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Cost Estimation Model for Web Applications using Agile Software Development Methodology

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ABSTRACT

There are many sophisticated models available for estimating the effort of the software project. However, estimation using existing model developed with agile software is questionable, making it necessary to develop a distinct model for web applications. This paper proposes a model that will evaluate cost of web applications developed through agile methodology and discusses the difference between the conventional software development and web application development.

Keywords: Agile software, cost estimation, function point, Kalman Filter, web objects

INTRODUCTION

Conventional software projects are developed through traditional software development life cycle models as given by Lazić and Mastorakis (2010). However, traditional models are not suitable for projects with changing requirements and rapid changes in application methods. For the development of web applications, different development methodology need to be used. Web applications can adopt agile methodology, which also supports rapid application development. In agile web development, professionals join for building blocks and reusable components using rapid application development process and continuous prototyping (Ziauddin & Zia, 2012). As the methodology opted for development is different for web applications estimation models are needed as suggested by Ochoa (Bastarrica & Parra, 2003).

For the successful completion of a web- based project it is essential to have a good predictor of time and cost in agile environment with limited resources.

In this paper, we introduced a Cost Estimation Model of Web Applications using Agile Software Development Methodology. The model is based on "Model-based Dynamic Cost Estimation and Tracking Method for Agile Software Development". Section 2 of

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the paper, compares the Agile methodology with traditional, RAD and DevOps. In the Section 3 we have presented traditional cost estimation model and agile cost estimation models along with the Characteristic of Agile Based Web Development Projects. The section 4 has the result content which emphasizes on the issues related to web cost estimation and problems associated with the existing models, thereafter, describes the proposed cost estimation model for web applications using agile development methodology.

Comparison of Agile with Traditional Methodology, Rapid Application Development (RAD) and DevOps

Traditional software development is based on factors such as requirement, analysis, design, implementation, testing, deployment and testing whereas agile in based on iterations which operate on confirmed requirements, develop, test system then release and start working on next project. RAD is based on prototype designing and then improving on the code. If there are new requirements traditional development does not have ways to handle it while agile process can keep the system running. Agile divide the solution into features. Devops is a new methodology compared with agile but it is complementary to agile as it is more about deployment and management rather than development. Agile development methodology differs with other methodologies in several ways therefore the estimation model incorporated for traditional methods should also be different for agile method.

METHODS

Traditional Cost Estimation Model

The primary focus of software developers and stakeholders is the time and cost estimation of the software at the time of project commencement. . Cost estimation models can be categorized in two types: 1. algorithmic, 2. non-algorithmic (Kumari & Pushkar, 2013a).

Algorithmic estimation method. Empirical formula are used to estimate the cost of algorithmic models (Kumari & Pushkar, 2013b). Most popular algorithmic software cost estimation models include Source line of codes (SLOC), Object points, Function Point(FP)(Albrecht & Gaffney, 1983), Constructive Cost Model-I (COCOMO-I)(Boehm,1981) and Constructive Cost Model-II (COCOMO-II) (Boehm, Madachy, & Steece, 2000).

Non-Algorithmic estimation methods. Many of the non-algorithmic cost estimation techniques rely on analytical comparison of similar projects done earlier and expert experience (Khatibi & Jawawi, 2011). Most are expert judgment, Analogy, Delphi technique, top-down, thumb rule, bottom-up, price-to-win and Wideband Delphi, Parkinson's Law.

Agile Cost Estimation Models. With the invention of agile methodology new opportunities have emerged. This methodology gained popularity because it emphasized collaboration with customers, communication among developers, fast delivery of product and on demand change

of requirements (Cao, 2008; Schmietetendorf, Kunz & Dumke, 2008). Extreme programming, scrum, crystal, feature driven development and learn development are some of the commonly used agile development techniques.

Agile methodology emphasizes team work rather than the individual which contribute to collective effort and work is quantified in terms of effort not in terms of time and changing requirements depending on demand. Various researchers have come up with cost estimation models which are suitable for agile method. Most common is planning poker (Cohn, 2005). Planning poker is simple to implement and it is non-algorithmic model. Other estimation models introduced by researchers are constructive agile estimation algorithm (Bhalerao & Ingle, 2009; Litoriya & Kothari, 2013), although these models have not been evaluated empirically yet (Munialo & Muketha, 2016).

Characteristic of Agile based web development projects. Developers are using various development technologies such as HTML, Java script and java applets, PHP for the development of web based projects. With the Agile process model, various web projects were evolved and became functional in a few months. This rapid development raised several issues. Web based projects were estimated for schedule and cost as the agile method came into existence.

"Agile software development paradigm with component-based software development, visual technologies, and systematic reuse, Reifer (2000)" is illustrated in Table 1. The priority of the companies is to get their software to the market first hence the desire for rapid development. Waterfall model software based on the requirement whereas, agile based Web development is based on iterative and incremental development, rapid application development and continuous prototyping which provided working software with building blocks and reusable components. Web development cost can be determined through Functional Metrics, (David Consulting Group) in Agile Estimation. Estimation of Agile Web developments are also difficult to estimate.

Table 1
Characteristics of conventional versus agile web development projects, Reifer (2000)

	Conventional Approach	**Agile Web-based challenges**
Estimating process	Use analogy supplemented by lessons gathered from past experience	Job costing done ad hoc based on inputs from the developers.
Size estimation	SLOC or function points are used. Separate models are used for COTS and reused software.	Applications are built using templates and a variety of web-based objects (html, applets, components, building blocks).
Effort estimation	Effort is estimated via regression formulas customized by cost drivers.	Effort is estimated by breaking the job down into tasks and identifying what is needed to do the work.
Schedule estimation	Schedule is estimated using a cube root relationship with effort.	Schedule is estimated based upon analogy. Models typically estimate schedules high because cube root relationship doesn't hold.
Model calibration	Measurements from past projects are used to calibrate models.	Measurements from past projects are used to identify myths.

Note. Table is an adaptation from Estimating Web Development Costs: There Are Differences by Reifer (2000)

RESULTS

Issues Related to Web Cost Estimation

Conventional software development is different than web project development. Agile methodology makes the web development more diverse. Table 2 compares conventional estimation approach and agile web cost estimation challenges (Reifer, 2000).

Estimation of size and duration are the key issues. There is a need to evolve a new metrics for size so that Web objects, building blocks and reusable components can be taken into account. With these many challenges, cube root laws don't seem fit for web applications. Therefore, we need to produce a new model.

Problems associated with the existing models. Characteristics of web based project are discussed with the agile method in Table 1. We cannot apply the prevailing estimation models to web based project developed by agile methodology because of the divers issues related to these models.

1) Model which are taking agile methodology into consideration are not treating web based project separately. Like "Model-Based dynamic cost estimation and tracking method for agile software development" proposed by Kang, Choi and Baik (2010) is the model which has resolved issues related to agile method but characteristics of web based project are not discussed.

Table 2
Challenges of agile web development Reifer *(2000)*

Characteristics	Conventional Development	Agile Web Development
Key objective	Build quality software products at minimum cost	Bring worth products to market as rapidly as possible under varying requirements of clients
Project size	Medium to large (hundreds of team members)	Small (5 - 7 team members)
Costing	In millions	In thousands
Development approach employed	Classical, requirements-based, water fall or incremental delivery, uses cases, documentation-driven	Rapid application development, gluing building blocks less paper work, XP
Major engineering technologies used	Object oriented methods, generators, modern programming languages (C++), CASE tools, and so forth	Web object based methods, fourth- and fifth-generation technologies like JAVA. Net framework PHP etc.
Processes employed	Capability maturity model-based	Ad hoc

Note: Table is an adaptation from Estimating Web Development Costs: There Are Differences by Reifer (2000)

2) Story points are used by many estimation models which are unable to determine the time duration required, Logue, McDaid and Greer (2007).

3) A story point is not quantitative measure it is a relative measure, its value changes depending upon the baseline story. Therefore, we require a cost metric whose value does not changes with time, Kang et al. (2010). Model proposed by Kang et al. (2010) have determined function point instead of story point but they have not evaluated the cost involved in web objects.

4) Kang et al. (2010) proposed "a function point based daily estimation as cost metric and model based cost estimation and tracking of agile project". Similar tracking for web component is also required.

Various models have not considered web objects during estimation, which is an important component in estimating the web based project with agile characteristics. Therefore, we proposed a model where web characteristics and agile characteristics are taken into account.

Proposed Model for Web Applications based on Agile Software Methodology

This paper presents a model for estimation of cost of a Web Application using agile software methodology that utilizes function points and web object as the base of measurement. All the function points and web objects are decided at the initial phase of the project. Further, this aggregated value is used as an input to the model proposed by, Kang et al. (2010). Model is used to evaluate the cost of time required by the project through the estimation of the size. Plan of the project can be determined through calculating the function point and web objects then estimation model is generated for rest of the function points and web objects then plan for the project is decided based on duration of the project. Thereafter, velocity is measured on daily basis and growth is traced. The model uses Kalman filter for day-to-day tracking.

Working of model. From estimation model depicted in Figure 1 the function points and value of web objects for the required features were calculated and the model function points obtained. Value of the web objects can be calculated as suggested by Reifer (2000) through Number of XML, HTML, query language links, multimedia Files, scripts, and Web building blocks. The project team decides the duration from release, iteration and day. The duration of release lasts a few months, iteration a few weeks and day to a day. After the velocity is measured for, every day and progress is tracked. The Kalman filter is incorporated for tracking the project. Cost estimation of the software is determined by evaluating the effort involved in developing the software. Function point and web object corresponds to the effort required to develop the software. Therefore, Function point and web object as sizing factors can be used to evaluate the cost of the software. None of the existing estimation model had considered web objects with the function point as a method to provide better estimates for web applications.

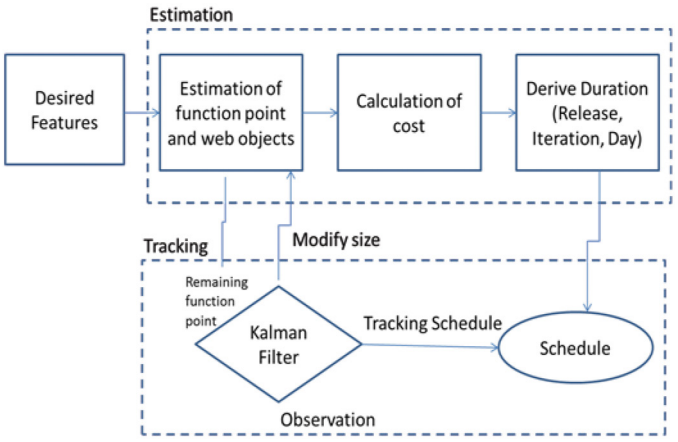

Figure 1. Model for cost estimation of web application using agile development methodology

Day-to-day Tracking. Kalman filtering is an estimating and tracking algorithm used in computer graphics (Welch & Bishop, 2001). Kang et al. (2010) have proposed "a state space model for historical data which estimate the future value of data using Kalman filter algorithm". If there is a change in the requirement by customer, then the scope changes accordingly and new function point and web objects would be added to the existing ones. This new value is given as input to the Kalman filter and which calculate the cost for new requirements.

Following formula is used to evaluate the estimation of the "state space model" at time t+1.

$$Ft = At\ Ft + Wt \tag{1}$$

Cost estimation can be done through the "state space model". The above formula can be used to evaluate the cost in terms of persons/month or LOC (lines of code). Equation for the same is given as follows:

$$Xt = Ht\ Ft + Vt \tag{2}$$

CONCLUSION

Agile methodology emphasizes rapid application development. Web based project developed through agile method are short-term projects. Developing a web based project using agile method allows the incorporation of existing estimation models. In this paper, we have discussed various open issues associated with web development particularly while opting for agile software development. We proposed a model for the estimation of cost for Web Applications developed using agile development methodology. The model used function points and web objects as base of measurement, which can be quantitatively measured rather than a relative measure like story point so it will produce accurate estimation. Empirical validation of the model remains to be done.

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