Assessment of Quality Assurance practices in Pakistani Software Industry

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Abstract-The growth of software industry in Pakistan in recent years is very impressive. However, to sustain this growth and deliver high quality software, software development organizations need to follow rigorous quality assurance practices. This defines the primary purpose of this research, which is to assess the current quality assurance practices in the Pakistani software industry in order to identify areas where improvements can be made. Major aspects of software quality assurance, namely testing methodologies and techniques, test automation and tools, test management, quality metrics, and quality assurance training and education, were taken into consideration. The results of the research show that currently the use of quality assurance related activities is not widespread. This is specifically true of small software development organizations. However, it is encouraging to see that they are very much inclined in incorporating such practices.

Keywords-Software Quality Assurance, Software Testing, Software Quality, Pakistan

I. INTRODUCTION

The software industry has shown a decent growth in the last two decades. A study on the value of software development shows that in software development industry, investment increased from $82 billion to $149 billion from 1995 to 1999 [i]. Charette stated in his report that $1trillion was spent on IT hardware, software and services during 2005 [ii]. Beside this growth, the software industry still needs improvement to produce such products that meet quality standards, time pressure and budget restriction [iii]. Information technology (IT) in today's world is very important, but IT has the challenge to develop successful products with well-known methodologies [iii-vi]. These software products not only affect the business but influence human lives as well [vii-viii]. Therefore, a focus on the assurance of quality software is becoming more and more important.

Software Quality Assurance (SQA) comprises a set of techniques that ensure the software engineering processes to produce a quality product [ix]. Software development organizations give less importance to quality assurance as it is the first option to cut back when deadlines are missed [ix]. The literature suggests that errors missed in the early stage of software development may have a rippling effects, and are time consuming and expensive to correct at the end of the project [x]. Ewsui-mensah [xi] shows that 52.7% of the software projects completed are 189% over budgeted. In 2005, US economy suffered at least $25billion and as much as $75billion was lost due to project failures [ii]. Hardgrave et. al. suggest that the software development needs improvement with methodologies, but these methodologies are not the solution of all software development problems [vi]. As Gill stated in his study, the project fails if the quality management process is not effective no matter how advanced the tools and techniques are [xii].

Feldman [xiii] defines quality assurance as "*providing guarantee and reliability that the product works correctly*". Merriam Webster [xiv] describes quality assurance as "*a set of services that inspires confidence and certainty*". Software quality assurance team is defined as "*professionals founded to promote the quality assurance profession through proliferation and advancement of high professional standards*" [iii]. Pyhajarvi and Rautiainen [xv] define the role of quality assurance team as exploring errors and assuring that these errors are resolved before the release of the product, unless management decides not to fix these defects.

This study aims at understanding the level of Software Quality Assurance (SQA) techniques and practices that are being followed by the software development organizations in Pakistan. This research will help to identify the best practices and the weaknesses in the quality assurance techniques currently used in the Pakistani software industry. Apart from this, this study will also help to find out whether the existing training courses of quality assurance taught in universities and private institutions of Pakistan cover the required types of techniques and skills that are useful for the present industry.

The rest of the paper is organized as follow:

section II explains survey methodology, section III presents the findings and analyses, section IV discusses the findings and section V concludes the paper with future directions of the research.

II. RESEARCH METHODOLOGY

The data was collected though a survey questionnaire from various software development organizations across Pakistan. The questionnaire consists of 24 questions related to software quality assurance. Two approaches were used for the distribution of questionnaire. The nearby organizations were approached in-person where hard copies of the questionnaire were distributed. A web based version was also designed and the link of the survey was emailed to the participants. About 150 organizations were contacted but only 42 participants participated in the survey.

The questionnaire was divided into five categories. In addition, an introductory section was also added to find the organization structure, size in term of employees, level of experience and the way they develop the software. The five categories under focus were: software testing methodologies and techniques, test automation and testing tools, test management, quality metrics, quality assurance training and education.

As the respondents were allowed to select multiple answers for some of the questions, the results show more than 100% bar for these questions.

III. SURVEY FINDINGS AND ANALYSIS

A. Organization Profile

Out of 42 responders of survey, almost half (42.8%) of the responded were the developers, 21.4% claimed to be testers, 16.6% were project managers, 19% were team leaders and the rest were system analysts and C.E.O's (as shown in Table I). 47.6% of the respondent stated that they have a master degree, 19% have MS/M.Phil, 23.8% have Bachelor, and 7.1% have PhD degree.

TABLE I
RESPONDENTS BY THEIR POSITION

Current position	Response	%
Developer	18	42.8
Tester	9	21.4
Team leader	8	19
Project manager	7	16.6
C.E.O	2	4.7
System Analyst	1	2.3

Most of the organizations were small in size, 33.3% had number of employees less than 10 and 23.8% had 10-20 employees. Some of the organization were large 7.1% (>500) (Table II). Some of these have a significant amount of experience in the field of software development: 47.6% respondents stated to have 2 to 5 years of experience, 23.8% with 1 year, 16.6% with 2 year, 7.1% respondent claimed to 5 to 10, and 4.7% have more than 10 years.

TABLE II
ORGANIZATION SIZE

Size of the company	Response	%
Less than 10	14	33.3
10 to 20	10	23.8
20 to 50	7	16.6
50 to 100	5	11.9
100 t0 500	3	7.1
More than 500	3	7.1
Total	31	100

As far as the development method of the organization is concerned, a mix response was noted. 33.3% respondents state that they are following agile methods while 26.1% say they are using some kind of phase oriented method. 66.6% of the organization claimed that they have a separate team for quality assurance, while 33.4% say that they do not have any dedicated team for quality assurance. In term of budget allocated to quality assurance process, 30.9% participants indicate that they allocate less than 10% budget (cost/time) to quality assurance process whereas 40.4% of the organizations assign 10-25% of the resources. This result shows that in most organizations quality assurance process is under estimated.

B. Testing Methodologies and Techniques

In this section the adaptation of software testing methodologies and techniques were considered. Regarding different testing techniques adaptation, 57.1% of the organizations claim that they are doing black box testing (also called functional testing) while 45.2% state that they are doing white box testing (also called structural testing). Method like inspection and other static techniques are not as common. The use of automated testing is also less popular due to the lack of expertise in automated testing tools. Only, 4.7 % of the organizations stated that they do not use any kind of testing techniques, but instead they do "ad hoc" testing.
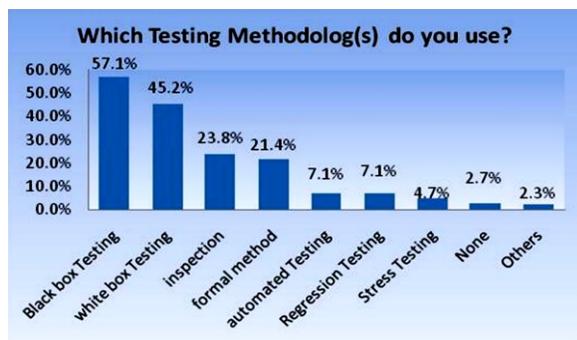
Fig. I. Testing Methodologies

1) Black box Testing Vs White box Testing

The survey result shows that black box testing is more popular in the organizations than white box testing (i.e. 57.1% follow black box while 45.2% perform white box testing). Boundary value analysis (45.8%) is the most common test case design techniques for those organizations that perform black box testing, followed by state transition testing and equivalence partitioning (33.33% each). Only 20.8% are using decision table testing.

For white box testing branch coverage (47.3%) is most frequently used as coverage criterion. Other common white box testing techniques are condition coverage (36.8%), path coverage (36.8%) and statement coverage (26.3%).

2) Static Vs Dynamic Testing

To test the software by execution it is called dynamic testing. White box, black box and ad hoc testing are parts of dynamic testing [xvi]. The survey result shows that dynamic testing is more popular than static testing techniques. This may be because of static review techniques such as Inspection, Desk check etc. require more time.

3) Brriers to adopting a testing methodology

This section investigated the views of the respondents on the barriers in adopting testing methodology in organization. The summary of the responses are presented in Table III. It can be seen that 45.2% of the respondents state that cost is the major factor preventing their organization from adopting testing methodologies. Lack of expertise (30.9%) is the second major factor that hampered the use of testing methodologies. Only 11.9% of the participants believe that there is no barrier.

The two large problems identified are cost and lack of expertise. The possible reasons for these problems are the small budget and size of the projects and may be the professional in software testing and software quality assurance are not sufficiently trained.

TABLE III
BARRIERS TO ADOPTING A TESTING METHODOLOGY

Barrier	Response	%
Costly to use	45.2%	1
Lack of expertise	30.9%	2
Lack of support tools	11.9%	3
Difficult to use	7.1%	4
Do not think there is any barrier	11.9%	3
Other	2.3%	5

C.   Test Automation and Testing Tools

It was observed that the use of automated testing and testing tools are not much common in the software industry. 35.7% of the respondents state that no automated testing is performed in their organizations. While 23.8% claim that less than 10% of the testing process is automated. 40.4% responded that they do not use any testing tool, while 26.1% say that testing tools are used in some project. Only 19% of the organizations are using testing tool in every project for testing.

The major issue in using testing tool is cost (47.6%) while 28.5% participant reported that testing tools are time consuming to use and 9.5% think that there is no barrier to use testing tool. Table IV summarizes the responses.

TABLE IV
BARRIERS TO ADOPTING A TESTING TOOLS

Barrier	Response	Rank
Costly to use	47.6%	1
Difficult to use	16.6%	3
Time consuming to use	28.5%	2
Do not think it is useful	14.2%	4
Do not know of any testing tool	7.1%	6
Do not know there is any barrier	9.5%	5
Other	4.7%	7

D.   Test Management

In order to produce high quality software, testing process must be performed efficiently [xvii]. All the documentation should be well planned and up-to-date. Test cases and defect tracking should be well planned to achieve the goals of an effective testing process. To avoid duplication test cases should be written down. However, only 14.2% of the organizations are using standardized forms for test case documentation. 50% indicate that they do not use any kind of documentation for test cases. These results are shown in Fig. II.
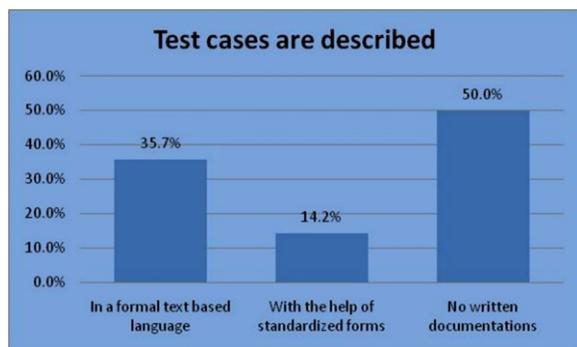
Fig. II. Documentation of Test Cases

A research suggests that organization must take data protection seriously [xviii]. However, still 30.9% of survey responses indicate that they test with original data from production. Only 16.6% of survey participants claim that they comprehensively document their testing. Testing documentation requires time and many other resources which need to be properly managed. The responses reveal that currently there is a lack of good testing management process in most of the organizations.

E. Quality Metrics

The usage of quality metrics to measure the quality of software in industry is discussed in this section. The survey result indicates that defect counting is the most popular method for quality metrics. This may be because of the simplicity of the process. About 64.2% of the organizations are using some kind of defect counting methods while only 14.2% indicate they are using number of test cases executed with in a period of time as a metrics.

It is sometime difficult for the organization to decide when to stop the testing process. Metrics such as 'no bug found per certain number of requirement any more' are most popular when determining criteria to stop the testing process. 47.6% of the organizations are using this criterion while 23.8% assign fixed resources (cost/time) to testing and stop the testing process when these resources are over. This shows lack of organized and systematic procedures to decide how testing should be done. This may be due to the small size of Pakistani software organizations. This shows that testing is not given the importance it deserves within software development process.

F. Quality Assurance Training and Education

This section was aimed at finding out the extent to which formal software quality assurance training has been facilitated by software organizations to train their employees. This also aimed at exploring the type of training that quality assurance personal in Pakistani software industry are receiving (i.e. universities education, in-house training, commercial training courses, or self-study).

Survey result indicates that only 21.4% of the respondents have knowledge of testing from courses offered in the universities while 73.8% of the respondents indicate that they have not received any kind of testing training or have studied testing by themselves (through self study). About half (54.7%) of the organizations favor to give training to their testing staff. This indicates that software organizations in Pakistan are aware of the importance of software testing for producing quality software's.

When asked about the major hurdles in delivering testing training 61.9% of the participants indicate that cost is the major barrier in providing training, followed by tight schedule (38%), and only 14.2% reported that there is no barrier. The responses from the survey are presented in Table V.

TABLE V
BARRIERS TO PROVIDE TRAINING TO SOFTWARE
TESTING STAFF

Barrier	Response	Rank
Cost	61.9%	1
Time	38%	2
Course	9.5%	4
Do not know there is any barrier	14.2%	3
Other	2.3%	5

IV. DISCUSSION

If sample is not representative of the population then one cannot make specific generalizations of the population [xix]. Presently, the small sample size was not strongly supported in order to either prove or disprove research question. However, the survey provides a view of the current quality assurance methods in Pakistan.

In Pakistani software organization cost is the most evident barrier to the use of automated testing tools (Table IV), software testing methodologies and technique (Table IV), and providing training to software testing staff (Table V). This may be due to the low budget of the project and the small size of the organizations. Lack of expertise ranked second in the list of barriers to use software testing methodologies and technique. This shows that there could be many software testers who are not properly trained.

There is also lack of good testing management techniques. This may be due to less allocation of recourses (time/cost) to the quality assurance process. As 71.3% of the participant said that they allocate less than 25% of the project recourse to quality assurance process. Another possible reason is documentation. As reported (section III (D)) 50% of the respondent do not use any kind of documentation. A significant amount

of the organization is not using proper stopping criteria to quit the quality assurance process. While it is encouraging that more than half of the organizations are using some kind of method to measure the quality of their products.

The organizations using agile methods for development testing is mostly done by the developers. While a mix response is recorded from organization using phase oriented style of development i.e. testing is done by developers in some organization while in other organization testing is done by trained testers. Although automated testing is gaining popularity among software testers, however in Pakistan most of the organizations are not using automated testing. As reported in (Table IV) the major factor to not using automated testing tool is cost and time.

Overall from the survey result the current state of quality assurance process is lacking some key components. Some of the findings are encouraging to see. The software organization is aware of the importance of good quality. Therefore more than half of the organization are providing training program to their testing staff. Most of the organizations are hiring separate employees for quality assurance process. This research has mentioned various factors lacking from the software industry. Adaptation of these factors to improve quality of the software product is primary concern. However, the capability of the organization to adopt these practices is still undiscovered and can be researched in future studies.

V. Conclusions and Future Work

This paper analyzed the software quality assurance method carried in Pakistan in 2013. While the sample data was smaller than ideal, but the results highlight some trends of the current practices of quality assurance.

As a second stage of the survey, it is suggested to increase the sample collection to facilitate a more dynamic statistical analysis of the data. Since not all the organizations contacted took part in survey will be contacted again to known their reason for not participating as well as will be encouraged to be a future participant. In future, a comparative study between Pakistan and other South Asian countries could also be managed in this sector. This would indicate the competitiveness of Pakistan among its neighbor's countries.

From the survey finding it is clear that, education and training in software quality assurance is not sufficiently addressed in formal education systems of Pakistan. A review of the current curriculum of the software engineering in the universities is also suggested.

The implication of this survey is clear. To find the best relationship between quality assurance methods and software quality, ensuring that quality assurance

methods are required for the highest quality software which is much more important as software is intruding more into the daily life. Despite limitations, the findings of this survey will be helpful in this process.

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