Factors Affecting the Delivery of Quality Software and their relationship in the Software Development Process

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Abstract - *As the world moves forward to paperless environment, the need of quality software is the key for successful business. So, it's important to understand the fact and develop quality product. This research is basically deliver the same idea and focuses on the factors that play an important role in delivering the quality software or product. These factors are beneficial for both of your business perspective and software development including the cost and time spent on developing quality software and also with proper testing and system development phase. How these are important to the business world and relates with each other is the main idea of this paper.*

Keywords: *Software Quality, Software Cost, SDLC, Time Estimation*

1. INTRODUCTION

It has been observed that most of the companies' business depends on IT, face Software Faults. The managers and professionals may have varied opinions about software development principles, but most of them agree on one thing above all that is the software you deliver must be accurate and reliable to end user. And successful software development professionals have recognized that effective testing methods are essential to meeting this goal. [1]

The delivery of quality software and services has become one of the most important factors that have an impact on national and international business. Achieving a high quality product is now the objective of many organizations. [2] For this we have to look into following goals

- *Deliver software with the expected functions and quality*
- *Within the expected time*
- *Within the expected cost*
- *Meet standards of testing*
- *Must follow proper SDLC phases*

The structure of this paper is designed in a manner to first understand what is meant by software quality? This is followed by the importance of software quality in section 2. In section 3, all the research and literature review is done and outcome of this review is notify in next section as the main statement of research. Later on we identified the variables for hypothesis; analyze them and finally the conclusive statement regarding research work.

2. HOW MUCH THE SOFTWARE QUALITY IMPORTANT?

"Quality is the totality of features and characteristics of a product or a service that bears on its ability to satisfy the given needs". [ANSI Standard]

"The degree to which a customer or user perceives that software meets his or her composite expectations. OR the composite characteristics of software that determine the degree to which the software in use will meet the expectations of the customer".

[IEEE Standard]

The above definitions of well-known standards and organization notify the importance of quality. Although there are a lot of factors on which the software or product quality depends. Some of these are usability, cost, efficiency, testability. As per business needs and perception, the role of quality software involve in marketing strategies, costing and time estimation, also productivity of that organization.[3]

3. BACKGROUND AND RELATED WORK

Software products mainly exhibit two general kinds of quality, which affect the software schedules in different ways. The first kind of quality that people usually think of when they refer to "software quality" is low defect rate.

Some of the project managers shorten their schedules by reducing the time spent on several quality-assurance practices such as process design and code reviews, which is vulnerable to reduction since it's the critical-path item at the end of the schedule.

There are some of the worst decisions a person who wants to maximize development speed can make. In software, higher quality (in the form of the lowest defect rates) and reduced development time go hand in hand. A few organizations have achieved extremely low defect rates

(shown in the figure below), and when you reach that point, need of further reducing the number of defects will tend to increase the amount of development time. [7]

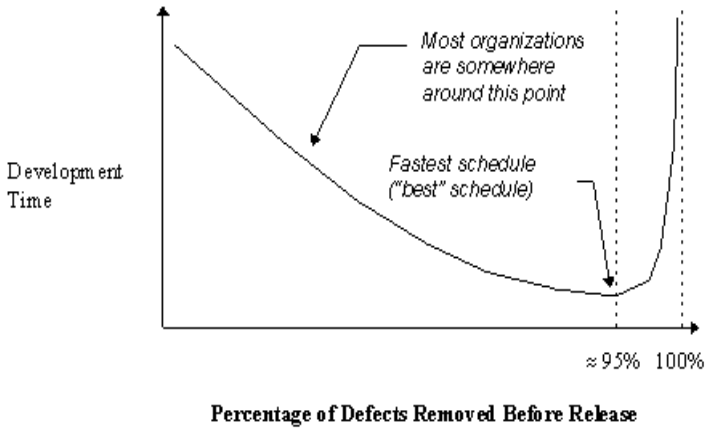

Figure 1: Amount of testing to minimize defects [7]

Software testing is necessary to make sure that the software product meets its predefined goals. Software testing can either be done manually or automated, to Improve Quality, For Verification and Validation, For Reliability Estimation. [4]

SQA plans are available from several software manufacturers for an additional fee when purchasing the rights to use the software.

For time saving, *m*any plans based on SQA are sold as packaged services and complete with the installation expertise of available certified software consultant. Many software manufacturers company will pre-package plans in one, three, five, seven or even ten day services, depending on the size of the deployment required. [5]

For money saving, software quality assurance plans is the ability to spread out payments option. Software manufacturers will require payment all on up front for the purchase of software licenses, which can take toll on an individual's or business' budget. As of 2009, the Microsoft Corporation charged an additional 25% on top of the cost of the software or product for server solutions and 29% for desktop and operating system solutions. Other software manufacturers may charge as high as 40% or 50% above the cost of the software licenses. [5]

The software development life-cycle depends on a series of phases that includes testing step as well. The testing phase of SDLC includes system validation, UAT, test case review and approval. Design faults comprise the most of bugs found in software. These bugs move through further development and testing phases. Defects occur are difficult to detect; same with software defects. The phases of SDLC are requirements analysis, design, program development, implementation, testing, system testing and maintenance. Thus since defects can be occur at any phase, the defect life cycle involves quality assurance at every phase. [6]

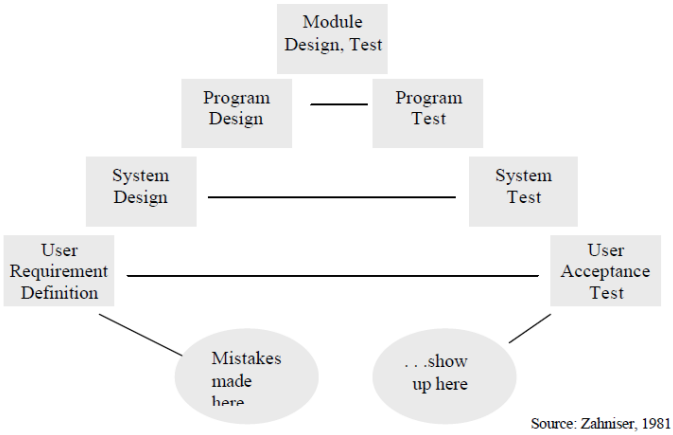

Figure 2: Steps of SDLC [8]

4. CONCERNED PROBLEMS DURING RESEARCH

The main concern of this research is how can we get quality software? For this purpose we need to identify the factors on the basis of which quality of software depends. Through the literature review it is identified that the quality of software can be achieved by following the processes that involve proper testing methods and techniques, the time required for completion of software and the actual cost of that software development process. The steps of SDLC may or may not affect the software quality will also be the point under research consideration.

5. IDENTIFICATION OF VARIABLES

The variables or quality measures of software are very important, we identify and will be analyzing following factors that affect the delivery of quality software.

- *Delivery of Quality Software (DOQS)*
- *Amount of Testing(AOT)*
- *Cost Involved(CI)*
- *Time Spent(TS)*
- *Steps of SDLC(SOS)*

6. HYPOTHETICAL OUTCOMES

***H_o* (Null hypothesis):** There is a relation between delivery of quality software with amount of testing, cost involved, time consumed, and SDLC.

$H_o = ß_1 = ß_2 = ß_3 = ß_4 = 0$

***H_1* (Alternative Hypothesis):** There is no relation between delivery of quality software with amount of testing, cost involved, time consumed, and SDLC.

H_1 = At least one ß is not zero.

6.1 Questionnaire Design:

The respondents responded to questions under each variable on five point Likert Scale with "Strongly Agree" dictating the highest level of satisfaction, "Strongly Disagree" as the highest level of dissatisfaction. Some demographic questions were also asked for more interpretation of responses. The developed questionnaire has been pre-tested with a few respondents to ensure the quality of the questions.

6.2 Model:

The researcher has used the **Delivery of Quality Software** (DOQS) as the dependent variable and **Amount of Testing (AOT)**, **Cost Involved (CI)**, **Time Spent (TS)**, and **Steps of SDLC (SOS)** as independent variables.

The researcher has run the OLS Regression model to determine the significance level of the variables under study. The basic model is as follows:

DOQS = f (Amount of testing, Cost involved, Time consumed, and Steps of SDLC).

Basically,

$$DOQS = \alpha + ß_1x_1 + ß_2x_2 + ß_3x_3 + ß_4x_4 + e$$

Where,

DOQS= Delivery of Quality Software,

x_1= Amount of testing, x_2= Cost involved, x_3= Time consumed, and x_4 = Steps of SDLC.

There α is constant and $ß_s$ are coefficients to estimate, and e is the error term.

6.3 Analysis and Findings

A total of 80 questionnaires were distributed to the respondents. The researcher discarded incomplete questionnaires and considered 60 questionnaires containing all information.

Table No. 1 Descriptive Statistics

	Mean	Std. Deviation	N
SQA	3.93	.551	60
Test	3.77	.444	60
Cost	3.88	.384	60
Time	3.96	.501	60
SDLC	2.84	.463	60

Source: SPSS regression results of the field work

Table No. 1 shows the mean value depicting the overall importance of "Delivery of Quality Software". As far as this descriptive statistics is concerned, DOQS is above satisfactory level (with a mean value of 3.93 on a 5 point Liker scale). The table also suggests that the main factors on which the software house managers are generally satisfied. As far as the mean values are concerned, respondents are fairly satisfied on amount of testing involved, cost involved, time consumed and SDLC steps involved.

The overall regression model and its ANOVA are summarized as follows:

Table No. 2 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.626[a]	.392	.385	.59705

a. Predictors: (Constant), SDLC, Time, Cost, Test

Source: SPSS regression results of the field work

Table No. 3 ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90.299	4	15.050	42.219	.000
	Residual	140.094	55	.356		
	Total	26.183	59			

Table No. 3 ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90.299	4	15.050	42.219	.000
	Residual	140.094	55	.356		
	Total	26.183	59			

a. Predictors: (Constant), SDLC, Time, Cost, Test

b. Dependent Variable: SQA

Source: SPSS regression results of the field work

From the ANOVA Test it shows the table Sig. value 0.05 is greater than the calculated Sig. value 0.000. It reflects the null hypothesis at 5% level of significance. It means there was a significant correlation between dependent variable and independent variables. Therefore software quality assurance level depends on quality dimension in different private software houses in Karachi, Pakistan. But it does not mean that all factors of service quality have significant correlation with software quality assurance level. The overall predictability of the model is shown in Table No. 2 above. The adjusted R square value of .385 indicates that the model explains roughly about 38% of the factors responsible for software quality assurance level.

Table No. 4 Coefficients [a]

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.185	.263		-.703	.482
	Test	.254	.060	.186	4.259	.002
	Cost	.402	.071	.280	5.684	.000
	Time	.266	.056	.248	4.735	.000
	SDLC	.064	.193	.054	.332	.742

a. Dependent Variable: SQA

The ANOVA table shown under Table No. 3 depicting significant F values implies that the model and data are well fit in explaining software quality assurance level. Based on the data found in Table No. 4 below, it can be interpreted that the independent variables such as Amount of testing, Cost involved and Time consumed have strong impact on software quality assurance level; hence, the other variable Steps of SDLC involved has been dropped from the final analysis based on (99% level of significance).

6.4 The Regression Model

From the above findings we can develop the following regression model:

$$DOQS = -0.185 + 0.254x_1 + 0.402x_2 + 0.266x_3$$

Standard Error: (.263) (.060) (.071) (.056)

T values (4.259) ** (5.684) ** (4.735) **

R square (Adj.) = .385, F = 42.219 **, significant at 99% level

Where,

DOQS = Delivery of Quality Software,

x_1 = Amount of testing involved, x_2 = Cost involved, and x_3 = Time spent.

Coefficient analysis shows the relationship between dependent variable and each independent variable. According to Sig. value amount of testing involved, Cost involved, and time spent has significant correlation with the dependent variable.

Table Sig. value is 0.05 which is greater than calculated Sig. value 0.000, 0.002 respectively. But the calculated Sig. value of amount of testing involved, cost involved, and time spent are greater than the table Sig. value. So, these factors have some impact on dependent variable but it is not significant.

Here, x_1 = 0.186 i.e. 100% change in amount of testing involved leads to 18.6% change in delivery of quality software.

Next, x_2 = 0.280 i.e. 100% change in cost involved leads to 28% change in dependent variable.

Lastly, x_3 =0.248 i.e. 100% change in time spent leads to 24.8% change in the dependent variable.

7. CONCLUDING REMARKS

From the statistical analysis it is observed that there is a relation between delivery of quality software and amount of testing involved, cost involved, time spent, and steps of SDLC used as such null hypothesis is accepted and alternative hypothesis is rejected.

A number of private software houses are operating their activities in Karachi, Pakistan. Many software houses can perform their activities by incorporating a permanent division of Software Quality Assurance (SQA).

The research conducted on the empirical analysis of the importance of software quality assurance procedure to be performed during the development of custom based software for customers showed significant relationships with the variables discussed in this study.

Further work may be conducted to analyze more factors which may affect the overall importance of software quality assurance, which eventually leads to more satisfied customers, and hence improve the goodwill and reputation of the software houses.

REFERENCES

[1] Ioan Mihnea IACOB and Radu CONSTANTINESCU "Testing: First Step Towards Software Quality", Journal of Applied Quantitative Method

[2] Sommerville I, Software Engineering, Addison Wesley, 2001

[3] Ronan Fitzpatrick "Software Quality: Definitions and Strategic Issues", Staffordshire University, School of Computing Report

[4] In 2004, Author Layna Uaha disused "Importance of Software testing" in book "The Art of Software Testing, Second Edition"

[5] In 2006, Jerry Mobbs Senior SQA Manager at UK Based software house he discussed about "Software Quality Assurance Plan" in *"Annual Software Assurance Plan".*

[6] Frankie Colbert worked at Carnegie Mellon University as Software Tester he discussed "What Is Software Testing, Life Cycle & Bug tracking".

[7] [Weblink]http://www.stevemcconnell.com/articles/art04.htm

[8] [Weblink]https://umdrive.memphis.edu/g-cscm/www/ctr4/ctrinsoftwaretest.pdf

[9] Herb Krasner and Krasner Consulting, "Using the Cost of Quality Approach for Software"

[10] Manju Lata and Rajendra Kumar, "An Approach to Optimize the Cost of Software Quality Assurance Analysis", International Journal of Computer Applications

BIOGRAPHIES

Muhammad Adeel Mannan is currently doing PhD in Computer Science. He has completed his MS in Software Engineering from SZABIST Karachi, and BS in Computer Science from University of Karachi. His research Interests are Software Engineering, Data Science and IT Project Management. He also holds an ITIL® foundation and COBIT® Certification.

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