14 OVM models and 150 participants 1 sub characteristics). We applied these techniques for few prospective:

Table.2 To study inter correlation between tailor ability and developed metrics

		RoMdtV	NTopV	NTopVP	RoC	RoAltVP
Tailorability	Pearson Correlation	-.624	-.844**	-.207	.174	-.133
	Sig.(2-tailed)	.017	.000	.478	.551	.651

As we see in table two metrics out of five has significant Correlation between developed metrics and tailorability. But it does not mean that we cannot predict maintainability by using these metrics. That' why, we perform multiple regression analysis to prove this.

Multiple regression analysis performed to predict the model for Tailorability

Tailorability: Tailorability is a loose term used in component-based software development to describe the ability to customize and configure components, but also to add new components to the system and combining services of multiple components in novel ways**.**

Table 3: Model Summary of Multiple Regression Analysis

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.844[a]	.712	.688	.278
2	.919[b]	.844	.815	.214
3	.930[c]	.865	.825	.298
a.Predictors(Constant),NTopV				
b.Predictors(Constant),NTopV,RoAltVP				
c.Predictors(Constant),NTopV,RoAltVP,RoC				

Table 4: ANOVA

Table 3 ANOVA						
Table 3 ANOVA		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Table 3 ANOVA	Regression	2.288	1	2.288	29.633	.000[b]
	Residual	.926	12	.077		
	Total	3.214	13			

Table 3 ANOVA	Regression	2.712	2	1.356	29.727	.000[c]
	Residual	.512	11	.046		
	Total	3.214	13			
Table 3 ANOVA	Regression	2.781	3	.927	21.402	.000[d]
	Residual	.433	10	.043		
	Total	3.214	13			
a. Dependent Variable: Tailorability						
b. Predictors: (Constant), NTopV						
c. Predictors(constant),NTopV,RoAltVP						
d. Predictors(constant),NTopV,RoAltVP,RoC						

Table 5 Coefficients:

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	6.882	.290		23.744	.000
	NTopVP	-.485	.089	-.844	-5.444	.000
2	(Constant)	7.477	.296		25.254	.000
	NTopVP	-.541	.071	-.941	-7.630	.000
	RoAltVP	-.788	.258	-.376	-3.051	.011
3	(Constant)	8.619	2.608		9.054	.000
	NTopV	-.568	.743	-.988	-7.854	.000
	RoAltVP	-.968	.444	-.462	-3.344	.027
	RoC	-1.418	3.090	-1.70	-1.259	.237
a.Dependent Variable: Tailorability						

Inference:

In table3 , The 'R' column represents the value of r, the multiple correlation coefficients. R can be considered as one of the measures of the quality of prediction of the dependent variable. The "R Square" column represents the R2 value, which is the proportion of variance in the dependent variable that can be explained by ratio of alternative variation points explain 93.0% of the variability of dependent variable i.e. tailorability. No of top variants and ratio of alternative variation points collectively explain 91.9 of variability of tailorability and number of top variants independently explains only 84.4% of variability of tailorability. Rest all the variables are excluded due to high level of tolerance.

In table 4, the F-ratio in the ANOVA table tests whether the overall regression is good fit for data or not. Statistically speaking, the metrics named Number of top variants; Rigidity of Configuration and ratio of alternative variation points can be significantly predict the level of dependent variable tailorability. F value of 21.372 is significant at the 0.000 level (i.e. the regression model is a good fit of the data).

In table 5, the significance value of predictors in model 3, also shows that the metrics are significant as well as strong predictors of tailorability, therefore, with the help of metrics used in model 3 tailorability can be predicted.

Therefore referring to the results of table 4, we formed following equation:

Tailorability= 8.619-.568(NTopV)-.968(RoAltVP)-1.418(RoC)

V. RESULTS VERIFICATION

For the verification of results we calculated the values of 14 models by using the linear equation which we formed from regression analysis and then we compared these values to subjective opinions of respondents which we got through questionnaire. There is 85.5% similarity between opinions and values calculated from equation. This proves that we can predict the maintainability by using these metrics. Tailorability can predict the model for maintainability of OVM product line.

VI. CONCLUSION AND FUTURE

In Software Product line it is very important to assess the quality of product line at the early phase that' why it is very important research area. In the end, we can say that we successfully we developed six metrics, by using of which we will fur access the maintainability of orthogonal variability model product line. In future we will empirically and theoretically improve that the developed metrics can predict maintainability.

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