Use Case Point Estimation Technique in Software Development

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Abstract: Software Projects are developed with the prior requirements and should be capable to complete on time under a fixed budget but it gets late to delivered, gets over-budget and even not able to meet user expectations. In agile approach, the estimation of software depends on expert opinion or on any historical data which is used as the input to previous methods like planning poker. The accuracy in estimation is the primary goal of any development but various factors related to environment and technical complexity which may further alleviate the size and effort of a project. Previously proposed estimation models were successful in estimation but lacks due to some obstacles such as less accuracy and customer satisfaction as per the requirement, other factors such as complexity, risk tracking and estimation. This paper emphasizes on a new algorithmic approach to estimate considering Environment and Technical factors so as to have a more accuracy with the use cases under agile development.

Keywords: Use Case, Use Case Point Estimation, Agile Development, Technical Complexity Factors, Environmental Factors.

I. INTRODUCTION

Development of a software through agile methodology makes the team to be more responsive towards the unpredictability through the incremental cycle and iteration work. The agile methodology has lowered the use of traditional software management techniques. Agile methodology is used for software development in industrial projects because of being flexible in nature the software developed and delivered in iterations. Therefore, anytime change in the requirement are always welcomed. Agile nature is dynamic, so its estimation, development or time and efforts are also very difficult to measure with accuracy. By literature survey, it has been observed that no method is much reliable to measure the estimation of an agile software with extent of accuracy since agile developing environment has the high uncertainty factor among various attributes of project. Therefore, there is one of the most appropriate reason is the unavailability of reliable amount of information. In early stage of development, estimations are not accurate, because for the estimator the accuracy relies on the availability information. In this paper, a use case point estimation method has been proposed that estimates the cost, total effort, development time of software with more accuracy under agile environment. Thus, this technique supports to achieve better accuracy under the adaptable and dynamic nature of agile.

In this paper, we focused on understanding the causes of inappropriate estimations of developing a software under agile environment and various other factors related to estimation of Agile development.

II. USE CASE POINT ESTIMATION TECHNIQUE

Use case modelling is a widely known and acquired technique which collects the various business processes and prerequisites to develop a software project. Use cases provides the functional points and it scope for an application, analyse it better and result with the valuable view of required efforts and size needed to design and deployment of any application. Use case point estimation involves major decisive points to achieve the completion on time, i.e.

- Total steps to complete the use cases, i.e. the functional points to achieve the completion of use case.
- Total number and complexity of actors through which the act of completing various use case points is achieved.
- Technical requirements and its complexities.
- Various environmental factors to achieve the completion of use cases and its complexity.

Using Use case point (UCP) estimation technique, any estimator will be able to produce a reliable estimate, which can be done at very initial stage of development cycle. According to Alistair Cockburn [9], use case point estimation is the best technique in agile development as the advantages are:

- Every use case has goal, therefore all use cases provide list of goals, kind of summary that system will offer.
- Each use case provided with an agreement that the system will do and it will not. It provides specific context regarding item requirement i.e. very hard to get anywhere else.
- The extension of each use case will be the functional points of any use case which provides framework for investigating all the necessary things that take more than 70% of development time and budget.
- The use case extension framework also provides answers to many detailed, hard and ignored business questions.
III. LITERATURE REVIEW

Many researchers have worked in the area of Agile development and proposed various models and algorithm to measure the accuracy of estimation agile environment.

Popli and Chauhan [4] proposed an estimating algorithm based on user stories to calculate size of project in story points, calculate development time, cost and effort. However, this method does not include factors that would affect the estimation during the development of software.

Choudhary and Suman [2] proposed that maintenance of software also effects the estimation of agile software and for this planning needed and activity involves such as duration, staff, cost and size estimation. Related Concept (RC) stories, are required with the extreme programming model for the maintenance of an agile development. Therefore, algorithmic approach for maintenance estimation was needed. In this study, Software Maintenance Effort Estimation Model (SMEEM) is proposed to calculate the volume of maintenance using story. Popli and Chauhan [5] identified other factors such as project and people related that impact the estimation of project. Estimated value of story points effort majorly depends on the value of people and project related factors. By this method cost, duration and effort can be estimated for small and medium size project.

Hamouda [6] proposed a methodology to user story point in CMMI organization due to which organizational level estimation was established and added the concept of Relativity in story points. They adjusted the environmental factors and system complexity factors with the agile story point values that cannot be considered in the estimation of relativity. After applying methodology in CMMI organization, the accuracy in estimation improves significantly and error of estimation in size decreases from 29% to 59% [6]. After reviewing different literature research work done by Abrahamsson [10], Cohen [10] and Erikson [11] stated that the state of art and various practices with the characteristics of agile methods and lesson learned by applying such practices in industry improves the efficiency and estimation of agile development.

Bulgione and Abran [12] proposed an application of INVEST criteria (Independent-Negotiable-Valuable-Estimable-Small-Testable) is a technique which improves the measurement of user stories by using units in sizing and a technique to negotiate requirement. Agile methods use the poor structure of user story technique to manage a project [12]. This can be improved by focusing on functional extension of use cases that can be achieved by use case point estimation.

The first problem is that early availability of information in agile development with user-story is not much reliable [4] which leads to the inaccuracy of estimation and involves further risk of deviation in results.

Agile methods use the poor and immature constructed structure of user story technique to manage a project [12]. This can be improved by focusing on functional extension of use cases that can be achieved by use case point estimation.

The estimation of maintenance effort is difficult and several factors that can affect such as documentation quality, structure, modularity [2]. This can be minimized by using use-case point as it provides more specific summary and structured way to achieve, which leads to less erroneous development of application. The release date of any software on which the final product is handed over to the client. But due to insufficient knowledge, tricky factors which may result in error of the functionality of software which in turn further extends the release time. This can also be overcome by using use case point estimation technique which provides a framework through which detailed information and needful business questions can be answered when the issue spotted by stakeholder that takes long time to answer. Therefore, better estimation of development time can be done.

Today, no existing method can estimate software with the most precise way. Therefore, faces higher uncertainty regarding various attributes of developing software. The factors and its complexities affecting the development, proper size by having complete structured and functional clarity can be achieved by properly analysing from every aspect.

V. PROPOSED TECHNIQUE FOR ESTIMATING IN AGILE

Identify total number of use cases as per the requirement of customer and the total use case points to develop a software.

Use case points tells the appropriate size of the developing software by which estimation will become accurate.

A. Algorithm for Estimation in Agile

1. Identify the total number of use case point (TUCP) 

   \[ TUCP = UUCP \times TCF \times ECF \]  \hspace{1cm} (1)

   Total use case point computation has following steps:

   i. Identify number of steps to complete a single use case i.e. number of transaction(T) in a use case.

   ii. Identify Total Technical Factor (TTF) 

      \[ TTF = \sum_{i=1}^{n}(Weight(W) \times Perceived \ Complexity) \]  \hspace{1cm} (2)

   iii. Then, calculate Technical Complexity Factor (TCF) 

      \[ TCF = 0.6 + (0.01 \times TTF) \]  \hspace{1cm} (3)
iv. Identify Total Environment Factor (TEF)

\[ TEF = \sum_{i=1}^{n} (Weight(W) * Perceived Complexity) \]  

(v) Now, calculate Environment Complexity Factor (ECF)

\[ ECF = 1.4 + (-0.03 * TEF) \]  

vi. Identify Unadjusted Use Case Weight (UUCW)

\[ UUCW = \sum_{i=1}^{n} (Weight(W) * No. of Use Cases(N)) \]  

vii. Identify Unadjusted Actor Weight (UAW)

\[ UAW = \sum_{i=1}^{n} (Weight(W) * No. of Actors(A)) \]  

viii. Now, calculate Unadjusted Use Case Point (UUCP)

\[ UUCP = UUCW + UAW \]  

2. Compute the velocity (Vc) from the first iteration.

\[ Vc = \frac{UCP \text{ Completed in one iteration}}{Use \text{ case points in one use case}} \]  

3. Compute the Estimated Development Time (EDT)

\[ EDT = EUCP / Vc \]  

Where Estimated Use Case Point (EUCP) is calculated by

\[ EUCP = TUCP + 0.1 \times \text{Unadjusted Factor Value} \]  

4. Now, compute the Productivity Factor (PF) = It can vary between 15 & 30, therefore, 20 is the value suggested by experts.

\[ PF = 20 \text{ (in hours)} \]  

5. Compute Total Estimate Effort (TEE)

\[ TEE = TUCP \times PF \text{ (per person)} \]  

6. Compute Total Estimated Cost (TEC) per use case point

\[ TEC = TUCP \times \text{Cost per use case} \]  

B. Proposed Activity Diagram for Agile Estimation

The figure describes the various steps that are involved from collecting requirements in the form of use cases, velocity calculation, and cost calculation.

VI. FEASIBILITY STUDY

The feasibility of this algorithm is shown by conducting a survey among the various software developers and managers of a project and by applying the algorithm on the input of a software project. Estimation was performed on the data of a live project mentioned the total number of use cases and on the basis of which the total number of use case point is calculated, technical complexity factor and environmental factor through which complexity among development is calculated. The use cases provided here are of agile development software application or kind of tool for traders to trade, capture deal of modules like Loan & Deposit, ForEx in the capital market etc. This whole software development comprises of developing various functional field. The table shows the example of some of the use cases from ForEx Spot. The purpose of the survey
was to discover the complexity of various factors affecting the software development and the type of use cases. The survey was conducted in the month of March 2016 to April 2016 by means of a questionnaire given to the professionals to complete and it consists of the following questions:

i. According to the given Technical factors (Table 2) what will be the perceived value among each factors that would affect the application development under this project?

ii. According to the given Environmental factors (Table 3) what will be the perceived value among each factors that would affect the application development under this project?

iii. What kind of and how many actors (Table 4) will be included under this given project?

iv. What will be the number of use cases (Table 5) and the type of each use case?

Other Inputs:
No. of Use Cases = 39
No. of Use Cases points completed in one iteration = 30
No. of days in one iteration = 10
No. of working hours = 8 hrs(per day)
Cost per use case point = Rs. 1900

TABLE 1: Use Cases

<table>
<thead>
<tr>
<th>S.No</th>
<th>Use Cases</th>
<th>Use Case Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spot deal entry screen</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Buy/Sell</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Counterparty</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Book (Treasury Book)</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Pair</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Buy Ccy and0 Buy amount</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Sell Ccy</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Trade Date</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Spot Date</td>
<td>6</td>
</tr>
</tbody>
</table>

TABLE 2: Input For Technical Factors To Proposed Agile Estimation Technique

<table>
<thead>
<tr>
<th>S.No</th>
<th>Technical Factors</th>
<th>Weight</th>
<th>Perceived Complexity (0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distributed System Required</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Response Time Is Necessary</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

TABLE 3: Input For Environmental Factors To Proposed Agile Estimation Technique

<table>
<thead>
<tr>
<th>S. No</th>
<th>Environmental Factors</th>
<th>Weight</th>
<th>Perceived Complexity (0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Familiarity with The Project</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Application Experience</td>
<td>0.5</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Experience in Programming</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Capability of Lead Analyst</td>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Motivation</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

TABLE 4: Input For Actors To Proposed Agile Estimation Technique

<table>
<thead>
<tr>
<th>S. No</th>
<th>Actor Type</th>
<th>Weight</th>
<th>No. of Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Simple</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Complex</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

TABLE 5: Input For Use Case Type To Proposed Agile Estimation Technique

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type</th>
<th>Weight</th>
<th>No. of Use Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Simple</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>Complex</td>
<td>15</td>
<td>6</td>
</tr>
</tbody>
</table>

TABLE 6: Estimation Results

<table>
<thead>
<tr>
<th>S.No</th>
<th>Hypothetical Values of Factors</th>
<th>Unadjusted Value</th>
<th>Output</th>
</tr>
</thead>
</table>
The data collected through survey questionnaires from different developers having different perceived impact of various technical and environmental complexity factors which have impacted the size of the project in terms of development time, effort and cost (Figure2). The number of survey shows the estimation varies as dependent on the complexity factors. The figure (Figure2) explains the output of different survey which varies in terms of development time, total labour efforts and number of use case point. Through this proposed algorithm, we can have a better approach to estimate our project under the complexity of different factors.

The future, the various other factors which may affect the estimation, or necessary for the stability of requirement to that more efficiency and accuracy can be achieved while estimation through use case figure.

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