Perception of IT Professionals towards Root Causes of Software Bugs

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ABSTRACT
The reason behind the software bugs have been reported differently by different researchers and to the some extent the professionals working on different software developments and quality testing of the same also agrees with it. In the context of the same the researchers in this study tried to explore the perception of the professional working in the IT industry regarding root causes of bugs in any software. The researchers studied the possibility of significant difference in the opinion about the reason of bugs by different professionals on the basis of their job profile, experience in the same domain, age group and gender. The outcomes of the study would be useful for further studies or the software professionals while software development and testing of the same.

General Terms
Software Bugs, Hypothesis, Association

Keywords
Software Bugs, Root causes, perception, IT professionals

1. INTRODUCTION
A software bug can be found in the program code part which would result in an error, fault or malfunctioning of the program. Some bugs can be detected easily during development. But some bugs are very difficult to found in the initial phase and will be found late in the development process. Probabilities of these bugs are very low and these bugs are hard to detect and occur on very light set of inputs. According to IEEE standards, a 'bug' is an incorrect step, instruction or data in a program. A failure is caused because of a bug and may alter the external behavior of the program. Software bugs are common in practice. Although there are many causes of software bugs, some causes are very common that can be the cause of software failures.

To make a bug free project a developer/tester must understand the various causes of the appearance of software bugs. Many causes contribute towards software bugs in the project such as product related reasons, process related reasons and project related reasons. The reason behind the software bugs have been reported differently by different researchers and to the some extent the professionals working on different software developments and quality testing of the same also agrees with it. In the context of the same the researchers in this study tried to explore the perception of the professional working in the IT industry regarding root causes of bugs in any software.

In this short paper we investigate whether there is any association or difference between causes of software bugs and IT professional's perspective. This study demonstrated a satisfied relationship among causes of bugs, the experience of developers/testers, job profile and level of the management, but no relationship with the gender of developers/testers.

2. LITERATURE REVIEW
Many researchers have been working on the subject of causes of bugs and perception of IT professionals and for the purpose of literature review researchers took the literature of the work done between 1976 till 2015.

2.1 IT Professionals Perspective Related Papers
In this study [9] researcher has found the relationship between bugs and four different developer variables, mostly assessing the developer's experience. They have concluded that there is a strong relationship between causes of bugs and experience of a developer.

In an another study[10] four developer variables has been included: a measure of the developer's overall experience, their recent experience, and their experience with a specific subsystem, as well as the number of developers who made modifications to satisfy a modification request. They found that the only statistically significant variable was the one that measured the developer's overall experience level.

2.2 Causes of Software Bug Related Literature
Various models of estimating bugs have been proposed in last 40 years. In 1976[1], Akiyama has given a study that estimates the number of bugs in the software projects. Researcher has taken complexity of code as the independent variable and number of bugs as a dependent variable, after that researcher found that Line of code (LoC) is the main reason of software bugs and LoC represents the complexity of software systems.

In 1976[2] and 1977[3] McCabe and Halstead proposed the cyclomatic complexity metric and Halstead complexity metrics respectively. In 1970s and 1980s most of the researchers have used these metrics to construct the bug prediction model.

In 1990s software developer/testers have started to include software development history into software repositories related to the historical data of the software bug. In terms of Object Oriented systems, Chidamber and Kemerer proposed several object-oriented metrics in 1994 .in 1996[4] ,Basili et al has used object-oriented metrics to find the most significant bug indicators and to predict software bugs.

In 2000s product metrics has also been introduced by Chidamber and Kemerer. The goal to introduce these metrics was assess these metrics as indicator of bugs. Similar work has already been done by Li and Henry, and Lech Madeyski and Marian Jureczko[5,6].

In 2007 researchers have found a significant relationship between faults and the experience of developers with the system, but no relationship with the number of developers [7].

In 2010 researchers have included two developer oriented variables: a measure of the developer's/ testers overall experience, and their experience and number of developers who made modifications to satisfy a Modification Request. They found that the only statistically significant variable was the one that measured the testers/developer's overall experience level. They have concluded that 20% of the files can typically contain 75 - 95% of the bugs because of testers/developers experience [8].

In 2015[11] researchers has included four software metrics (WMC, CBO, DIT and LoC). And it has been concluded that there is a positive relationship between number of bugs and these four software metrics.

Objectives of the study: In the present study the researcher studied the following objectives:

1. To explore various reasons of software bugs
2. To find out the association between demographic profiles of the respondents and their perception about causes of software bugs

To explore the difference in the perception of the respondents about causes of software bugs on the basis of not associated profile.

3. RESEARCH METHODOLOGY

The present study is exploratory and descriptive in nature. The data collection technique for the study is of primary and secondary data. The secondary data collection was done through the published articles, reports, and other research work published in journals etc. During the study the primary data collection was done through self administered questionnaire in which the reasons of the software bugs were listed and the same were compiled after thorough literature review and the consultation with various software industry experts. Apart from the demographic profile including gender, job profile, experience and level of management the respondents were asked to rate their perception about causes of software bugs between 1 to 5 where 1 means strongly disagree to 5 strongly agree.

The questionnaire was prepared and a preliminary test was conducted and during the same the questionnaire was found suitable for distribution and data collection. The convenience sampling technique was used to get the responses from various software engineers, quality managers, test architects, project leads; quality leads etc. through personal interaction email and telephonic interaction. For primary data collection 627 respondents were approached with request for filling out questionnaire data. However out of 627 responses only 453 responses were deemed fit for use and were included in analysis. The descriptive of the respondent's demographic profile is given below in table no 1.

Table No.1 Demographic Profile of the respondents

Variables	Categories	Frequencies	Valid %ages
Gender	Male	302	66.7
	Female	151	33.3
Job Profile	Tester	289	63.8
	Developer	106	23.4
	Project lead	12	2.6
	QA Lead	30	6.6
	QA Manager	5	1.1
	Test Architect	11	2.4
Experience	Less than 5 years	231	51
	5-10 years	190	41.9
	10-15 years	15	3.3
	15 years and above	17	3.8
Level of Management	Lower Level	224	51.3
	Middle Level	191	43.7
	Top Level	22	5

The present study has 453 respondents and 66.7% of them are male. In case of job profile it was found that 63.8% of the respondents were testers and 51% respondents were from less than 5 years of experience in the industry. Among the participants the 51.3% were form lower level of management.

The analysis includes hypotheses testing to find out association between the perception about the causes of bugs and the demographic profile of the respondents. It also includes the application of statistical test to find out difference in the perception about the causes of bugs of the respondents on the basis of their gender, job profile, experience and the level of management.

4. ANALYSIS

In this work researcher has considered 6 null hypotheses and 6 alternate hypotheses to find out the association and difference among causes of bugs and IT professional's perspective.

1. **Null Hypothesis 1:** There is no significant association between Causes of Bugs and the Gender of the respondents.

   Alternate Hypotheses 1: There is a significant association between Causes of Bugs and the Gender of the respondents.

   To test the association between perceptions about causes of bugs and gender of the respondents the chi-square test was performed and the output of the same is given in table no 2.

Table no.2 Chi square for test of association between Perception about causes of bugs and gender

	Value	Df	Asymp. Sig. (2 Sided)
Pearson Chi – Square	37.506	40	0.583
Likelihood Ratio	39.849	40	0.477
Linear by Linear Association	0.096	1	0.756
No. of Valid Cases	443		

From the output table of chi-square test, the significance level is 0.583 at 95% confidence level, which is greater than .05 thus the null hypotheses 1 can't be rejected and alternate hypotheses can't be accepted. The value of Cramer's V is 0.291 and it is also less than 0.5, thus the researchers interpret the results of chi-square test of association between perception

about causes of bugs and the gender of the respondents as very weak. Hence form the above test it is evident that there is no significant association between perception about the causes of bugs and the gender of the respondents.

2. **Null Hypotheses 2**: There is no significant association between perception about the causes of bugs and the job profile of the respondents.

   Alternate Hypotheses 2: There is a significant association between perception about the causes of bugs and the job profile of the respondents.

To test the association between perception about causes of bugs and the job profile of the respondents the chi-square test was performed and the output of the same is given in table no 3.

Table no.3 Chi square for test of association between Perception about causes of bugs and job profile

	Value	df	Asymp. Sig. (2 Sided)
Pearson Chi – Square	258.691	200	0.003
Likelihood Ratio	191.856	200	0.648
Linear by Linear Association	4.335	1	0.037
No. of Valid Cases	443		

From the output table of chi-square test, the significance level is 0.003 at 95% confidence level, which is lesser than .05 thus the null hypotheses 2 can be rejected and alternate hypotheses can't be rejected. As the value of Cramer's V is 0.342 and it is also less than 0.5, thus the researchers interpret the results of chi-square test of association, as a weak association between perception about causes of bugs and the job profile of the respondents.

3. **Null Hypotheses 3**: There is no significant association between Causes of Bugs and the experience of the respondents.

   Alternate Hypotheses 3: There is significant association between Causes of Bugs and the experience of the respondents.

To test the association between perception about causes of bugs and the experience of the respondents the chi-square test was performed and the output of the same is given in table no 4.

Table no.4 Chi square for test of association between Perception about causes of bugs and experience

	Value	Df	Asymp. Sig. (2 Sided)
Pearson Chi – Square	147.786	120	0.043
Likelihood Ratio	118.492	120	0.522
Linear by Linear Association	5.539	1	0.019
No. of Valid Cases	443		

The value of significance level from the output table of chi-square test, is found as 0.043 at 95% confidence level, which is lesser than .05 thus the null hypotheses 3 can be rejected and alternate hypotheses can't be rejected. Apart from it the value of Cramer's V is 0.333, thus the researchers interpret the results of chi-square test of association, as a weak association between perception about causes of bugs and the experience of the respondents in the same industry.

4. **Null Hypotheses 4**: There is no significant association between Causes of Bugs and the level of management of the respondents.

   Alternate Hypotheses 4: There is a significant association between Causes of Bugs and the level of management of the respondents.

To test the association between perception about causes of bugs and the level of management of the respondents the chi-square test was performed and the output of the same is given in table no 5.

Table no.5: Results of Association between Perception about Causes of Bugs and Level of Management

	Value	df	Asymp. Sig. (2 Sided)
Pearson Chi – Square	85.040	80	0.329
Likelihood Ratio	85.767	80	0.309
Linear by Linear Association	4.802	1	0.028
No. of Valid Cases	443		

From the output table of chi-square test, the significance level is 0.329 at 95% confidence level, which is greater than .05 thus the null hypotheses 4 can't be rejected and alternate hypotheses can be rejected, thus the researchers interpret the results of chi-square test of association between perception about causes of bugs and the level of management of the respondents not associated with each other.

According to the above analysis and results, null hypotheses 2 and 3 can be rejected so it can be concluded that there is the association between causes of bugs and respondent's job profile & experience. On the other hand null hypotheses 1 and 4 can't be rejected so it shows there is no association between causes of bugs and respondent's genders & level of management. To make it more reliable researcher will try to prove these not rejected hypotheses to find out the difference between causes of bugs and respondent's gender & level of management.

5. **Null hypotheses 5**: There is no significant difference in the perception of employees about the causes of bugs on the basis of their gender

   Alternate hypotheses 5: There is a significant difference in the perception of employees about the causes of bugs on the basis of their gender

To test the difference in the perception of the employees about the causes of bugs on the basis of gender the independent t test was performed and the result of the same is compiled in the table no 6 .

Table No.6 Results of Difference in Perception of Employees towards Causes of Bugs on the Basis of Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means		t-test for Equality of Means				
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Standard Error	95% Confidence Interval of the Difference	95% Confidence Interval of the Difference
Causes	Equal variances assumes	3.34	0.068	0.31	441	0.757	0.30022	0.96896	Lower	Upper
									-1.60414	2.20457
	Equal variances not assumes			0.3	268.487	0.764	0.30022	0.99993	-1.66849	2.26893

The value of Levene's test to analyze the equality of means is 0.068 which indicates that the two groups hence equal variance and alternate hypotheses 5 can't be rejected. The table shows that the test statistics indicates that the two groups male and females, have equal variance, therefore the statistics associated with equal variances assumed is being used for the t-test for equality of means.

The t-test result (with equal variances assumed) shows t statistics of 0.310 with 441 degrees of freedom, the corresponding two-tailed p value is 0.757, which is higher than .05. Apart from the mean value of both the samples are 67.368 and 67.068 for males and females respectively; therefore we cannot reject the null hypothesis 5 at 5% significance level. It means that the perception of employees towards causes of bugs do not significantly differ from each other on the basis of gender.

6. **Null hypotheses 6**: There is no significant difference in the perception of employees about the causes of bugs on the basis of their level of management.

   Alternate hypotheses 6: There is a significant difference in the perception of employees about the causes of bugs on the basis of their level of management

To test the difference in the perception of the employees about the causes of bugs on the basis of their level of management the one way ANOVA was performed and the result of the same is compiled in the table no 7.

Table No. 7 ANOVA results for different perception towards causes of bugs on the basis of level of management

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	591.091	2	295.546	3.244	0.04
Within Groups	40085.943	440	91.104		
Total	40677.034	442			

To find out the difference in the perception of employees about the causes of bugs on the basis of level of management, the researchers applied one way ANOVA and the result indicates the significance of f test as .04. The value of significance of f test is less than .05 at a confidence level of 95% and thus the f test proves the model as significant.

On the basis of it the null hypotheses 6 can be rejected and alternate hypotheses can be accepted this means that there is significant difference in the perception of employees about causes of bugs on the basis of different level of management.

5. DISCUSSION & CONCLUSION

The present study describes the perception of the professionals towards causes of software bugs. During the study the researchers found that the gender and the level of management plays role in framing the perception of the professionals about the causes of software bugs, however it is the job profile and the experience which make the professionals to identify the causes of the software bugs. Apart from it the researcher also found that the perception of the professionals about the software bugs do not differ on the basis of gender, however it can differ from each other on the basis of their job profile, experience in the industry and their level of management. Thus the researchers conclude that the experience and job profile in the industry matters significantly in framing the perception towards causes of software bugs.

The factors extracted from the factor analysis confirm the same factors as previous work done by the Garg, (2014). As limited work has been done on the human or behavioral aspect of the professionals in the industry, the researchers suggest that the future work can be carried out on product, process and project based factors and their association with job profile and experience of the professionals in the industry. Apart from the causal relationship can also be tested among both the variables i.e. Factors of software bugs and the demographic profiles of the respondents.

6. REFERENCES

[1] Akiyama F. An example of software system debugging. Proceedings of the International Federation of Information Processing Societies Congress. 1976; 71:353–79.

[2] McCabe T. A complexity measure. IEEE Trans Software Eng. 1976 Dec; 2(4):308–20.

[3] Halstead MH. Elements of Software Science (Operating and Programming Systems Series). New York, USA: Elsevier Science Inc; 1977.

[4] Basili V, Briand L, Melo W. Measuring the impact of reuse on software quality and productivity. Comm ACM. Oct 1996; 39(10):104–16.

[5] Madeyski L, Jureczko M. Which process metrics can significantly improve defect prediction models? An empirical study. 2014.

[6] Henderson-Sellers B. Object-oriented metrics: measures of complexity. Upper Saddle River, NJ, USA: Prentice-Hall, Inc.; 1996.

[7] Weyuker, Elaine J., Thomas J. Ostrand, and Robert M. Bell. "Using developer information as a factor for fault prediction." Proceedings of the Third International Workshop on Predictor Models in Software Engineering. IEEE Computer Society, 2007.

[8] Ostrand, Thomas J., Elaine J. Weyuker, and Robert M. Bell. "Programmer-based fault prediction." Proceedings of the 6th International Conference on Predictive Models in Software Engineering. ACM, 2010.

[9] Mockus and D.M. Weiss. Predicting Risk of Software Changes. Bell Labs Technical Journal, April-June 2000, pp. 169-180.

[10] Ostrand, Thomas J., Elaine J. Weyuker, and Robert M. Bell. "Programmer-based fault prediction." Proceedings of the 6th International Conference on Predictive Models in Software Engineering. ACM, 2010.

[11] V. Gupta, N. Ganeshan , T.K. Singhal, "Developing Software Bug Prediction Models Using Various Software Metrics as the Bug Indicators", International Journal of Advanced Computer Science and Applications (IJACSA), 6(2), 2015.