

Determination of Homeland Criteria for UML Adaptation Evaluation

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Abstract

It is neither technically wise nor economically profitable to build most complex systems without first creating a model. Unified Modeling Language (UML) has helped raise general awareness about the value of modeling when dealing with software complexity. Since UML has become a bonafide industry standard for software modeling, a lot of studies has been carried out round the globe on its adoption and usage but the researcher's homeland has been neglected. Moreover, while most studies ends up as survey result/discussion on how different UML diagrams are being used, none has actually scientifically determined a suitable evaluation criteria for developers UML knowledge. This work which is part of a bigger study reports the determination of the evaluation criteria for developers UML Knowledge evaluation Model using the result of a previous survey by the researcher that reports how far African software developers are adapting to industry standard and the usage level of the various UML modeling tools. Survey research methodology was employed. The research question used was, which of the UML diagrams are the most/less used in practice? The statement of hypothesis is that there is no significance difference in mean usage of different UML diagrams. Different techniques of analysis were employed. Majorly, the statistical tools used by the researcher to analyze the data were percentages, mean and One Way ANOVA for test of research hypothesis. The result shows that there is a significant difference in mean usage of UML by types which gave rise to the two components of the evaluation criteria. The main contribution of the work is the creation of evaluation criteria for homeland UML knowledge evaluation which have the General Knowledge (GK) component and the Detailed Knowledge (DK) component.

Introduction

At the core of every mature discipline, from the arts to the sciences and engineering is a common language and common approaches that enable practitioners to collaborate and the discipline to evolve (Alhir, 2010). Software engineering discipline is not left out. Earlier, Cernosek and Naiburg (2004) has noted that it is neither technically wise nor economically practical to build certain kinds of complex systems without first creating a design. This is why professional architects might build a simple pet house without a design diagram, but will never embark in the construction of any complex building without first developing an array of architectural plans in line with Coleman, Liebovitch and Fisher (2019) observation that modeling helps us to determine results of interaction between all interacting factors. This means that modeling provides different professionals with the ability to visualize entire systems, assess different options and communicate designs more clearly before taking on the technical, financial or other risks involved with the actual construction. For the Software Engineering industry, Unified Modeling Language (UML) has helped raise general awareness about the value of modeling when dealing with software complexity.

Evaluation is used in many models, across many disciplines and for many different purposes (Nikfard, 2013). Since UML has become a bonafide industry standard for software modeling, a lot of studies has been carried out round the globe on its adoption and usage but the

researchers homeland has been neglected. Moreover, while most studies ends up as survey result/discussion on how different UML diagrams are being used, none has actually scientifically determined a suitable evaluation criteria for developers UML knowledge. This work which is part of a bigger study reports the determination of the evaluation criteria for developers UML Knowledge evaluation Model using the result of a previous survey by the researcher that reports how far African software developers are adapting to industry standard and the usage level of the various UML modeling tools. Survey research methodology was employed. The research question used was, which of the UML diagrams are the most/less used in practice? The statement of hypothesis is that there is no significance difference in mean usage of different UML diagrams. Different techniques of analysis were employed. Majorly, the statistical tools used by the researcher to analyze the data were percentages, mean and One Way ANOVA for test of research hypothesis. The result shows that there is a significant difference in mean usage of UML by types which gave rise to the two components of the evaluation criteria. The main contribution of the work is the creation of evaluation criteria for homeland UML knowledge evaluation which have the General Knowledge (GK) component and the Detailed Knowledge (DK) component.

Related Works

Mathew, Trueck and Truong (2017) did a study on Methods for evaluating the results of monitoring adaptation projects and programs. They explained that the evaluation of adaptation planning includes the need to track actions that are being undertaken and to provide feedback to relevant stakeholders regarding the success of actions and any necessary adjustments. Evaluation also includes considering and assessing a project or program as a whole, and determining whether the objectives of the program were achieved. Their study derived range of activities and outcomes that may be evaluated from different foci of evaluation based on the work of Pringle (2011). Summary of this is shown in fig 1.

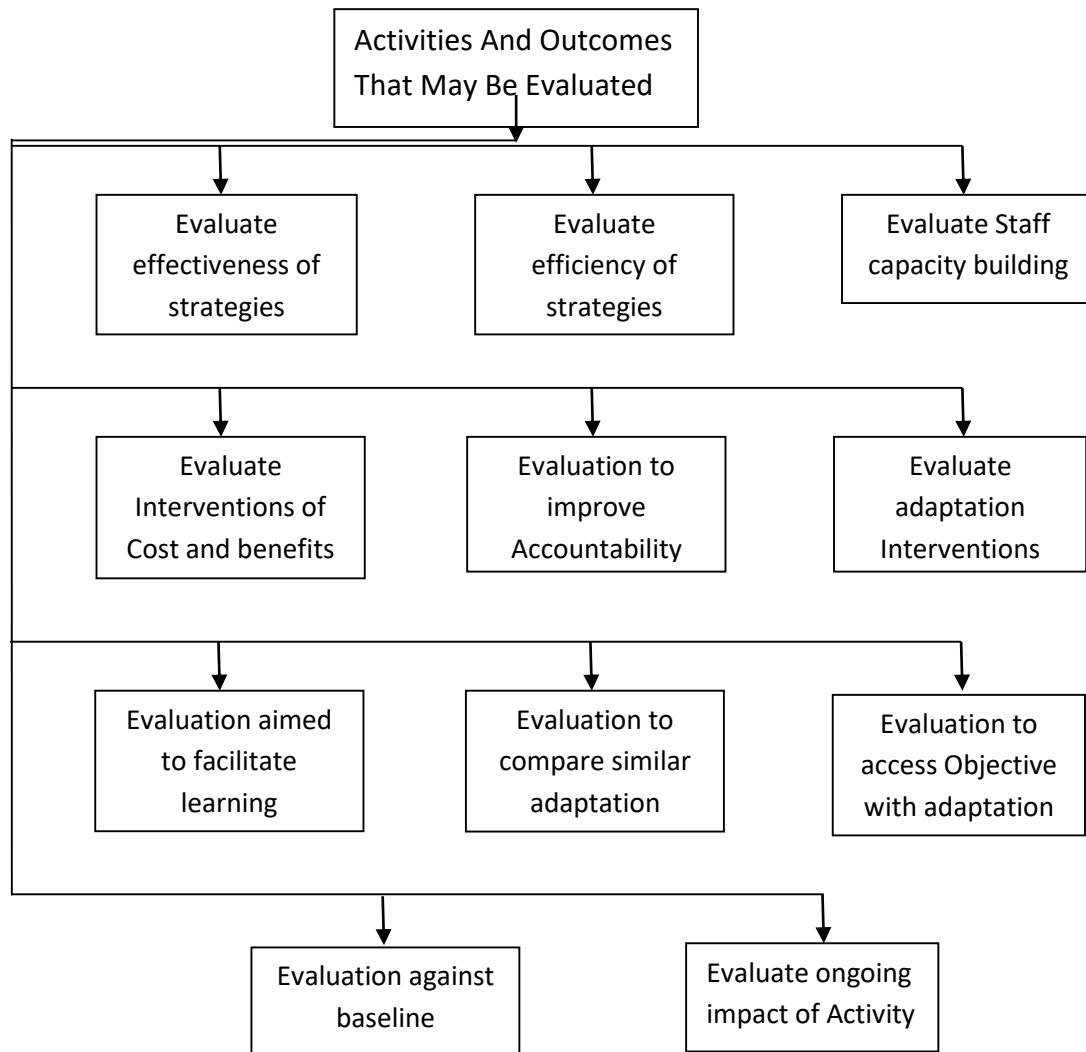


Figure 1: Summary of Different Foci of evaluation based on the work of Mathew, Trueck and Truong (2017)

Lebani and Hamid (2018) in their overview of adaptation techniques noted that computer systems in general and application particularly have evolved considerably over time and adapting these applications has become a major challenge that needs to be addressed. Lebani and Hamid (2018) conducted a survey and analysis study to identify a set of proven software technical adaptations to help companies address the challenges of adaptation. The result was a classification of technical and functional criteria.

For UML, an industry standard for software modeling, a lot of studies has been carried out round the globe on its adoption and usage but the researchers homeland has been neglected. Reggio, Leotta, Ricca (2014) in their paper presented some results about knowledge and usage of the UML diagrams by means of a personal opinion survey with 275 participants from both industry and academy. They reported that they have respondents from many different nationalities but out of the 275 participants, 231 participants were from Europe (mainly from Italy with about the half of the survey's respondents, and then Germany and France), 32 from Americas (mainly from US, Brazil and Canada), 10 from Asia, and only 2 from Africa. These studies did not give a good representation of African, the researchers homeland in the study. The survey research presented in Ezeasomba and Anigbogu (2019) was aimed at determining UML diagrams usage levels among software developers in Africa.

From the literatures reviewed, a research gap was discovered. Firstly, not much work has been done on adaptation evaluation criteria in general nor software adaptation criteria. While the work of Mathew, Trueck and Truong (2017) showed different Foci of evaluation, it did not derive the detailed evaluation criteria for each focus. Moreover, their work was also based on climate change adaptation. For Lebani and Hamid (2018) who conducted an overview of adaptation techniques. The work has a general focus and covered a wide space of time from 1991-2017. For the studies that focused on UML adoption/adaptation, most of them end up as survey result/discussion on how different UML diagrams are being used, none has actually scientifically determined a suitable evaluation criteria for developers UML knowledge evaluation.

Initial Survey Results of UML Diagrams Usage

The level of usage of the various UML diagrams as reported by Ezeasomba and Anigbogu (2019) is shown in Fig. 2. The chart shows that the level of usage is quite different. The diagrams usage level can be distributed in three main groups: G1, G2 and G3. G1 are those diagrams that are without any doubt widely used. These include the use-case diagram (98%), class diagram (97%), and sequence diagram (95%). The most known one is the use case diagram, and this is not surprising, since this diagram may be used without any other part of the UML, and it is truly useful to complement classical textual use case based requirements specifications, offering a nice way to visually summarize use cases, actors and relationships among them.

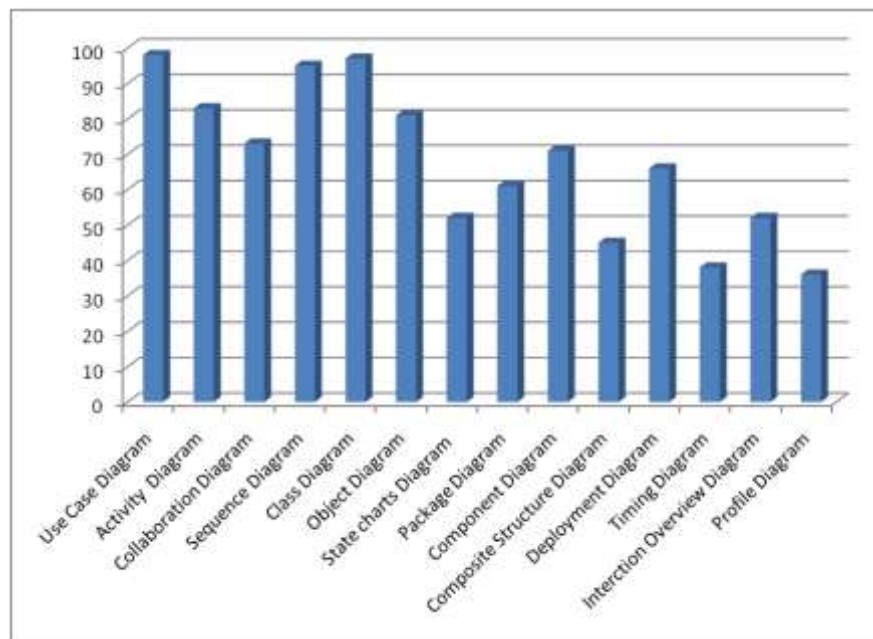


Figure 2: Usage Level of different UML Diagrams

Source: Ezeasomba and Anigbogu (2019)

G2 diagrams are used with averagely good percentage. They are state-chart diagrams (52%), package diagram (61%), component diagram (71%), object diagram (81%), deployment diagram (66%), and collaboration diagram (73%). Lastly G3 are the remaining diagrams which are scarcely used. They are: composite structure diagram (45%), profile diagram (36%), interaction overview diagram (53%), and timing diagram (38%). The answer to RQ2 is that some UML diagrams are very widely used (G1), others are averagely used (G2), while the remaining ones are scarcely used (G3). The least used among them is the profile diagram followed by the timing diagram.

Detailed Analysis of Result

To ultimately achieve the research objectives, different techniques of analysis were employed. Majorly, the statistical tools used by the researcher to analyze the data were percentages, mean and One Way ANOVA for test of research hypothesis.

Descriptive Statistics (Mean)

Descriptive statistics (mean) was utilized in answering the research question. The rating scale used was 4 points attitudinal rating scale, often referred to as “Likert Scale” (Brown, 2010). The scale was quantified as follows:

Often = 4, Not Often)= 3, Sometimes = 2, Rarely =1

The formula for mean is given as $(\bar{x}) = \frac{\sum fx}{n}$

Where : x = Each of the rating scale point

f = Frequency of the Responses

n = Total number of respondents

Cut off mean = $\frac{(4+3+2+1)}{4} = 2.5$ and above (Accept).

Table Percentage and Mean usage of each UML diagram Type

S/N	Often	UML TYPE	PERCENTAGE (%) USAGE	MEAN USAGE
1		Case Diagram	98	2.82
2		Activity Diagram	81	2.70
3		Sequence Diagram	95	2.74
4		Class Diagram	97	2.81
5	Not Often	Collaboration Diagram	70	2.50
6		Object Diagram	79	2.54
7		Package Diagram	60	2.44
8		Component Diagram	69	2.51
9		Deployment Diagram	64	2.12
10	Sometime	Compute Structure Diagram	44	2.11
11		Interaction Overview Diagram	50	2.20
12		Scale Chart Diagram	49	1.82
13	Rarely	Profile Diagram	35	1.54
14		Timing Diagram	36	1.33

Result Interpretation

From table 1, based on the analysis in percentage and descriptive statistics (mean), it's evident that Case Diagram has the highest percentage and mean usage among the UML types that are often used by the respondents with 98% (2.82), followed by Class Diagram, Sequence Diagram and Activity Diagram with percentage and mean usage of 97% (2.81), 95% (2.74) and 81% (2.70) respectively. Profile diagram and Timing diagram was observed to have the less usage in practice.

Test of Research Hypothesis at 5% Level of Significance.

Statement of Hypothesis

The statement of hypothesis is given as:

H_0 : There is no significance difference in mean usage of UML by types.

Table 2: One Way ANOVA test on the difference in mean usage of UML by types.

ANOVA

MEAN_USAGE

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.597	3	.866	55.342	.000
Within Groups	.156	10	.016		
Total	2.753	13			

*Significant at 0.05; df = 3&10; F – critical 4.00.

Decision Rule

The decision rule is given as:

Reject the hypothesis if P-value is < 0.05 , otherwise accept.

Results Discussion

From the Table 2, $F(3,10) = 55.342$; $P = 0.000 < 0.05$. Following the decision rule, the above hypothesis is rejected hence we conclude that there is a significant difference in mean usage of UML by types. However, it implies that the result obtained through the percentage and mean was not by chance. Based on this investigation one can infer from the result that Use Case diagram, Class diagram and Sequence diagram has the most usage in practice while profile diagram and Timing has the least usage. These are employed as evaluation criteria.

The Evaluation Criteria

Since from the statistical investigation derived in the previous section, Use Case diagram, Class diagram and Sequence diagram has the most usage in practice while profile diagram and Timing has the least usage. Good working knowledge of these three diagrams and a general basic knowledge of other UML diagrams (including identification of the diagrams and basic usage of the diagrams) will provide adequate evaluation criteria for the model. The evaluation criteria therefore has two major components; The General Knowledge (GK) and The Detailed Knowledge (DK). The formula used in measuring Developers Adequate Adaptation to UML (DAA_{UML}) therefore states that:

$$DAA_{UML} = GK_{AD} + DK_{OUD}$$

Where

DAA_{UML} is Developers Adaptation Adequacy to UML

GK_{UML} is the General Knowledge of UML diagrams

DK_{OUD} is the Detailed Knowledge of Often Used UML diagrams

GK_{UML} is given as:

$$GK_{UML} = GA_{DK} + GA_{DU}$$

and

DK_{OUD} is given as:

$$DK_{OUD} = DA_{KUC} + DA_{KUU} + DA_{KUS}$$

Where

GA_{DK} = General Adequate Diagram Knowledge

GA_{DU} = General Adequate Diagram Usage

DA_{KUC} = Adequate Detailed Knowledge and Use of Class Diagrams
 DA_{KUU} = Adequate Detailed Knowledge and Use of Use Case Diagrams
 DA_{KUS} = Adequate Detailed Knowledge and Use of Sequence Diagrams
 Figure 3 shows the Model of Homeland Criteria for UML Knowledge Evaluation.

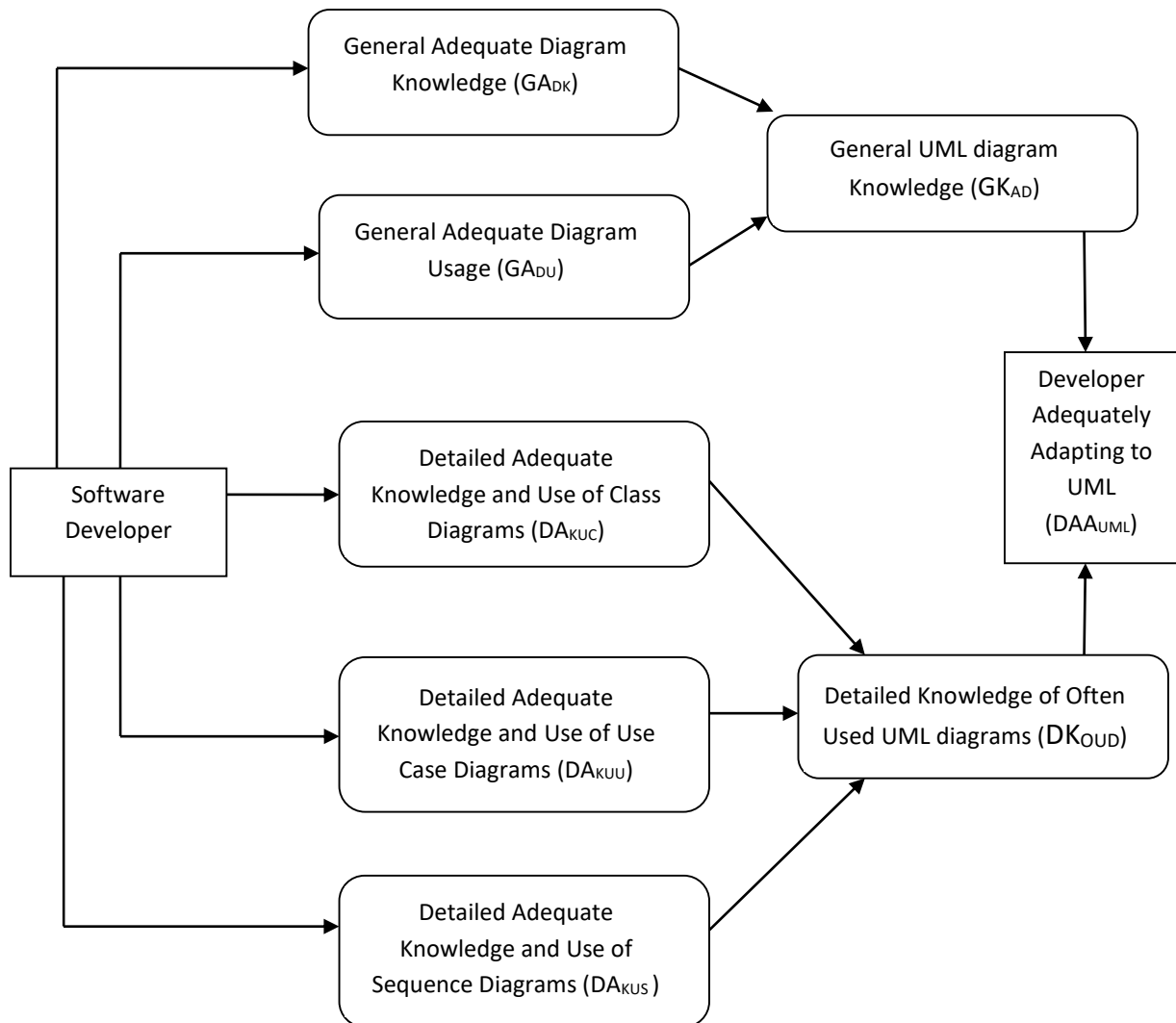


Fig 3 Model of Homeland Criteria for UML Knowledge Evaluation

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