

Improved Scrum Model with SDLC

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ABSTRACT

System development life cycle provides a way to develop reliable software. Agile methodologies are enhancement in SDLC with the aim to provide more efficient software on time. SDLC is designed for Scrum process and a case study is conducted in distributed environment with Danish company mermaid technology with their partner Media soft in Pakistan. It is noticed that Scrum post game phase is further enhanced in case of applying SDLC.

Keywords: GSD (Global Software development), SDLC (System development Life cycle).

I. INTRODUCTION

This research paper mainly focuses of Scrum with distributed environment having SDLC phases. A case study is performed and system is applied on Media Soft Pakistan. This paper is divided in to nine sections. Section II describes the related work of different researchers in the field of Agile modeling and especially in Scrum process in fully distributed environment ,section III describes the features of traditional Scrum and its practices ,roles and responsibilities followed by the section IV implementation and experiences faced by the different researchers in the field of Scrum as development process. Section V describes the limitation in traditional Scrum model. Section VI shows the suggested Scrum model having SDLC phases, its introduction and design of the new system called Vtouchpro and the phases for Traditional Scrum model.

II. RELATED WORK

Software development life cycle model relies on maximum number of changes which can be seen in the completion of a project time line [1]. The writer introduced a potter model with the changes in agile model as it focuses on architecture rather than emphasizing on people and resources. Potter model introduced software like pottery is that built from scratch. Writer did this by providing provision in case of increment in non structural portion. Software engineers must have some idea about any feature that can be introduced in software by using potter model.

In 2007, a research has been conducted based upon the relationship of software development project success goals. These goals are quality, scope, schedule and cost [2]. They did this by covering 25 countries and analyzing these factors in 109 companies. The result has shown a 12 factors as hypothetical critical success factors. After examining and applying these factors on case study it was noticed that only

5 factors considered being true factors. These factors are delivery strategy, agile software project management technique, team capability, project management process, team environment and collaboration between customer and team members. The sample was taken from 62 Brazilian companies. This was also noticed that some other non agile attributes like scheduling and costing affect the project goals.

Rising and Janoff [3] find that Scrum is more suitable for small teams, which includes a cyclic short development phases or iterations (“sprints”). A Scrum team plays an authoritative role for completion of their role, like planning, scheduling, handing over tasks to members, and making decisions.

GSD (Global Software development) introduces the concept of outsourcing, partnership, a major technique of software development now days. It is gaining popularity now a day by minimizing the key factors associated with time to market, increasing productivity as well as quality and getting benefit for cost and improving efficiency [6]. Different communication channels provide a key role in communicating these globally distributed environments.

Scrum is an iterative process that mainly focuses on closed collaboration and strong communication between inside and outside factors of the project. Certainly,[4] the author, argues that major factors behind success of the Scrum project is strong involvement and commitment towards team members. Regardless of differences of key principles of Scrum and

distributed environment, different ways are opening due to the interest and usability of Scrum in globally distributed environments [5].

III. FEATURES OF TRADITIONAL SCRUM

This literature review describes all about Scrum, first reference we are going to cite is use of term ‘Scrum’ which was introduced in article [69] by Takeuchi and Nonaka. In this model, fast, self-organizing adaptive product development process was introduced that was firstly originating from Japan and also presented in [7]. Use of term ‘Scrum’ originally derives from planning strategy in rugby game where it tells “putting ball back in to the game” by using team effort [7].

Scrum approach is introduced by managing the system development process. It is a pragmatic approach that applies the idea of industrial control theory to the system development that resulting the idea of [7]. It does not describe the predefined techniques for development of software but helps that how team members should function in order to produce high quality software in a rapidly changing environment.

The main idea behind Scrum is that system development has several technical and environmental variables like variation in technology, time frame, changes in requirements in each process. This will enable the development process more complicated, flexible, changeable for system development. As a result of above requirements we are able to deliver a useful system [8].

Scrum enables us to expand the continuing engineering principles in the light of management activities that plan to know deficiencies or weaknesses in the development process or also in applying principles.

A. Process

Scrum process has three phases namely pre-game, development and post-game

Following are the Scrum phases that is introduced by Schwaber [8,7].

Pre –Game Phase

This phase has further two sub phases: Planning and Architecture

Planning consists of complete information of the item that system needs to be developed. Product backlog is build by adding all the requirements that are currently known. These requirements are generated by the customer and sales and marketing departments, end user center and software developers. A priority list is established to implement these requirements and also estimate the effort needed to implement these requirements. The product backlog list is updated daily on the bases of the new upcoming requirements and their priority list is also maintained. Definition of project team tools for estimation, risk analysis, resource utilization is also the part of planning. Product backlog is reviewed by the scrum team whenever it is updated.

High level design of the system in architectural level based on the current item in the product backlog. In case of updating of the existing system, changes that are needed in the backlog items are noticed besides with the problems that cause due to them. A meeting is held to review the design and check these in the proposal for implementation and decisions are made bases upon this review. Moreover, initial plans are released and prepared.

The development phase is also called the game phase and is part of the Scrum process. This is also treated as black box where unexpected things are expected. The different variables related to technical and environmental like time span, quality, requirements, resources and implementation of technologies and also development methodology is known in SCRUM, which can be change in a process and are noticed and controlled by using different Scrum practices in each sprint. Scrum not follows the traditional approach to control only at the beginning but it tries to control all the cycle to provide more flexibility in changing requirements.

In development phase system is build in sprint. These sprints are actually iterative cycles, and enable the system to provide functionality for upcoming new increments. The Sprint is mainly consist of traditional software development phases: requirement, analysis, coding, design and testing. Architecture and design is developed or changed during the Sprint. So it implies that there may be more than three to eight Sprints and there may be more then one team that performing their key role in each increments.

The **Post-game phase** is actually end of the release. This phase is started when an agreement has been completed that requirements are completed and now there will be no more welcome to the new requirements nor can any item be issued or invented. This actually the sign that system is now ready for release and all other task such as integration ,testing and documentation is completed.

B. Roles and Responsibilities

There are approximately six identifiable roles in Scrum that also perform different duties and fulfill different tasks: Scrum master, Product Owner, Scrum Team, Customer, User and Management. In the following these key roles are mentioned according to definition of Schwaber and Beedle in [7]:

Scrum Master

Scrum Master is introduced by Scrum to perform management role. Scrum Master is responsible for guaranteeing that project must meet the criteria as mentioned by the practices, values and rules made by the Scrum according to plan. Scrum Master communicates with the project team as well as with the customer and management during the project. He also performs the key role to remove any obstacles and do changes in a process to help his team members in working smoothly.

Product Owner

He is officially responsible for controlling, managing and making perceptible to product Backlog list. He is appointed by the Scrum Master, customer and the management of the product. He is key person of taking all the decision and estimates the development effort and turn product backlog into those features that are going to be developed.

Scrum Team

Scrum team is actual project team who has the responsibility to take decision and organize itself to achieve each sprint goals. The team key responsibilities for example are, estimating the sprint and analysis of product backlog and pointing towards those barriers that are necessary to be removed from the project.

Customer

Customer take part in all the tasks that are related to the product backlog items for the system that are going to be developed or updated.

Management

Management is that team which is responsible for the implementation of all standards, procedures and constraints that are followed in a project. Management also plays a major role of setting goals and requirements. For example management takes part in the activity with Scrum Master of measuring and reducing Backlog.

C.Practices

Scrum does not need or offer any specific software development methods to be applied. Instead it applied certain management practices and tools in the different stages of Scrum to keep away from confusion resulted by unpredictability and uncertainty.

Following practices are mentioned by [7].

Product Backlog

Product backlog tells everything that is needed in the final product based upon current knowledge. So it describes all the work that is needed for a project. It consists of prioritized and consistently updated list of business and technical requirements for that system which is going to be built or enhanced. Backlog item can consist of like functions needed to be performed, bugs that are to be fixed, defects, and requests that will helps to upgrade technology. It will also helps to provide solutions for those backlog items that are not been added yet. There are more than one actor who can participate in Product backlog items. The product owner is the person who holds a responsibility of maintaining Product Backlog.

Effort estimation

Effort estimation is a cyclic process, which helps to reorganize the backlog items on a more accurate level when there is chance of availability of more information for a certain product Backlog items. Effort estimation is the combine effort from Product Owner and Scrum Team.

Sprint

Sprint is the procedure of adjusting according to the environmental variables (time, resources, changes in technology, knowledge). This is the responsibility of the Scrum team to manage itself for the new complete product in a sprint that will sustain approximately for thirty days. The tools used in Sprint are Sprint planning meeting, Sprint Backlog and daily Scrum meeting. The Sprint with practices and inputs used is illustrated in Figure

Sprint Planning Meeting

Sprint planning meeting has two phases and organized by the Scrum Master. The first stage participants are customers, Product owner, Management and Scrum team. They decide the goals and functionality of the coming Sprint. The Second phase meeting participants are Scrum Master and scrum Team focused on the implementation of incremented projects.

Sprint Backlog

It provides a starting point to each sprint. It shows the list of those items that are needed to be implemented in the next sprint. These items are selected by the Scrum master and the product owner. Sprint backlog cannot be changed for 30 days like product backlog. When all the items are completed then a new iteration of the system is started.

Daily Scrum meeting

This meeting also serves as planning meeting to check the progress of the scrum team. This meeting also checks that previous and upcoming tasks and their progress. The time span of this meeting is very short about 15 minutes daily. Any weaknesses and obstacles in the system development process and practices are noticed.

Sprint Review meeting

Results of sprint is presented by Scrum master and Scrum team at the last day of the sprint. The participants like customers, users and management judge the increment in a product and finalize their views by taking action that either system direction will be changed or introduce new product backlog items.

IV. IMPLEMENTATIONS AND EXPERIENCES

As scrum doesn't need any engineering practices, it can be used a management practices in an organization [7] Though, Scrum can be used to change the job type and traditions of the Scrum project team. For example it is not necessary that Scrum master always organize the team, the team can organize itself and apply their own decision regarding the nature of their task. This can be called self organizing and self motivating team[7]. Despite of this that Scrum master works to remove any weaknesses, or to do daily basis decisions, his role is now more towards coaching the project rather than managing the project.

Schwaber and Beedle [7] notices two types of circumstances in which one can adopt Scrum: an existing project and a new project. These two are describe in the following. A common case of adopting the Scrum in available working project is that development environment and the technology they are using is already exist but team is facing problem due to rapidly changing requirement and more difficult technology. In this scenario the scrum is introduced with daily scrum meeting with a Scrum Master. The objective behind the first sprint should be "showing any piece of user functionality on the available selected technology"[7]. This will help to build confidence among team and customers. Team can remove any barriers during the first sprint meeting to improve their progress. Sprint planning meeting is started to select goals and requirements for the upcoming sprint, and there is session between customer and scrum master at the end of each sprint to decide about direction.

Second case, of adopting Scrum in a new project,"[7] proposed that it is better to work with customer and team to prepare initial product backlog. At this step, product backlog contains user functionality and business technology requirement. Actually the first step is to build an initial system framework, working prototype of the system. Sprint backlog must include all those tasks that are necessary to fulfill sprint goal. Now the main point is how to adopt Scrum at this stage?, Sprint Backlog also have tasks needed to build team and Scrum roles, and building all those practices that are the key points of managements in Scrum. Team with the help of sprint backlog and the product owner after communication with the customer build more comprehensive Product backlog. This will helps us to plan for the next sprint after the first sprint review. In [72] give information about their successful experiences of using Scrum in three software projects. They mentioned that Scrum is not an appropriate approach for large, complex projects, but we find this better for small isolated team. They experienced that it is good to apply two to three times daily scrum meetings to keep track of the Sprint. Other sign of positive experiences include strong collaboration among team members and effective problem resolution.

V. LIMITATIONS OF SCRUM

The writer found that applying Agile practices in Global Software development(GSD) are becoming popular day by day[9]. Many project managers are applying Scrum in their distributed projects. SD always needs a strong communication that is part of successful Scrum implementation. According to the author, applying Scrum in fully distributed environment some time restrict team collaboration [10]. Some researchers also noticed that Scrum is difficult to expand its working in fully globally distributed environment [11]. The use of Scrum in GSD still demands clear debate [9,10,11]. The study also claimed that project success factors are limited by using scrum in distributed projects [9].

There are some limitations in Scrum described by the author[6]. As a qualitative study, the research does not claim about the implication of this research to other global software development. But rather it could be seen in [6] that there is a no way of global software development by applying Scrum practice, but it is seen that project manager must put some efforts to fit a project in global environment. Instead, this paper shows some general principles on how Scrum can be used in global software development. Another limitation of the Scrum in GSD [6] is Scrum implementation by changing the parameters of project setting in global distributive environment. According to the researchers, there is also no claim exists that Scrum is best for GSD.

Research [77] also claims that it is not seen yet that how continuous Scrum is adaptive in such an environment where large number of IT system is going to be managed, especially in traditional systems. Continuous Scrum is so far seen in collocated team, there is a need to be check the impact of Scrum performance in distributed team.

According to the author [12], there is a need to know the cooperative task board for web 2.0 platform so that it is better for distributed team to register themselves and use the scrum as software development process[12]. In another research article[13] writer discovers that there is a need to check the scrum in distributed projects of a student, having different time zone and different geographical boundaries [13].

VI. EXPERIMENTAL SETUP

A. Introduction of the System

The system is developed for Mermaid Technology Denmark with their partner Media soft here in Pakistan. A case study has been conducted with the help of Media soft here in Pakistan. Media soft is working on the system name VtouchPro. VtouchPro is the web based application that handles their clients in all over the world. The application is displayed their product sale information, stock, order, delivery information and upcoming stock information daily in all over the world.

The most known customer of Mermaid is the shopping stores in Scandinavia. Some of the clients of Mermaid are the Leaf Denmark, Apotekernes, Louis Poulsen, Seven Eleven and Carlsberg. The leaf Denmark has 65 stores which have more than 1200 screens in their shopping malls.

This application work in the following way

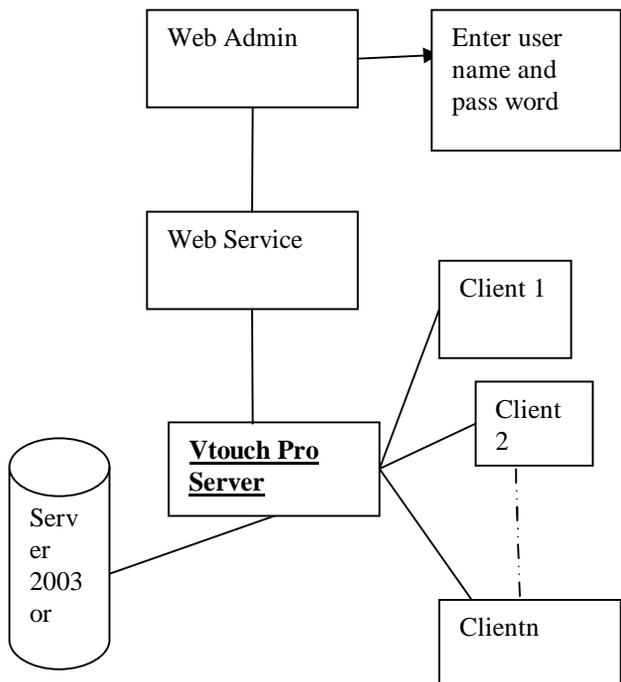


Fig.1 Vtouch Pro system

Our case study is a product development program known as Vtouchpro from an IT company located in Denmark. The company main services are in Europe but it also has distributed environment in other part of the world, e.g., China, Ireland, and Norway. The company is very experienced in distributed projects as it was working on it since last ten years with little changes over time. The company introduces agile practices since last 3 years. The case selected for our study is product development program that was already working in their environment using Scrum as an agile practice, but we redesign its phases and introduces system development life cycle in Scrum that helps to control their iteration and also helps top level management to working on new upcoming requirements.

Company has so many customers and also clients in 7 countries. Company is working in fully distributed environments. New product versions are released after one year or some time when ever there is some new requirements, currently they are on 6.1 releases. The product organization is grown over the year from 10 employees to a current size of 250 employees in all over the world where 25 employees are in Pakistan. The organization set up new releases for its Danish client based upon their current and upcoming requirements and maintains their documentation as well. The organization has approximately 25 persons here in Pakistan and 30 persons in Norway, the strength of the resource persons working in other countries are approximately same.

Our case organization has used Scrum from the last six years. Before this they used RUP and iterative way of working that include so many activities related to planning, and deadlock after each phase of RUP due to shortcomings that stop the process and it's also very difficult to remove the delay in each release and also communication hurdle due to distributed

environments. The quality was also suffered after the first release as it was difficult to maintain new and old requirements in the next phase. It was also noticed that customer demands more agility and it's hard to keep track of it in old processes. The organizations had mainly focused on traditional methods of applying changes and also keep track of those changes. That was another factor that encourages the manager to bring change in their traditional methods. The main client in Denmark encourages the company to bring the changes in their current process and then discuss their views with other team members in different locations.

Consequently, they decided to apply Scrum as development process on test basis for three months. After this decision they give brief overview about Scrum and apply this in all steps and try to work according to Scrum principles. Now there is a no way for the old process and Scrum is now fully applied in their organization. A complete documentation is followed for every step of conversion from the old system to the new one. The most important task for the team is to produce quality in every sprint. The overall product consists of 38 modules where 24 modules are in a current release. A customer can order more than one product as the program is constantly developing new versions, each release project is known as project.

The distribution of the team members between onsite (Media Soft Pakistan) and Mermaid Denmark is described in the following diagram

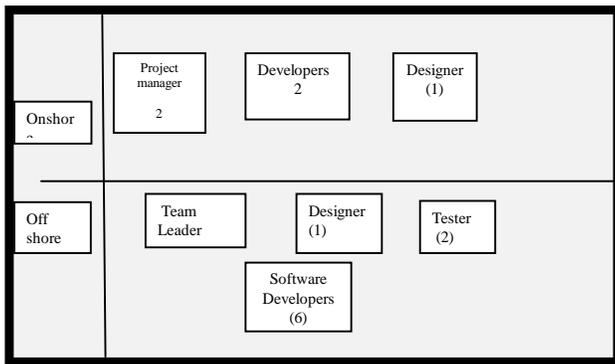


Fig.2 Team distribution of Distributed Scrum Model with SDLC phases

The system is working as a team: a development team, quality assurance team, designing team and testing team. Quality assurance team and testing team is the most important team, where the most experienced team members are required, because they are the key persons who focused more on quality and also testing in each sprint. Their work has significant impact on customer satisfaction and also on our research project because we design SDLC for Scrum and quality and testing is the key steps in SDLC. Some team is distributed in Norway, China, Pakistan and Denmark. The number of the person is varies from release project and also between iteration. In each team there may be from 5 to 10 persons, so we can say that our distributed Scrum environment work with large team size. The working environment is distributed so communication is handled through Skype.

The time line is decided for each type of the meeting like for quality assurance meeting the time is 20 to 30 minutes daily but developer meeting is between 25 minutes to maximum up to one hour based upon the task that are needed to be completed every day. Meeting time is also depends upon the task, urgent and current issues. As the team is working in distributed environment so the team members are also in different countries like two developers from Denmark, four are from Norway, six developers from China, one from Ireland and six developers from Pakistan. The team also includes one designer who is from Pakistan. So there are also three Scrum master one in Pakistan, one in Denmark and one in China. This implies that one Scrum master may have several team to work with it. Moreover the product owner is from Denmark. The time difference between Denmark and Pakistan is three hours, China and Pakistan is three hours and from Ireland four hours in all seasons. However the daily working time in Pakistan is bit longer and they also have more than 12 hours shift.

B. Agile Practices

In this section we describe how we were apply our Scrum model in distributed project.

Daily scrum meetings.

Daily Scrum meeting is started in Pakistan every day at 9:00 AM, and Daily Scrum meeting task allocation between different sites are arranges using Skype and telephone conferencing using web cameras. Application sharing can also be handled but it is mainly not required. The meeting normally takes place between two hours during morning time. The meetings between different teams are occurred one after another and also in the same meeting room. Every team have different time frame as discussed already, for example in case of quality assurance, if all the quality assurance team is from Pakistan, the meeting is still distributed as the product owner is from Denmark. Mainly in first session, it is difficult for everybody to tell

about their own task and issues related to them but with the passage of time all are familiar with the environment and meeting agenda will be clearer. The meetings normally takes 30 minutes each based upon agenda and will be lengthier depending upon tasks.

Scrum-of-Scrums.

A scrum of Scrum meeting can be arranged once in week based upon the requirements and the problems that are needed to be addressed by all team members. The team makes decision that who participates in this meeting, like one member from each group of quality assurance, development and testing. This is not necessary that same person participate every time, but the rule is that u must know about the agenda and your team performance issues. The issues are discussed every time and new tasks are planned and the performance for each week is measured. This meeting also helps to improve the performance and also remove impediments. This meeting also open the doors for additional questions like “what impediments occur in other team work due to you”. The goal of this meeting is to ensure successful implementation of sprint tasks.

3-week sprints.

Application size is change with each sprint, so the number of modules is also varies to each sprint and the user stories are also varies, some stories takes one sprint but some others may exceed and complete in 2 to 3 sprints. It depends upon the task allocated and work effort needed to complete a tasks. This also shows that it is not necessary that all sprint start or end at the same time, some takes 3 weeks and some completed only in one week.

One week testing and quality assurance sprints.

The maintenance team has the one week sprint for quality assurance and testing, testing is go side by side with as sprint one is going on, and also at the completion of each sprint it will be again checked at the end and then finally quality product is delivered. This cycle also affects the maintenance and reduced the maintenance cost, defects, and also maintenance hours.

Distributed sprint planning meetings.

The sprint planning meeting is divided in to four phases. The time period for daily working hour is 11 and the meeting is scheduled between this form 9 am Pakistan time to 10 pm Pakistan time. The four phases of the meeting, distributed meeting between Denmark and Pakistan, Local meeting in Pakistan, Distributed meeting between China and Denmark and Distributed meeting between Pakistan and China.

The first part is the time boxed of one hour between Denmark and the Pakistan and the Second part is of 30 minutes time boxed in Pakistan. Distributed meeting held virtually using Skype and telephonic conferencing and the daily tasks and the “doneness” of the tasks are checked. Do’s and don’ts are discussed and the meeting agenda is discussed. These distributed meeting is again give some output and the meeting is held in Pakistan at 1pm locally to check the developers and quality assurance team performance. For application sharing Microsoft Net meeting is used, and the tasks that are assigned to each person is discussed and the testing and quality assurance team continue their work.

The meeting in Pakistan goes on and the work is finalized and then after the lunch time of China the meeting is started and it goes on for one hour. Before every meeting the product owner prioritized the backlog and made an estimate for the backlog.

Sprint demos.

Demos are managed using same technology as in sprint planning meeting: Skype as a communication channel. The team has weekly agenda, and their product owner and scrum master participate in this agenda. Following is the rough pictures of the agends of quality assurance team.

Daily builds and automated testing.

The team checks their code daily using centralized control system available in Pakistan. It can be overviewed by all team members. During evening the whole product is bult and if this is not successful then rebuild the story again to remove errors.

Separate backlogs for each team.

The backlog list is maintained using excel. All team members have access to excel sheet. Each team has its own excel sheet for maintenance. The quality assurance and testing team has its own sheet, to which product owner can add new issues.

Team rooms.

In Pakistan and Denmark there is only one room for all team members, this will encourages team members to discuss their problems more easily. If the person switches from one team to another he also relocate the new team rooms and the project move on.

Daily Scrum Report

The development team sent a daily report to the team leader. It is normally an informal report, and the team leader inform the developers about the today's task and this could be again reviewed by the quality assurance team. Following questions are asked in the session of review

- What is the problem in the task?
- What we have completed today
- What will be the task for tomorrow work?

Weekly Report

As Friday is the closing day, so remote team members sent daily report to the team leader on Friday. The team leaders of the Danish office keep track of the progressed work and the tasks that are completed is noted down in Burndown chart. Weekly report includes the following information

- A report of the last week work
- Coming week tasks
- Weekly bug report
- Weekly risk report
- Weekly report from the testing and quality assurance team

Sprint Review Report

This report consist of the description about the completed tasks. This report shows the status of the ongoing projects. The main content of the report include product features, finished tasks, expected risks. This report is sent by the product owner once the sprint is completed and the aim of this report is to shows the progress to the customer. The report has the following information

- Sprint summary
- Sprint deliverables
- Sprint burn down chart.

Mid Sprint Report

The team leader sends a report to the product owner about the current status of the project. The report contents are same as sprint review report. This is an important communication activity in distributed environment. There are some following formal or informal meetings are organized

Weekly Meeting

Weekly meeting is organized using Skype and the developers, team leaders and the Project manager took part in this meeting on every Monday. The participants are the onsite and offsite team members and took time approximately 45 to 60 minutes. The agenda of the meeting is the current week issues.

Several other meetings also took place like mid sprint meeting, sprint review meeting and lunch break meeting that helps to manage the sprint tasks.

VII. SCRUM SYSTEM DEVELOPMENT LIFE CYCLE

System development life cycle is developed to control the process and run system successfully. System development life cycle controlled different phases and also helps to improve the quality of the working product. It minimizes errors and maximizes efficiency. Here we are going to describe the phases of our proposed Scrum SDLC phases, our proposed Scrum model consist of five phases

- Planning
- Coding
- Testing
- Quality assurance
- Release

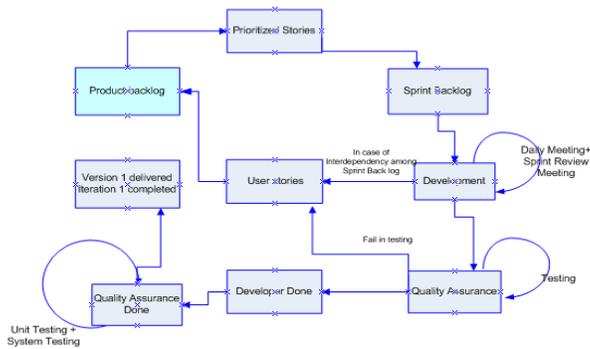


Fig 3.Scrum SDLC

Planning

Planning phase is further subdivided in to two iteration: iteration -1 and iteration 0 [agile SDLC] as followed by the principle of agile SDLC. We designed iteration -1 as initial requirement phase that takes requirement from customer, stakeholders, developers, market statistics that also produces new requirements, and product owner. These requirements are reviewed and suitable requirements are selected in iteration -1. Iteration 0 gives the name of these requirements to a stories depending upon the sub stories or also called a sub tasks. A priority loop is maintained for these stories that help to identify and judge all of these stories and set priority level for these stories. Planning phase convert these requirements into story and attach additional story field that helps the developers to know more about upcoming requirements.

Development

Development is started after requirements and, a story is selected, these stories are divides in to sub stories and the task is allocated for each of these stories. Priority level for these tasks are also selected and it consist of 20 to 30 minutes review meeting, the agenda of the meeting is change day by day and it will progressed as the development progressed. Iteration one goal related to development is completed and we are able to run the Sprint review meeting.

Testing and Quality assurance

Testing and quality assurance is go side by side testing is done for each subtask as soon as one sub task is completed it will transfer towards testing, the testing is done on daily basis as per requirements. Quality assurance is started to check the sprint and check the quality of iteration 1. If its possible then loop will be goes on and again need feedback from the developers. Developers mostly work side by side with the quality assurance and testing team. When the task is properly completed and testing is completed a review session is held by the developers and the testing team, finally the task will be completed after quality assurance review by the developers and bugs are fixed and then it will again completed reviewed and checked by the quality assurance and the signal of done in case it will be completed. If it will not completed and there is error after quality assurance then it will again go to the planning phase for review.

Release

Finally the system is tested and sprint one is released and iteration one is completed and the product is gain moves towards planning for the next iteration of Sprint2.

VIII. CONCLUSION

Scrum can be applied with SDLC phases that also control the iterative process and it gives an additional control for development process. The research addresses the case study of Scrum in fully distributed environment having SDLC phases. Testing phase is introduced and there are also separate quality assurance phases that first check the development work and then perform testing on daily basis.

Another goal which has been achieved is the high productivity and better performance of the development team. We have successfully achieved this objective by continuous testing and quality assurance phase. This phase is also helpful in order to reduce the defect density.

IX. LIMITATIONS

The main limitation of this research is the non availability of some dataset. The data is collected only from the company located in Pakistan and one telephonic conference was conducted from the Scrum master in Denmark. The Media soft company here in Pakistan is taken as the main research company.

Scrum with SDLC phases can also be applied for small teams that are working in collocated environment and then comparison can be made with the teams that are working in distributed environment but having similar geographical boundaries with same time zone. This type of research could help to introduce the concept of distributed team but in same cultural boundaries where time and cultural aspects are not present.

Another limitation of the research is that costing parameters that are also related to efficiency are not applied. These parameters are helpful to calculate the budgeted cost, an estimated cost and also perform the time variance estimate that help not only to set the project control parameters for time but also estimate the cost that is needed for the successful project.

X. FUTURE WORK

In this study, main focus was on the Scrum in fully distributed environment with SDLC phases. The future research could be the application of fully distributed scrum in fully distributed environment having small team size and then check its effect in collocated teams that have same geographical boundaries.

Another research area could be to increase the Sprint cycle time and introducing pair programming and refactoring as part of the Scrum SDLC process and then check the results with our proposed SDLC model for better agility and productivity.

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