Agile Testing Challenges and Critical success factors

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Abstract—it has been seen in recent years that agile software testing comes out as a most productive, promising and effective testing technique in large scale and small scale software development process. Testing is one of the prominent and continuous activities in the agile process. Transition of the testers from heavyweight traditional process to an agile lightweight process becomes challenging and sometime they feel that they are micromanaged because of the continuous interaction with project leaders. In this paper we have identified challenges of the agile testing, skills which tester should have for working in agile projects and provided agile success factors. If any agile projects consider the success factor and adhere to them then project will be delivered successful with minimum issues

Keywords-Agile Testing; Agile testing challenge; Agile testing success factors; Tester role; Role of Testers; Quality Assurance

I. INTRODUCTION

Quality software product is a continuous biggest challenge for software development organizations. Software testing has its own importance in software development life cycle and it is a one of the important processes to verify the quality of a software product. For making a project successful, correct testing approach is very much necessary. Correct testing approach can save significant effort and increase software product quality tremendously. Thorough testing reduces post-delivery defects and reduces maintenance costs which effectively increase customer satisfaction. Testing is generally described as a group of procedures carried out to validate and verify some aspect of a piece of software. Bronstein mentioned that Testing can be described as a process used for revealing defects in software, and for establishing that the software has attained a specified degree of quality with respect to selected attributes. Testing provide real feedback of system behavior which helps to deliver high quality software.

Software testing has been successfully evolved over the time and it has provided efficient and continuous support for improvements in software quality. It is still treated as a challenge for higher management to convince client for its massive resource consumption within software project development lifecycle. Researches are working on software testing and focus is given for designing new techniques and investigating software testing effectiveness in real development contexts. In the history of the software development, testing methods and techniques struggled to keep faster evaluation and trends in software development paradigms.

Some companies and experienced software developers consider testers as a second-class citizen. Testing practices in software industry are not treated as very effective, due to this new joiner of software industry perceived higher satisfaction from developing something new rather than testing something which is already exists. This perception will be changing with the introduction of agile development methodologies, in which testers become fully integrated part of the software development team.

Testing in the agile methodology is one the complex and controversial issue in the literature of the agile methods. Different agile practitioner has different opinion about software testing in the agile methodology, because frequently used agile methods do not gives much focus on software testing activities. Agile methodologies give more focus on high customer collaboration, short iteration at max one month and frequent delivery of working software. When it comes to software testing in agile methods it become challenging task as agile methods do not use the practices which are used in the traditional methodology. In agile methods developers and testers are part of the same team they work in collaborative environment sits next to each other and tester's enables visibility, enhance communication and provide feedback about software quality to the developer. Early feedback allows the developer to modify the products in a timely fashion and thereby reduce overall project and

schedule impacts. Agile methods needs that each and every deliverables of each cycle needs to be tested thoroughly and identify problems, issues, defects as early as possible. In Agile testing focus is given to implement requirement correctly and solution should meets business needs as well as performance criteria. This is a biggest challenge for testing in agile because agile methods has rapid release cycle and it puts fixed deadlines for testing activities . If more defects found then the estimated in a particular iteration it does not allow extending the testing period.

In agile methods Automation is the key to do agile testing. While doing development using agile methodology, test automation frame work is essential and it should be created from first sprint .It can be evolved as development progresses in each sprint. Investment for creating automation frame work should be done and it pays off later in the software development. Tools which are going to be used need to decided, testing framework should be created, development and testing environment should be up and running before first sprint begins. Test automation should cover functional as well as regression testing it helps to improve the quality of software. Agile methods works in the time box environment it is very important to give focus on the automation. If automated testing framework created then it can be setup to run on demand and/or overnight which saves developers and tester time. Regression testing and functional test cases can be executed every day or on every check-in of the code.

Agile Software Testing requires innovative thinking and the right skills of people should be chosen for doing the testing .Experienced, skilled and self-motived test engineers are required to be part of agile team because learning curve for the resource is not present while doing development using agile methods. Test engineers of agile team pushed hard for writing new automatable, scriptable test cases early in the development process which will be used at the time of automated testing. Both developers and test engineers works parallel in agile methodology and produce the code and test script as an output. Every check-in of the code needs to be tested with the help of automated testing and if it breaks communication should be given to all the developer's involved in the development, it speedup the process which is a key for agile methodology.

Traditional testing cycle has its own phase and it occurs at the end, after the development has been completed. High level and low level technical Documentations are handed over from development team to testing team. There is formal process setup for communication between testing and development team. Detail specifications and test plan created and maintained throughout the life cycle. Testing is driven by the requirement prospective and automation of the test cases is optional. In many traditional projects testing time reduced because coding phase takes longer than expected which create big impact on the quality of the software.

Agile testing does not have its own phase and done in the development phase only with every scrum. An agile method means iterative and incremental development which means testers test each increment of code as soon as it has completed. Lot of interaction happen between the developer and tester as both are part of the same team. No formal process is setup for the communication between tester and developers. User stories are used for creation of the test cases and it contains the acceptance test criteria as well, light-weight test planning is done which ensures low management overhead. Testing is driven by the customer perspective and high degree of test cases automation is recommended. Agile team member will need to be adaptive to the team's needs.

In traditional methodology test cases are created using the requirements document that was created by business analysts at the beginning of the project and before anyone thought of writing a line of code. In agile methodology testers need to write test cases that illustrate the requirements for each user story just some days or hours before coding begins. Test case creation is done in collaborative manner between a domain expert, tester, developer and business analyst. Testers conduct manual testing to find important bugs and testers might pair with other developers to create automatic test script and execute scripts as coding on each story proceeds. Functional test cases must be automated and should be added to the regression test suite. When testing of demonstrating minimum functionality is completed, the only story can be considered as finished. Testers are also participating in retrospectives and other process improvement activities. The most important difference for testers in an agile project is the quick feedback from testing and it helps developers to figure the issues in very early stage.

The remaining of this paper is organized as follows. Section II describes Literature review of agile testing challenges and success factors. Agile testing challenges and agile tester's challenges are discussed in the section III. Section IV presents the critical success factors of agile testing and benefits of agile testing. Finally section IV concludes the paper.

II. LITERATURE REVIEW

Literature in the field of agile testing contains a large body of research work. However, we have focused this literature survey on agile testing challenges which are faced by the testing team members when they move from traditional to agile methodology. We have identified critical success factors for agile tester which needs to be taken care while working with agile team.

Haugset and Hanssen has presented their study on automated acceptance testing. They have mentioned that automation of acceptance tests can be a good initiative for improving the efficiency of development, writing and

not least maintaining such test cases which come with a cost. Test case can be written by the tester but customer's high involvement should be there once test cases are automated it helps customer to execute test case in very short span of time and do the regression test as well[1].

Puleio presented how agile testing needs to be done. Author has mentioned that getting the various testing practices in place and make sure that they are functioning properly in agile environment is biggest challenge. Common understanding of the agile testing practice, estimating test effort, allocation time required to automate testing in feature driven culture is biggest challenge. Quality assurance (QA) team who has traditional software development process background often cannot divide the testing tasks in manageable pieces of sub-tasks. In The Agile methods requires that the task should be divided in chunks of 2 to 8 hours to create user stories for backlog and it ease the effort of tester while creating test cases for use stories [2].

Janzen and Saiedian has presented their study to find out how test driven development improves software design quality. Test driven development provides impact on code size, complexity, coupling between objects and cohesion between the object. They suggested that programmer who uses test-driven development are more likely to write software in more and smaller units that are less complex and more highly tested [3].

Adnan et al presented their study on role change of the tester while transiting from traditional to agile methodology. They have specified that attention needs to be given in the integration testing. They have suggested new project mentor role for new agile testers. This role of mentor aims to utilize the knowledge that testers already have in business domain and development technology together and utilize it in quality practices. This role enhances the stature of the tester enable company to easily deploy tester in new agile environment [4].

Itkonen et al focuses on quality assurance in agile software development. They have specified quality assurance practices for four agile methods and come to the conclusion on agile methods follow constructive quality building practice. They have suggested independent tester role for session based exploratory testing [5].

Janzen and Saiedian presented their study on test driven development. They have specified challenges which are faced during adoption of test driven development. TDD needs a good amount of discipline on the programmer's part. Hence, programmers have to have good reasons before they start using TDD. Good knowledge of TDD is necessary before deciding to use it. TDD still widely misunderstood because of its name and developers feels that TDD only address testing and not design. Best fit for test driven development has to find out before using it because TDD doesn't fit in every situation. Developers and managers must determine when to use TDD and when to use some other methodology [6].

Stolberg focuses on continuous integration in agile testing. Use of continuous integration and automation is a key of the success of agile testing. Developers and testers must decide and work on automation of the acceptance test cases. Automation close to 100% should be done for acceptance criteria. Latest tools should be used for automation and it should cover more than 95% or code coverage. All the test cases need to be run by using regression test suite with the build, daily. Unit test cases should be developed for all the new code during development and defect fixing. All the unit test cases must be executed with every build [7].

Huo et al presented their study on software quality assurance (SQA) in agile methods. They have compared SQA of traditional methodology and agile methodology. Agile QA activity occurs much earlier than it occur in waterfall development, Frequency of SQA activity is more than the traditional methods as most of the SQA activity included in each iteration and iteration are repeated during agile development. Agile methods use dynamic quality assurance technique and traditional use static and few dynamic techniques [8].

Vodde and Koskela describe the case study of Nokia Networks which changes their development methods from traditional to agile. They have focused on the test driven development. They suggest less emphasis on test document may result in premature sprint output, test coverage in scrum should be nearly 100% percent, feature driven and integration test cases both should be consider, quality of the software should be tracked with tool needs to be taken care to successful delivery of the software using agile methodology[9].

Bhat and Nagappan presented their study on test driven development. They have compared development of the software using test driven development in two different environments. They have compared efficiency of the test driven development. They have observed significant increment in quality of the software code for the projects developed using TDD compared to similar projects developed in the same organization in a non-TDD fashion. Automated unit test cases served as auto documentation for the code which is used as library or API. It helps maintenance team as well and they need to only update it as and when enhancement of fix is needed [10].

Cristal at all presented their study on scrum practice and they have suggested that work should be assign to tester and developer together. For example, assigning unit test cases script for peer review to tester can increase test coverage and it will reduce the probability of missing any requirement. After Adoption of this practice anticipation to get defects in to development phase will increase rather than finding defects only after promoting build to test. They have observed that Teams in which Tester working with the developer's delivered better working software in less time and keep the testing on track. It has found very easy to track the project progress in this environment [11].

Harish et al presented their study on agile testing best practices. They have provided best practices which should be followed by the agile testing team. They have mentioned that automation in agile testing not only provides helps while doing regression testing but also helps in carrying out work in iterations. Automation will help to avoid any mistakes which can otherwise be possible while doing manually testing [12].

III. IDENTIFIED TESTER'S RESPONSIBILITIES, CHAALANGES AND CRITICAL SUCCESS FACTORS

We did extensive literature survey and interacted with agile practitioners to identify challenges which agile tester's face. We have also identified what is expected from the testers when they moved from traditional methodology to agile methodology. We have suggested critical success factor which needs to be consider while doing testing in agile methods.

A. Tester Responsibilities

In agile methodology process and test phases are same as traditional methodology but they are shorter in duration, iterative in nature, incremental and fully integrated with development. For small scale projects testers are always a part of development team and do the testing to get the feedback early with in a collaborative environment. For the large scale projects special test phase called release testing phase is established and full release test needs to perform. Lightweight and cross cutting test management process should be adopted to make successful agile project. It should be clearly defined before starting the project that which type of tests will be done in the each iteration and which one should be outside of iteration with individual phase. Agile tester should consist of following skills while working in agile project.

- Agile testing is done in very demanding and aggressive environment, agile tester have to have comprehensive knowledge of the software engineering. Tester should be experienced and well versed with the software practices like how software is specified, designed, and developed.
- Agile tester should have good communication skills and needs to be able to handle higher management and end client properly as daily status and feedback is required in agile testing.
- Agile testers are expected to have knowledge of fault types and where faults can occur in code constructs. Agile tester needs to have technical knowledge as well. Tester should know automatic testing and technically good.
- Agile Tester needs to have good functional and technical knowledge. Tester domain knowledge plays very important role in agile testing as agile testing happens in very short duration.
- Agile Testers needs to have skills to simplify things and can create automated test cases. Agile tester needs to create and document test cases. Testers needs to automate the test cases, must get input from different stake holders always ready to accept the changes, create test cases for changes and mange those test cases.
- Agile testers need to design and create test plane, procedures for running the Tests. They should be able to do estimation of the test cases. Successfully execution and record the result of the testing is also come under tester responsibility.
- After completing testing, tester needs to analyses test results and needs to take decision on success or failure. Proper reason of test failure needs to be given by the tester, it needs good amount of domain knowledge and they needs to justify it to the developers and guide them to fix the defects.
- Agile testing focuses on the automated testing, agile tester needs to learn the new automated tools and keep up his/her knowledge with the newest test tool advances.
- In agile testing lot of communication and coordination are required, agile testers needs to have more contact to client. Tester needs to cooperate with requirements engineers, product designers, and product developers on daily basis and must establish a good professional and personal relationship with clients and users.
- Agile testers should Practice continuous improvement, always ready to respond to change, self-organized, provide continuous feedback to developers and higher management. Agile Testers needs to be educated and trained in the specialized area and it is required to update his/her knowledge on a regular basis.

B. Agile Testing Challanges

Documentation: To find a balance between lightweight ways of testing with 'no documentation' versus creating fully comprehensive test scripts is biggest challenge during the agile testing. Agile methods give priority to working software rather than having comprehensive documentation. Documentation does have much importance in agile methodology and limited time has been given to create the documentation. It may result misleading if requirement are not present in the proper manner to tester. It creates challenge for tester to create the proper test cases because of less information present about the requirement. Agile methods demands that changing requirements should be welcomed and accepted even in later stages of the development. Traditionally after

completing of successful development, testing activities starts. Development phase used for test design and test development and for quality assurance activity. In agile methods as development done in the iterative phase and if any change comes in the development it should be analysis and if cannot be fit in the current development then it should be incorporated otherwise it should be moved to the next iteration. Tester has to be attentive and should change their test cases according to the new changes. Importance is given to face to face communication some time requirements are not present in the documents and it is presents in customer mind. Testers faced challenge to capture the entire scenario as some of them have not been mentioned in the documentation and have to be covered by doing communication with the client. As agile methods has requirement in very high level some time, Creation of test cases is one of the big challenge for the agile testers.

Communication: it is one of the very important factors for creating successful product using agile methodology. More than one developer, requirement engineer and test engineers are involved in product development , it is very important that highly collaborative environment should be created during development using agile methodology in which testers, requirement engineer and developer's should have friendly relationship, sit next to each other and communicate with each other on daily basis . It has been observed that communication between developers, testers and requirement engineer do not happens frequently and creates problem of successful delivery of the project. Communication becomes more challenging in case of big complex project which is distributed in different countries and different time zone.

Estimation: During the release planning phase less emphasis is given on testing estimates. It results unrealistic time estimates for the testing and creates lots of problem during the testing. It has been observed that in agile methods ratio of the tester and developer's needs to be increase as agile demands delivery in very short span of time. It increase cost and higher management try to reduce it. Agile Estimation should include time of different type of testing and should include testers while doing estimation for iteration which is usually avoided and become a big challenge.

Automation: Agile testing contains high initial costs due to the set-up of test automation. Agile methodology gives emphasis on automation testing. In agile methods workable software delivery needs to be done in short iteration at max one month time duration. Automation is recommended as, regressions testing in iteration is important to deliver successful project and automation saves lot of time as well. Initial cost of automation is more especially at the time of writing the test cases or configuring the automate framework. It is biggest challenge to get experience test engineers who have expertise on writing automated test scripts and have good domain knowledge. Manual testing is also required as all of the scenario cannot be cover using automated testing. It is a big challenge to find out which all test cases should go in automation and which all should go in manual testing. Predictability, traceability, and a high systematic test case design are required to do successful test automation.

Integration and performance: Agile methods prefer to use user stories which are directly given by the customers. User stories are written from the end user's prospective and it contains feature information and focus given on the benefit or result that they get, results can be treated as acceptance criteria. Agile tester's gives focus on features which are going to be delivered in iteration. Less importance is given to write test cases for integration with the different module. User stories do not contain the information about the performance of the system and it has also given less importance. It is observed that the functional and regression testing with automation testing are done in each iteration during the testing but very less importance is given for security, performance, availability and stress testing. It is one of the very big challenges for the testers to cover all the integration and performance test criteria in each sprint. Integration and performance plays very important roles and tester should cover all the aspect of these testing and give more emphasis while creation of automated and manual test cases.

Mindset transformation: Traditional methodology works on command and control culture. Agile methodology works on collaborative environment. For successfully adoption of the agile methodology mindset transformation is required. Customer ownership, management commitment and development cooptation with agile testers is required to deliver successful project. Agile methods do not work in phase driven manner and it works on short iterative manner. Iteration contains analysis, design, development, testing and deployment. Daily status needs to be given while using agile methods. You cannot hide anything in agile methods. Trust based relationship with agile developer, requirement engineer and testers are required. Developers and tester both should always ready for learning and accept new changes. Developers should learn from the testers and testers should learn from developers. It needs mindset change which is very difficult. Less focus is given in status reporting while doing testing and mind set change needed and proper status reporting needs to be maintain while doing stats reporting. Developers and testers should work in parallel and support each other.

C. Critical success factors

After having discussion with the agile practitioner and experience agile testers we have identified critical success factors. If agile testers and higher management give emphasis on these success factors and follow them then they can delivery successful product using agile methodology.

Team collaboration and Team management: For delivering successful project using agile methods Team collaboration and Team management is very important. Involvement of whole team is necessary during testing. If whole team will take responsibility then variety of skill, experience will participate and they can easily solve whatever any issue arise during testing. With the group of skilled programmers, test automation will not be a problem. If testing is a team priority then team design testable code and anyone from team should have access to every artefact which helps to resolve the problem early. Team management should help the team member to adopt team collaboration and managers should work as facilitator to team. Testers should participate in the planning meeting and tester should actively participate on that and provide their suggestions, feedback. Testers should help requirement engineer and business user if they struggle to define user stories.

Adopting Agile testing Mind set: If testers are moving from traditional methodology to the agile methodology project then they come with quality policy mind set and changing it, in which tester's should be proactive, creative, open to new idea and willing to take any new task takes time. In agile team testers and programmer work on parallel and both work as a team and help each other to deliver best possible product. Successful agile tester needs to continuously improve skills set. Learning new tools, reading new books, blogs, article, come up with new ideas, attending new conferences helps testers to improve their skill set. Adopting these skills needs to have a big change in the mind set and good training and proper coaching should be given to the tester before start of the development using agile methods.

Automated Unit, functional and regression Testing: Automation is a key for success of the agile testing. One important question comes again and again that can agile project get success without automated testing, maybe it can but as per our experience automation helps testing team to work upon the new ideas and use it in testing and try to break the code with different ways. In agile methods delivery happens in very short iteration, Automation of the Unit test cases, Functional test cases are very necessary. Iteration is having some part of the old code which is updated and regression testing plays very important role and it should be automated and executed frequently to delivery successful high quality code. For delivering successful agile project automation needs to be taken care from the beginning of the project. Putting effort in automation from start of the project is hard and sometime tester's feels it like big pain for them but team management should provide enough support in term of time, training and motivation to make it successful.

Emphasis on the feedback mechanism: Early feedback is one of the core agile value. Short iteration of the agile methods is designed to provide early feedback to the team. Testers should provide proper feedback to developers early on and take the feedback from the developers, requirement engineers and customers to improve the testing. Tester should provide automated test results, do the test result analysis and provide observation of the code quality and part of the code which has more defects. It helps developers to improve their code quality and reduce the defects in next iteration. Tester needs to learn skill to get feedback on their work. Issues and challenges of the testing which tester faced needs to be discussion in daily meeting and retrospectives talks. Suggestions should be always welcomed in agile methods and needs to be provided by each and every team members to make successful agile development.

Crate foundation of core practice: Every agile project needs to follow some standards practice to deliver high quality project.

Integration Testing: Source code management and successful integration testing is key of successful project. For testing successfully you need to know what you are testing, code should be present for the functionality which you want to test, code should be successfully deployed to the test environment. At least once in a day automation integration test needs to be executed, feedback should be given to success or failure of the build to the developers. Before starting of the project continuous integration process should be created.

Test Environments: Testing should be done in individual test environment. It should be controlled by the tester. In development environment testing should not be done. Testers must know what version of build deployed, which database schema they are using, who all are updating the schema or have update access of schema, is there any other process running on the test environment. Open source software can be used to create good automated test environment. If any problem is in the test environment then highlighting of this issue with the different forum is the responsibility of the tester and make sure environment is up and running.

Defect management: Every team feels time pressure, get quick fixes, and neglect refactoring. As code size increases it become more confusing, more bugs come and then defect management plays very important role. Test Team should work on defects aggressively and resolve them and remove them from their plate. They should provide proper comments with the defects so that it can easily reproduced.

- **Code and test one process**: As per the agile principles testers should involve throughout the iteration, whole development cycle to deliver high quality software. A tester needs to write test cases with the help of the example which customer provide to help the developer's to get started with the development.

Customer should provide acceptance criteria with each and every story and that need to be tested by the developer's and testers as well before delivering the code. Programmers should show the functionality which they have written to the testers and testers should show the unexpected behavior they found in testing. High collaboration between testers and developer's is required. Testers write more and more test cases as coding proceeds and programmer make them pass , tester validate to learn whether right value has been delivered to pass the test case or not. Iteration consists of quick, incremental test-code-test-code iterations.

Following benefits has been identified while using Agile testing over traditional testing:

- Many Critical defects identification in very early stage of the project development and resolution provided very early in the project
- Due to iterative testing cycles faster delivery of workable and usable are provided
- With the high customer collaboration frequent customer feedback received while giving demo of workable software
- Developer's and tester's collaboration improves overall quality of software
- High level of transparency of progress, costs, and quality of the software maintain which helps to provide quality delivery
- Emphasis is given to automation which helps long term savings and sustainable quality due to automation

IV. CONCLUSION

We have identified common challenges which are faced by the agile testers when they move from traditional methodology to agile methodology. Testers who work on the agile methodology play very critical role on successful delivery of the project. We have identified roles and responsibility of testers who works on the agile methods. We have suggested agile testing critical success factors which need to be taken care while working on the project which is using agile methodology.

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