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The Role of Functional Requirements, Operational Quality and Usability In The Success Story Of Software Projects

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***ABSTRACT** : The Role of Functional Requirements, Operational Quality and Usability in the Success Story of Software Projects*

I. INTRODUCTION

The development of high quality software is important for the successful implementation of a software project. But to develop a bug free software is definitely a challenge. As per report of National Institute of Standards and Technology (2003), software errors cost approximately $60 billion per year in terms of lost productivity, increased time to market costs, higher market transaction costs, etc.Study of project management and project management success is relevant even today inspite of project management usage from 1960's, as large number of failure of software projects have been reported (Riley, 2006; Hass, 2007; Xia &.Lyu, 2007).Projects fail due to number of reasons; it may be bad system design, improper process, unclear requirements, poor quality etc. good quality management is an important factor to implement a successful software project (Jones, 2006; Leveson, 2004; Hosalkar & Bowonder, 2000; Markus, 2000; Glass, 1999). Quality attributes are the overall factors that affect run-time behavior, system design, and user experience. Managing quality is critical because it is very difficult to improve or adjoin quality to the software once it is developed, even the rectification have its overheads in terms of time and budget. According to Reel (1999), it is desirable to establish procedures and benchmarks for high quality before beginning the development process, which may require hiring expert developers. Success of quality can be measured through conformance to functional requirements specified by the customer and other technical specifications (Morris & Hough, 2004; Boehm &Turner, 2003).

Other quality features like performance/ response time, reliability and usability are factor's which lead to a success full project. Role of software is evident in all fields, which indicates the growing complexity and diversification of information system. Complex softwares are associated with reliability problem (Zheng, Xu, 2008).It is important for a system to remain operational over time. Reliability is measured as the probability that a system will not fail to perform its intended functions over a specified time interval.Functionality and usability are critical factors of project success (Bayraktaroglu, Calisir & Gumussoy, 2009; Juristo, Moreno & Sanchez-Segura, 2007). Usability defines how well the application meets the requirements of the user and consumer by being intuitive, easy to localize and globalize, providing good access for disabled users, and resulting in a good overall user experience. Performance is an indication of the responsiveness of a system to execute any action within a given time interval. It can be measured in terms of latency or throughput. Latency is the time taken to respond to any event. Throughput is the number of events that take place within a given amount of time. Good response time or the real time response affects the success of a software project (Fujiki & Hasegawa, 1992; Pekilis & Seviora, 1997; Alander, Mantere, Moghadampour & Matila, 1997). Customer satisfaction is essential for success if a software project. (Howard, 1992;Narayanan, Balasubramanian&Swaminathan, 2011).Customer satisfaction was initially not considered while measuring quality of software and only technical aspects and process improvement were included, specifically it is very important for customized software to be of good design and match the user requirement **(**Macaulay, Sloan, Jiang, Forbes, Loynton, Swedlow, andGregor, 2009; Schlossberg, 1992; Anonymous, 2001). They also emphasized on the preparation of proper user manual to enhance the usability of the software. Satisfaction of stakeholders including customer satisfaction has also been highlighted by Meister (2008)for the project success.

As per Bayraktaroglu, Calisir & Gumussoy (2009) user centric software is an indicator of quality it is important to balance out between the functional requirement of the user and usability of the software. According to James Johnson (2001) chairman of Standish Group International, user satisfaction is one of the best practices that an Information technology project management should involve. Meeting the requirements of customer creates a value for them, and this finally leads to success of a project. Watts S. Humphrey, a Fellow of the

Carnegie Mellon Software Engineering Institute and Former Director of Software Quality and Process for IBM (2003) indicated that even experienced developers can write ten percent defective code. But if best development practices are followed it can be lowered down by fifty percent. Although importance of quality, functional requirement, usability and ratability has been emphasized for more than a decade not much empirical work has been done to understand their impact together.

II. LITERATURE REVIEW

Musaand Everett (1990) highlighted that software development has reached the stage based on reliability, starting from function oriented; schedule oriented and then cost oriented stages. Djambazov & Popov (1995) conducted an experimental study, to find out the effect of testing on reliability, considering the impact of reliability on the project success. Simulator was used for understanding the effect of fault in design on behavioral modeling of software. Result of the experiment established that failure was caused due to interplay between design faults.Huang, Lin, and Sue (2004) gave a stochastic reliability model for software failure based on Software Reliability Growth Model (SRGM) and NHPP model. Reliability model was useful during testing phase to remove errors, which increases project success rate. Xia & Lyu (2007) emphasized on measurement of failure data from various stages; preprocessing of data, analysis of data, model structure identification and parameter estimation, reliability model solution and analysis of models. This was necessary to appropriately estimate and predict ratability of software systems. Gayen (2009) also professed the analysis of error-based model for predicting minimum reliability of a software. The model is based on the concept that reliability is a function of number of errors reported by the software for a given duration. In another study conducted by Aljahdali&Sheta (2011) have proposed use of Fuzzy logic for predicting reliability of a software. Data were obtained from Bell Telephone Laboratories; the dataset consists of software fault data on sixteen projects. Fuzzy Model Identification Toolbox was run on data, where seventy percent data was for training and thirty percent for testing. As a result a fuzzy nonlinear regression models were developed for predicting the total fault of software applications. Fujiki, Hasegawa, Wongwarawipat & Ishizuka (1992), emphasized on the importance of response time for good software quality, with reference to virtual reality applications. The result of the study was a proposed solution, which was combination of hardware and software algorithm. Importance of response time for real time software was also highlighted by Pekilis & Seviora (1997). Black box testing technique is suggested to detect degradation in software quality and response time failure. Alander, Mantere, Moghadampour & Matila (1997) through their study established the use of genetic algorithm for measuring response time of the software, which will help in improving it. Use of software transactional memory (STM) is suggested by Fahmy, Ravindran & Jensen (2009) to improve the response time for multiprocessor environment. They conducted experimental study and proposed an algorithm which was validated using simulation.

Functional and usable software products are more popular among users. It is critical to balance out both the factors i.e. functionality and usability. According to Bayraktaroglu, Calisir, Gumussoy (2009) this balancing can be taken care during the design phase. And to do this perception of project mangers regarding user's expectation must match. This study compared th**e** project managers' and potential users' evaluations of the relative importance of usability and functionality factors in a software design project. (ANP) was used to analyze the relative importance of the factors. Analytical Network Process is helpful in solving decision making problems when factors involved are interrelated. A study was conducted by Macaulay, Sloan, Jiang, Forbes, Loynton, Swedlow, and Gregor (2009) to understand the usability and customer centric image project. The study showed that it was challenging for the scientific developers to work around user centric projects. And in order to increase the number of potential users of the software, barriers to adoption of new software must be reduced. Design ethnography was used as methodology to do the research. Proper user guide and user tutorial including web based tutorial movies were prepared.The sample size of the survey was forty four of scientists working with microscopy images at Dundee.

Project performance and customer satisfaction were established as important factor for the project success by Narayanan, Balasubramanian & Swaminathan (2010). They conducted this study for outsourced software projects by using a proprietary panel dataset. Eight hundred twenty two customers from hundred eighty two projects responded. Five point likert scale was used to measure customer satisfaction and regression analysis was applied to understand the impact of overall satisfaction on project performance. Although there are few studies to understand the implication of customer satisfaction on project success but factors like reliability, response time are not being empirically tested. Through this paper we propose to take data from developers and project managers on usability, operational quality and whether customer requirement were met. Novelty of the study is to empirically establish the impact of all three quality factors on project performance/ success, by applying regression analysis.

III. HYPOTHESIS

H1: There is a significant positive relationship between the success of the software project and conformance to functional requirement (functionality) of the software.
H2: There is a significant positive relationship between the success of the software project and operational quality of the software.
H3: There is a significant positive relationship between the success of the software project and usability of the software.

IV. RESEARCH DESIGN

The present research is causal in nature, trying to figure out the impact of process guidance by the tool, integration of task and information, work flow, transparency of information, visualization of analyzed information on the success of automated software projects.

4.1.Sampling Design

The research was carried out in the software organization of India. We have taken the sample of software professionals by dint of stratified random sampling resulting into total sample of one hundred and fifty. Respondents were given the questionnaire over electronic-mail and were required to rate the questions on a seven-point Likert scale. Thirty questionnaires were sent to each IT organization and the final respondent participated in the study by returning the self-administered questionnaire was 150.

4.2.Data Collection Design

The data were collected from five leading software companies of India through a questionnaire where each item was measured in Likert scale. The operational quality, functionality and usability are measured through a composite score of ten items.

4.3.Statistical Design

Multiple regression was used to assess the impact of functional requirement, operational quality and usability on success of software project, where success of software project is the dependent variable and functional requirement, operational quality & usability are the independent variable.

4.4.Model and Variable Definitions

The following model is used for testing hypotheses:
Success of the Project = $\beta_0 + \beta_1$operational quality + $\beta_2$functionality + β_3Usability. The variables are explained as following:

4.5.Success of the software project

Successful software projects are often defined as meeting business objectives, deliver on time and within budget, and meeting requirements (Nasir&Sahibuddin, 2011).

Operational quality

1. The degree to which a system, component, or process meets specified requirements.
2. The degree to which a system, component, or process meets customer or user needs or expectations.(Pressman, Scott (2005), Software Engineering: A Practitioner's Approach (Sixth, International ed.), McGraw-Hill Education Pressman, p. 388)

4.6.Functionality

Functionality estimates the extent the software operates in the way it is structured and is expectedto perform as user's desire. *Usability* Usability assesses the extent a software facilitates users utilize the offered functions easily and appropriately.

4.7.EMPIRICAL RESULTS

Correlation Matrix

The correlation between variables indicates that how much of variables changes is explained by other variables which is between 1 and -1. The correlation between variables is shown in Table 1.

Table 1 Correlation matrix

		Operational Quality of the software	Functional requirement	Usability of the software
Success of the software project	Pearson Correlation	.781**	.855**	.507**
	Sig. (2-tailed)	.000	.000	.000
	N	150	150	150

The results provided in Table 1 reveal that the correlation coefficient between success of software project and functional requirement is .855, operational quality is .781 & usability is .507 and the correlation is significant ($p < .05$).The dependent variable shows a high & significant correlation with the independent variables operational quality, functionality and usability, which shows that we have selected fairly good set of independent variables.

Table 2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.211	.294		.716	.475
	Operational Quality of the software	.228	.077	.218	2.972	.003
	Functional requirement	.639	.078	.622	8.211	.000
	Usability of the software	.118	.053	.105	2.243	.026

a. Dependent Variable: Success of the software project

Table 2 reveals that Functional requirement($t = 8.211$, $p < .05$), operational quality($t = 2.972$, $p < .05$) andusability($t = 2.243$, $p < .05$) all the three independent variables leaves a statistically significant impact on the success of the software projects. All hypotheses got accepted and all the three variables leave an impact on the success of the software project separately.The relationship between functional requirement, operational quality & usability and the success of the software projects is as follows:All the three variables taken together make a statistically significant impact on the success of the software project.

Table 3

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	193.160	3	64.387	150.940	.000[a]
	Residual	62.280	146	.427		
	Total	255.440	149			

a. Predictors: (Constant), Usability, Operation Quality, Functional Requirement

b. Dependent Variable: Project Success

Table 3 shows that the model is statistically significant ($F= 150.940$, $p < .05$)

Table 4

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.870[a]	.756	.751	.653

a. Predictors: (Constant), Usability, Operation Quality, Functional Requirement

Table 4 reveals that a significant regression was achieved with adjusted R^2 of 75.1% which shows that the relationship between Software project success and operational quality, functionality & usability. 75.1% of the variation of success of software project is explained by operational quality, functionality & usability. Since each of the variables considered in this study are significant as shown by the result of t-test, the model is significant as per the result of ANOVA and the variation explained by all the independent variables on the dependent variables is 75.1%, hence we can form the regression equation from the Table 3 as follows: Success of the Software Project = .211+. .228operational quality + .639 functionality + .118usability

V. DISCUSSION

Customer satisfaction is achieved by delivering software which conform to the quality assurance, conform to the functional requirements and is usable. Lack of all these features lead to rework, lost time and eventually unhappy customers i.e. project failure. The result of this research highlights the importance of operational quality, functionality and usability of the software for the successful implementation of the project success. The result further reveals that the functional conformance leaves highest impact on the software project success. The basic and most important attribute of a software product—or any other product, for that matter—is that it delivers its specified functionality accurately. Second highest impact on software project success is of operational quality. Quality attributes are the overall factors that affect run-time behavior, system design, and user experience. They represent areas of concern that have the potential for application wide impact across layers and tiers. Some of these attributes are related to the overall system design, while others are specific to run time, design time, or user centric issues. Functional quality means that the software correctly performs the tasks it's intended to do for its user. Quality is vital for a software project to be successful. It is a complex concept and it is related to business goals, good software leads to good business. Establishing a quality-oriented mindset is a top management responsibility, but it is up to the software development organization to adopt and execute on that mindset. IT must embrace the right process and tools, and seek the right guidance or training to produce the results that management, customers, and end-users are seeking. Though among the three factors usability is having least weightage as per the result, but definitely leaves an impact on the success of the project. With higher usability users require to spend less time learning the system and are more likely to achieve their goals, they have a satisfying experience, increasing the likelihood of future use and recommendation to others and will be able to develop trust and use the system with greater confidence. It is very clear that the core requirement is to deliver software with all the functional aspects, with good quality and the one which is usable, to make the customer satisfied and software project a success.

VI. CONCLUSION

Customer satisfaction is a key to success for a software project. The customer is satisfied if the software conform to the functional conformance, is of high quality and usable. It is extremely important to understand the requirement of the customer/ end user in order to deliver fully functional product. The best way to do this is to deliver in phases and get it approved by the customer, so that efforts of redoing the whole thing are minimized. Quality, error-free work holds down costs Quality assurance provides the mechanisms for paying close attention to details so that tasks are completed correctly and accurately every step of the way. A quality assurance role should be established for all projects. Users tend to use functional and usable products more frequently. The navigation facility, reports generated by the software etc. must be easy to learn and logical. The documentation should also be proper to make the software product usable. This research helps in understanding the importance of functionality, operational quality and usability on the success of the software project. The uniqueness of this study is to explain the impact of all these three factors taken together. The research considered the sample of hundred and fifty software professionals in India, which could be enhanced in terms of a bigger sample and expanded geographic coverage.

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