A Study of Agile Iterative Development Methodology on Web Application Quality

Rayaguru Akshaya Kumar Das(✉) and A. B. Khan

Institute of Management and Information Technology, Cuttack, Cuttack, Odisha, India

Abstract. With the increase in use of web based applications in different fields, the competition for providing secure efficient and quality software increases with a demand for decreased cost of the product. To improve the product development process in environment of the ever dynamic customer requirement and to meet the quality parameters of the software products many in the industry, have adopted agile software development. Although the nuances of agile methods like iterative development existed decades back the term Agile software development was coined in 2001 in a small group industry meet. In this paper we have tried to scan the literature for any correlation between the agile development methods and software quality. We have conducted a survey to understand how one of the major factors of agile development i.e. iterative development influences the quality of the software.

Keywords: Agile development · Iterative methods · Web application · Software quality · Web application quality

1 Introduction

The modern software applications, irrespective of size and sophistication and size are driven by quality motive. Quality motive is a prime driving force in modern software industry. The customers want value of their money in terms of quality. The quality of software applications, especially important in the present scenario where almost all the applications are web based and are very complex, multi-tired, sophisticated. This forces some core changes to the traditional software development method. Agile software development method is considered to be one such solution to gain advantage in this cutthroat competition age. After that many of the industry leaders have adopted the Agile development method for better quality products [13, 14]. In this paper, we will try to establish some known parameters of agile development to the software quality of service based web applications.

2 Literature Review

Even though the software industry has comprehensively understood and embraced the agile methods, not much empirical study has been done to examine the agility parameters

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and its effect on quality of the software products [7–11]. Most of the studies are based on the productivity and performance of the software application.

Consequently, there are many studies covering iterative or incremental software development and software productivity. Behem [2] measures productivity as output to input of the process. Some of the drivers of the productivity are volatility of the requirement, use of different modern tools, program complexity etc. Krishnan [3] in an imperial study tried to find correlation between productivity and quality which is expressed as product size, use of tools quality and capability of the development team etc. Behrens [4] discussed the way to apply different function points to the productivity measurement. The productivity trends in software iterative development are outlined by Thomas [5]. He tried to find out the relationship between the different attributes of productive trends like stability of staffing, adaptability of design to the iterative development. Claudia de O et al. [12] conducted a case study on productivity and suggested that the software companies need to reorganize the organizational structure and find out the best fit between the organizational structure and agile methodology. Bohem et al. [13] suggested a method and strategy for incremental application development and tradeoff of strategies. Shetal S [15] suggested that the factors which affect the quality of the software are reliability usability reusability extensibility portability etc. Two scholars Li & Calantone conducted empirical study on 236 software professionals to determine the relationships between customer market knowledge, competence and performance. Beck, Jiang, & Klein surveyed 286 software personnel involved in development to determine the effects of prototyping on project performance. What they found was prototyping use, learning, and interactions were correlated to project success.

Separate studies were also carried out for web site web portal quality. Yang and others [16] conducted empirical study involving 1,992 web users to determine the relationships between service quality and overall quality of Internet portals. They conclude that the usability, usefulness, adequacy, accessibility, and interaction of Internet portals were correlated to their overall quality. Two scholars Sullivan & Walstrom surveyed 82 designers to formulate instrument to measure website quality. Tsikriktsis conducted a study on 171 web users and found that an instrument measuring website quality was correlated to cultural dimensions. Many such similar studies were undertaken by different scholars. However, we are unable to find a single study which tries to co-relate the iterative development of Agile development to website quality. We are unable to find a single study where the iterative deployment is directly compared to the software quality.

3 Software Quality

There are many quality models for software. Some of the quality models are: Mc Calls's model, Boehms Model, FURPS model, Ghezzi Model, IEEE model, Dromey's model, Stac's model, CMM (Capability Maturity model), EtailQ model etc. For our research we have chosen the "EtailQ" model which is very much suitable for e-commerce websites and other service oriented websites. Presently most of the websites and the underneath web application provides some kind of service. Hence we feel that the EtailQ model is one of the appropriate models to measure the quality of web applications. The parameters measuring the website quality in the EtailQ model are: Fulfillment and reliability, Privacy

and security, Website design and customer service. The EtailQ model gives an instrument to measure the parameters. For our research, we interpreted each of the parameters of quality in the following manner (Table 1):

Table 1. Web site quality parameters

Quality parameter	Measurable variable
Fulfillment and reliability	Received order
	Delivery time
	Accuracy of order
Website design	In-depth information
	Efficiency of order processing
	Processing speed
	Product selection
	Personalization
Privacy and security	Feeling of safety
	Protection of safety
	Adequate security
Customer service	Willingness to respond to customer need
	Willingness to fix the issues
	Proficiency in answering the customer queries

For our study we have used the above mentioned parameters to measure the quality of the web portal. As it is evident from the above table the by measuring three parameters we can measure fulfillment and reliability which is just one of the four components of quality.

4 Agile Software Development Methodologies

The Quest for quality software and the short duration for the software development lead to more and more software development firms moving from traditional software development methodologies to Agile software development methodology. The characteristic feature of the Agile software development methodology are better customer interaction, shorter development cycle, frequent design changes to accommodate the customer feedback and incremental product delivery. The Agile development is driven by the Agile manifesto [20]. There appeared several version of agile development like Extreme programming (EX), Scrum, Kanban etc with some variation in different parameters. In spite of the difference, all the above mentioned methodologies have some basic common parameters. One of the common parameter which is common to all the agile development methodologies such as XP, Scrum and Kanban is iterative development. One of

the main thrusts of Extreme Programming is continuous and effective interaction with the customer so that the customer feedback is incorporated in the software as soon as possible, thereby changing the previous version of the software. The main driving force of such iterative development of software is based on the customer feedback. The Scrum development also talks about iterations. In Scrum, the iterations are called sprints. For the entire duration of the sprint extensive planning is needed. At the end of each sprint, a check is carried out to find possibility of areas positional improvement to the product. The Kanban methodology of Agile software development recommends the use of short iterations. Thus in the modern software or web application development, iteration plays an important role as the competition and the ever dynamic world requires the software to be dynamic and capable of accommodation the changes quickly effectively without compromising the software quality.

5 Iterative Development

According to Larman, iterative development as a software development method which is defined as "an approach to building software (or anything) in which the overall lifecycle is composed of several iterations in sequence". Furthermore, "each iteration is a self-contained mini-project composed of activities such as requirements analysis, design, programming, and testing." Iterative development is a lifecycle of software development. The iterative development is generally used to evolve operational software into finished products gradually. This is done by continuously and constantly incorporating customer feedback, test results and other problems discovered into its design. Iterative development falls under the category of time-boxed design, meaning that delivery dates are fixed by reducing product requirements. In simpler term, iterative development refers to a much more dynamic release of beta versions using the Internet. Different scholars have used different sub-factors for iterative development. There are different ways of quantifying the iterative development. However, for our study, we will consider the following five sub-factors of iterative development. These are:

(a) Time-boxed releases: software release based on time
(b) Operational releases: software release based on operation or increment
(c) Small releases: software release based on small iterations
(d) Frequent releases: software release like in weekly monthly etc.
(e) Numerous releases: software release in multiple increments.

6 Objective

The goal and the objective of the study are very clear and precise. The objective of the research was to find out if there is any correlation between the Agile iterative development to the website quality. The iterative development of agile development is becoming popular among the developers. This may imply a strong reason that the iterative development causes better quality products. This assumption has to be formulated in form of hypothesis and proved to confirm the assumption. The hypothesis was formulated as:

Hypothesis - (H1): "Implementation of Iterative development methodology corresponds to produces quality web-application"

It is not straightforward to measure the quality of web-application. The EtailQ quality model has four sub-factors namely website design, website privacy and security, website reliability and customer service. Hence, we somehow need to quantify the different parameters of web-application quality with the iterative development method. The effect of the iterative development on website design, privacy and security, reliability and need fulfillment and customer service need to be established. Considering the sub factors of the website quality, it would be logical and to suggest four sub– hypothesis. The suggested sub-hypothesis are:

Hypothesis 1a - (H1a): Implementation of Iterative development methodology corresponds to better web-application designing capability
Hypothesis 1b - (H1b): Implementation of Iterative development methodology ensures privacy and security.
Hypothesis 1c - (H1c): Implementation of Iterative development methodology corresponds to higher reliability and customer need fulfillment.
Hypothesis 1d - (H1d): Implementation of Iterative development methodology corresponds to better customer service.

The justification for formulation of hypothesis and sub-hypothesis that the quality is complex and is associated with different aspects. Due to its complexity the hypothesis is broken down to the sub-hypothesis there by making somehow easy to do an empirical study to ascertain the quality. Broadly, quality requirements are "characteristics that make the product attractive, usable, fast or reliable" [23]. In order to incorporate the feedback of one particular quality parameter the next product might compromise the other quality aspects. Hence all the quality parameters has to be measured against each version launched after iterative development.

7 Data Analysis

Data collected from the software professionals developing web applications in the agile iteration based development and they are asked to name the sites which uses the web applications in the full stack. Another independent assessment was done to evaluate the quality of the web application by interacting with the sites which uses the web applications. For our study the survey instruments will consist of a five point Likert-type scale from with numerical values from one to five. The lowest being score 1 and the highest is considered to be score 5. As per the plan, data were collected for software design methods, website quality, and project outcomes. Almost 1506 respondents responded to the questionnaire on different web application design methods, and 324 respondents responded on web application quality data. Correlation analysis was conducted on the above parameters and are displayed in Table 2. Pearson correlation was conducted and the values of adjusted R^2 values are is calculated. After that there is the need to reduce the data for easy analysis. In the next step the website quality data is examined. Like in the previous case the Pearson correlation analysis were performed on the 14 variables of

website quality and the result is prepared and analyzed. On analysis it is found that many of the variables associated with each of the four major parameters of website quality were found to be closely correlated.

Table 2. Correlation analysis of iterative development

Factor	1	2	3	4	5	Respondents	score
Time-boxed releases	135 (9%)	195 (13%)	75 (5%)	451 (30%)	646 (43%)	1502	3.85/5 (77%)
Operational releases	60 (4%)	136 (9%)	241 (16%)	361 (24%)	708 (47%)	1506	4.01/5 (80.2%)
Small releases	90 (6%)	135 (9%)	284 (19%)	404 (27%)	583 (39%)	1496	3.84/5 (76.8%)
Frequent releases	134 (9%)	223 (15%)	208 (14%)	402 (27%)	521 (35%)	1488	3.64/5 (72.8%)
Numerous releases	90 (6%)	285 (19%)	315 (21%)	270 (18%)	540 (36%)	1500	3.59/5 (71.8%)

Adjusted R2 values of the data based on the website quality is analyzed and it is found that almost all the groups have high adjusted R2 values. This was especially true for the last two groups i.e. Fulfillment and reliability and customer service. This analysis implies that the variables are correlated within individual categories and the website quality instrument is reliable and valid.

Based on the data a statistical model is prepared. The four major factors of web application quality are represented in which columns to the rows figuring the iterative development in Table 3.

Table 3. Web-application quality factor analysis

Factor	Variable	Website design	Privacy and security	Fulfillment and reliability	Customer Service	Composite
Iterative development	*Adjusted R^2 value*	0.546	0.860	−0.120	−0.187	0.326
	F-value	3.163	12.053	0.807	0.716	1.872
	Significance	*0.144*	0.016	*0.599*	*0.644*	*0.282*

Five statistical models were constructed between the four major factors of website quality (including a composite model called eTailQ) and iterative development. The model, privacy and security and fulfillment and reliability as a function of iterative development have high adjusted R^2 value and are statistically significant. The composite

quality model was significant at the 0.10 level, which was far above the minimum threshold for significance used in this analysis.

8 Conclusion

Based on the data analysis of the hypotheses and sub-hypotheses was performed. There was some evidence that iterative development was correlated to website quality, website design, privacy and security, and fulfillment and reliability at the 0.05 level. The summary is presents in the Table 4.

Table 4. Model analysis

	Hypothesis	β	t-value	p-value
Iterative development	H1 Iterative development → Website quality	0.758	0.039	$p < 0.05$
	H1a Iterative development → Website design	0.745	0.028	$p < 0.05$
	H1b Iterative development → Privacy and security	1.029	0.007	$p < 0.05$
	H1c Iterative development → Fulfillment and reliability	0.634	0.040	$p < 0.05$
	H1d Iterative development → Customer service	0.632	*0.286*	$p > 0.10$

From this it is clear that the hypothesis H_{1a}, H_{1b}, H_{1c} are accepted and the hypothesis H_{1d} may not be accepted as it is outside the threshold of significance. The Main hypothesis H1 is accepted. Thus we came to the conclusion that the agile iterative development increases the web application quality.

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