International Journal of Ethics in Engineering & Management Education
Website: www.ijeee.in (ISSN: 2348-4748, Volume 1, Issue 4, April 2014)

Impact of Development Phases in Object Oriented Software Testing: A Survey

Sanjeev Patwa
FASC
Mody University of Science and Technology, (MUST)
Lakshmangarh-Sikar,Raj. India-332311
sanjeevpatwa@yahoo.com

Anil Kumar Malviya
Department of Computer Science & Engineering
Kamla Nehru Institute of Technology *(KNIT)*
Sultanpur,U.P., India-228118

***Abstract*— The focus of this survey paper is on the analysis of factors of different phases which affect software testing in Object Oriented Software with the opinion of people who are engage in software development phases. The study uses a questionnaire to analyze the factors and identify the phase that has significant impact on software testing. The research focuses on the perspective of the primary participants, managers, programmers, testers and other people involved in software research or development teams.**

***Index Terms*—Software testing, Object Oriented Software, Development Phases, Factors, Relative Weight Method**

I. INTRODUCTION

In Object Oriented Programming, our aim to write easily maintainable and reusable pieces of code that can perform collectively very complex tasks. However, the whole structure of an object-oriented program is very different from the structure of an equivalent program written in a procedural language. The object oriented approach follows an iterative and incremental approach to systems development. The phases of the traditional systems development approach do not match with those of the Object Oriented (OO) life cycle; but in each increment, all phases of the traditional life cycle (requirements, analysis, design, implementation, testing) are visited iteratively until the developers are satisfied. Software testing is as old as the hills in the history of digital computers. Testing is important for software quality and evolution, it is a major cost driver as well: about 25% to 50% of an average development budget is spent on testing [1].The actual amount of time and money which is needed to achieve the test goals all depends on several factors of different phases. These factors include not only human skills and knowledge but also the characteristics of the software. Our study focuses on the Object Oriented Software testing and on the several factors which may impact on the testing in Object Oriented Systems. This Study discusses about testing effort in object-oriented software due to several factors of OO Software development. The goal of performing this empirical research is to find out that which phase of OO software development has more impact on testing. The factors considered in this study include characteristics of the software itself (e.g., size, program categories etc.); the analysis and design (e.g., requirement analysis, design methodology etc); and all other factors during the whole software development process. The importance of any particular factor varies from application to application. Our work presents the findings of empirical research from several companies all over the India participating in software development and testing to identify the phase that may impact on Object oriented software testing. Twenty potential factors which involved in every phase of the software development process have been identified. The study uses a Relative Weight method to analyze these factors and identify the phases that have significant impact on object oriented software testing.

II. RESEARCH METHOD

This study is exploratory in nature yet specific in view of the conceptual models. The factors of each phase are considered to be the independent variable. The significance is measured by the percentage of the agreed participants. The independent variables are the 20 factors [2].We utilized Relative weight method, for statistical analysis

A. Categorization of Respondents

The people involved should be as heterogeneous as possible to assure that the representation does not reflect a unilateral viewpoint. For this purpose an attempt was made to include respondents with a variety of individualities. The type of respondents required for this study (programmers, testers, managers and analysts) are very busy people who have hardly any time for this sort of occupations. Even so, 168 respondents from a range of fields, with varying experience and of different places of the country have been participated. The parameters used to describe the respondents and their opinions are:

Current Position: Description of the position held by the respondents within the company or industry for which they work.

Years of Service: How many years the respondents have held their current position.

Type of software development: In which type of application development the respondent involved.

Impact of factors: To what extent respondent believe that the factors will impact on OO software testing.

Reusable code: This parameter of questionnaire provides information regarding average percentage of reusable code in respondent's software applications.

Categorization of Respondents is summarized in Table1 which is based on section B of questionnaire.

International Journal of Ethics in Engineering & Management Education
Website: www.ijeee.in (ISSN: 2348-4748, Volume 1, Issue 4, April 2014)

Table I CATEGORIZATION OF RESPONDENTS

Personal/demographic factor	Mean score	Sample size
1. Current job position (distribution of the survey participants)	project Manager: 13% Programmer: 63% Tester: 22%	168
2. Number of experience (years)	4.67=5 Years	156
3. Significance or agreed on impact of factors	82.85%	168
4. Percentage of reused code	50.17%	168
5. Percentage of time spent in analysis	22.07%	168
6. Percentage of time spent in design	19.60%	168
7. Percentage of time spent in coding	28.67%	168
8. Percentage of time spent in testing	26.33%	168

B. Questionnaire for Participants

Previous research on new developments has identified a large number of factors which belongs to different phases may have an impact on testing and software reliability [3]. These factors are summarized into a questionnaire in the research. Section A of questionnaire contains several factors which affects software testing in object oriented software. These factors are grouped under three different phases according to their temperament, which are summarized in Table2 which is based on section A of questionnaire:

Table II. PHASES AND FACTORS

Initial Investigation	Analysis and design	Coding
1.Complexity in logic	8. Requirements analysis	15. Programmer /Tester skill
2. Program categories	9. Volume of program design documents	16. Programmer /Tester organization
3.Difficulty of programming language	10. Design methodology	17.Development team size
4. Amount of programming effort	11. Relationship of detailed design and requirement	18. Program workload
5. Level of programming technologies	12. Frequency of program specification change	19. Domain knowledge
6. Percentage of reused modules	13. Development management	20. Human nature
7. Programming language	14. Work standards	

C. Scales Used for Response

The survey examining the perceptions of respondents (the term will be used hereafter to refer to the people like tester, programmer, manager etc., who have participated in survey) with regard to involving of these factors in Object oriented software testing. The survey used a 5 point Likert scale to identify the degree to which each factor (the independent variables) is a significant influence on testing. In the survey form, "1" indicates "not significant" and "5" stands for "most significant". If these factors are irrelevant, score of "1" would be expected; if they have significant impacts on software testing, the average score would be close to "5".

III. OBSERVATION

Based on the information obtained from the survey data, a number of observations could be devised concerning the impacts of factors on software testing. The following observation will be studied empirically in this research paper:

Observation: The impact of all the phases of software development on testing of OO software is at the same level.

IV. RESULTS AND FINDINGS

A. Relative weight method

For analysis of observation the relative weight method is use to obtain the final ranking for the factors of each phase. Let rij be the original ranking of the i th factor on the j th survey. We first normalize these rij's such that

$$wij = \frac{rij}{\sum_{i=1}^{n} rij} \quad \text{----------(1)}$$

Where n is the number of factors on the jth survey. Therefore $\sum_{i=1}^{n} wij = 1$ for all j.

Different people may give different original ranking and some of them may give higher scores for all factors. Therefore, the summation of all the scores from f1 to f20 ranges from 375 to 658. By normalizing the original ranking scores using Eq. (1), one can get rid of this bias. We then average these wij's to obtain the final weight for the ith factor such that

$$wi = \frac{\sum_{j=1}^{l} wij}{l} \quad \text{----------(2)}$$

Where l is the number of surveys used in this method. Based on these relative weights, we could obtain the final weight for each factor.

Results by the relative weight method are given in Table 3 and Table 4. As seen from the table 3, the top 10 most important factors are classified as factors in the Initial Investigation phase (two factors), analysis and design phase (four factors) and coding (four factors). The column named Normalized Priorities gives the contribution of each factor. Higher priority value indicates a higher ranking. Since lower class rank implies decrease in magnitude of relative importance or effectiveness, software programmer and tester should then pay more attention to the factors with high ranks and the phases from which they belongs. The application of this finding is not to discard the factors and phases having lower ranking. The ranking can be obtained by adjusting to different applications of software products. The final priority information can then be used to guide the Object Oriented software testing process of different applications. The ranking of factors also supported by some previous results as domain knowledge is consistent with the observations of Beer and Ramler [4] and Kanij et.al.[5] reporting experience resulted in higher domain knowledge that helped testing in case of insufficient or inaccurate

International Journal of Ethics in Engineering & Management Education
Website: www.ijeee.in (ISSN: 2348-4748, Volume 1, Issue 4, April 2014)

specifications. Table 4 shows the ranking of phases on the basis of normalized Priorities of belonging factors. It shows that the total of all the factors belong to Analysis and Design phase is 0.17438363 which is highest among all, it means that this phase of software development has highest impact on testing of Object Oriented Software. This kind of finding can be used to help software developers to determine the most important factors they need to focus on subject to the available resources they have.

TABLE III .FINAL RANKING OF FIRST 10 FACTORS BASED ON RELATIVE WEIGHT METHOD

Rank	Rank factor	Factor Name	Normalized Priorities
1	f11	Relationship of detailed design and requirement	0.0483978
2	f1	Complexity in logic	0.0462188
3	f16	Programmer/Tester organization	0.0458077
4	f15	Programmer/Tester skill	0.0446987
5	f12	Frequency of program specification change	0.0444152
6	f14	Work standards	0.0441917
7	f19	Domain knowledge	0.0430985
8	f6	Percentage of reused modules	0.0422766
9	f8	Requirements analysis	0.0373789
10	f20	Human nature (mistake and work omission)	0.0369283

TABLE IV. RANKING OF PHASES ON THE BASIS OF TABLE III (FACTOR RANKING)

Rank of Phases	Rank factor	Factor Name	Normalized Priorities
1.Analysis and Design	f8	Requirements analysis	0.0373789
	f11	Relationship of detailed design and requirement	0.04839781
	f12	Frequency of program specification change	0.04441524
	f14	Work standards	0.04419168
		Total	**0.17438363**
2.Coding	f16	Programmer/Tester organization	0.04580766
	f15	Programmer/Tester skill	0.04469867
	f19	Domain knowledge	0.04309846
	f20	Human nature (mistake and work omission)	0.03692825
		Total	**0.17053304**
3.Initial Investigation	f1	Complexity in logic	0.04621879
	f6	Percentage of reused modules	0.04227664
		Total	**0.08849543**

V. DISTRIBUTION OF DEVELOPMENT TIME

Paper also summarized the data obtained from Section B of the survey forms. In Section B, we asked the survey participants to estimate how much time they spend in each of the development phase, and how much code is reusable in their software products. Based on the response we analyzed from the opinion of this group of survey participants and found, analysis, design, coding and testing take about 22%, 19%, 28% and 26% (approx.) of the development time, respectively. Analysis, design and testing together take about 67% of the total development time. This confirms our finding (Table 3) that nine out of the top 10 factors are from these phases. This time allocation had been verified to agree with the practice in some software development companies such as MetaCube, HCL and TCS. This result may vary for different projects or applications. We also observed that people in different positions have different opinions regarding importance of several phases in OO software development process (Table 5). The significance of incorporating the 20 factors into software testing studies averages at 82.85%, ranging from 82.89% of the programmers, 83.88% of the testers, and 83.67% of the managers.

TABLE V. SUMMARY OF DISTRIBUTION OF DEVELOPMENT TIME

	Programmer (107/168)	**Average %**
1	analysis phase	23.95455
2	design phase	19.22727
3	coding phase	31.36364
4	testing phase	25.45455
	Significance of factors	**82.89%**
	Tester (38/168)	**Average %**
1	analysis phase	21
2	design phase	25
3	coding phase	30
4	testing phase	36
	Significance of factors	**83.88%**
	Manager (23/168)	**Average %**
1	analysis phase	15
2	design phase	20
3	coding phase	40
4	testing phase	25
	Significance of factors	**83.67%**

VI.CONCLUSION

In the study, we defined the factors involved in software testing. A survey was performed to collect the data. The survey has unique features such as liker scale from 1 to 5 and has 20 factors which relate to testing. The survey in addition to confirming some popular beliefs also lists several noteworthy findings from the perspectives of respondent categories such as programmer, tester and managers. From the study, the following conclusions can be drawn:

- The relative ranks of the factors and phases have been provided in terms of the significance of their impact on software testing. People can check the list and find out the most significant ones similar to their software testing and development process.

- Some information of the time allocation of every phase of the software development process is also summarized. This information can provide managerial suggestions for software development projects.

The findings, however, are based on the group of people who participated in this survey. Cautions need to be taken when applying these results in other applications. In fact, some information of our results can be used after make some appropriate adjustments for other software applications. Our ongoing research work attempts to refine these findings through directed interviews as well as through further investigations in a wider context. We are also working on the definition of a methodology for dynamically incorporating such findings in the management decisions on strategic challenges such as introduction of new technologies, processes, and effort allocations in relation to testing.

REFERENCES

[1] M.Pol, T.Koomen, A.Spillner, "Management and Optimization of the Test Processes": Practical Manuals for Successful Software-Tests with TPI and TMap, dpunkt.verlag(Publishing House):ISBN 3-932588-65-7,2000.

[2] S.Patwa, A.K.Malviya, N.Kumar, "The factors of Testing Techniques for Object oriented software", International Journal Of Computer Application (Online),2 (4), ISSN 2250-1797, 55-64,2012.

[3] H.Pham, X. Zhang, " An analysis of factors affecting software reliability". The Journal of Systems and Software, Elsevier, 43-56, 1999.

[4] A.Beer, R.Ramler, "The role of experience in software testing practice" in SEAA '08: Proceedings of the 2008 34thEuromicro Conference Software Engineering and Advanced Applications. Washington, DC, USA: IEEE Computer Society, 258–265, 2008.

[5] T.Kanij, R.Merkel, J.Grundy, "A preliminary study on factors affecting software testing team performance," in ESEM 2011: Proceedings of the 2011Conferenceon empirically Software Engineering and Methods, Banff, Canada, IEEE., 2011.