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Prioritization in Scrum: Impact of Maturity of Product Backlog Item

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Abstract: *Requirements are the crucial part of software development. In the customers' viewpoint all the requirements are critically important to implement. However, it is impossible to implement all the requirements at once. Therefore, selection of correct candidate requirement to implement is necessary. Prioritization is the finest way to determine the correct candidate requirement, especially in scrum agile methodology. In scrum, there are different factors such as business value, importance, risk, time, cost and dependencies, which consider for prioritizing the product backlog items in a product backlog. However, prioritization with these factors has no mean until the requirements are immature. This research paper has been aimed to present the impact of maturity of product backlog item on prioritization through a PBIMM (Product Backlog Item Maturity Model). A product backlog of real project has been considered to visualize the concept of product backlog item maturity. A survey has been done to analyze the impact of bug, reusable component, refinement on maturity and prioritization of product backlog items. The survey has resulted that the maturity directly impacts the prioritization of product backlog item.*

Keywords: *Agile, Scrum, Prioritization, Product backlog, Maturity.*

1. Introduction

Software systems have become the backbone of almost all business operations. Advancement in technology and business needs force customer to evolve their project requirements day by day. Evolving requirements is a big challenge in software development. Agile methodology is the best solution to work with such evolving requirements. Scrum is one of the efficient agile methodologies to provide flexibility in development. Scrum follows incremental and iterative approach to provide delivery of valuable product features in several releases. Product backlog items which have to implement are prioritized. Prioritization is difficult and ongoing task in scrum because of evolving requirements. Ignorance of any crucial product backlog item can make the customer unsatisfied. Therefore prioritization process is the core activity in scrum and should be done carefully.

There are many factors which consider for prioritization such as business value, cost, dependencies, resources, and security. However, until the product backlog item is not mature enough to develop, prioritization has no mean.

For example Person A wants to reach at address "House number. 4123, X city, Y country". Let us suppose this is the requirement of person A. It seems very simple but actually it is not easy to reach at this destination. This is immature address because it doesn't contain complete information regarding destination. If the information is complete, like "House number, 4123, ABC street, near bus-stand, X city, Y country", then it becomes easy for "Person A" to select the route for destination. Similarly, during sprint execution development team apply efforts to complete a shippable small release. Selection of requirements to be

implemented in sprint is very crucial task. If the requirements are mature and small enough to complete in one sprint then it becomes easy to develop the shippable small release. Requirements will mature if it will complete in itself. Now it has been sure that the highly mature items should have high priority as compared to requirements having less maturity.

According to one of the agile principle, requirement should follow the INVEST (Independent, Negotiable, Valuable, Estimable, Testable) criteria to be include into sprint. Product backlog item should be small enough to be able to implement in one sprint. This INVEST criteria can be achieve by refinement of product backlog item during sprint planning meeting (formal) and refinement meeting (informal).

This research paper has been intended towards the maturity of product backlog item. Therefore, the purpose of this research paper is:-

- To include the factor "Maturity of product backlog item" for prioritization.
- To evaluate the impact of bug, refinement and reusable component on maturity of product backlog item.

The paper has been structure into 6 sections. Section 2 is dedicated to explain the basic terminologies used in this research paper. Related work and proposed work has been discussed in section 3 and 4 respectively. Section 5 is given to discuss the results. Conclusion and future work has been given in section6.

2. Basic Concepts

In this section, the basic terminologies have been discussed which are using widely in this research paper.

2.1 Product Backlog and product backlog item

Product backlog is one of the crucial artifacts in scrum. It is the collection of prioritized product backlog items. Product backlog are the requirements which can be new feature, bug, enhancement and technical work. Microsoft excel is the simple tool for management of product backlog. However, there are so many online and special tools are also available for management of product backlog.

Product backlog items are the constituent of product backlog. User-story is the excellent way to write the product backlog item. For example: -

As a user, I want a login screen on front of application so that I can securely use my account.

2.2 Prioritization

Prioritization is the process of determining the inclusion of candidate requirement in the certain release [21]. Value-based prioritization is the core principle of scrum.

There are different prioritization techniques which consider different factors for prioritization. Scrum uses Value-Based prioritization technique to arrange the product backlog items. Product backlog items which are highly valuable and important for customer are kept at the top of product backlog item. Along with business value of product backlog item other factors such as dependencies, risk, cost, availability of resources are also taken into account during prioritizing.

3. Related Work

Most important research papers have been summarized in this section to get an overview about research state of the requirement engineering and prioritization in scrum.

Requirements illustrate the software product. The evolving business needs and technology has triggered the user requirements to change almost every day. Traditional methodology is unable to cope up with changing requirement. However, scrum is one of the agile methodologies that emerged as flexible approach which can easily cope up with changing requirement. Requirement engineering with changing requirements is a difficult task. [15]

Selection of group of important requirement to be implemented in iterations is achieved by continuous requirement prioritization. R.H.AL_Ta'ani et al. has proposed a conceptual framework that outlines the factors and activities involved in the requirement prioritization process. [7]

Work allotment and issues raised in self-organizing team management has been addressed by M.V.Mohamed during the implementation of scrum in an online project. Increase in the number of sprints with new requirements is one of the crucial issues that have been identified. [2]

J.Savolainen et al. has discussed learning in two agile transition processes. Based on experience they concluded that agile processes can be used in embedded software development. Varying size of user requirements, the role of system requirements and architecturally significant requirements are included as challenges. [20]

A.Batool et al. has proposed a conceptual framework. The emphasis of conceptual framework is to make the requirement process more effective. This framework also minimizes the complexities and barriers faced during the traditional requirement engineering process. [14]

N.Chugh and A.D.Mishra provides a solution to requirements related issues in agile environment and proposes an approach which integrates four layered

approach to NFR with Agile Requirement Engineering that is helpful to improve requirement analysis process which would help in the prioritization of user stories. It also describes in detail the factors that could be considered for prioritization of user stories. [10]

A.Iqbal et al. has analyzed AHP (Analytical Hierarchical Process), SERUM (Software Engineering Risk: Understanding and Management), EVOLVE and VOP methods that are used for requirement prioritization with the different factors such as cost, value, risk, benefit, dependency constraint etc. They concluded that there is no single technique that addresses all these factors. The proposed approach addresses all the factors for prioritization. After dependency constraint check the requirements reach at second step where they prioritized by using VOP. The output of this step is a set of requirements that should be implemented in current release. However, there are other factors too that should also considered. Implementation effort, resource constraint and benefit factor addresses by the step three, four and five. [25]

R.popli et al. has proposed importance and effort related factors. Prioritization of user-stories is highly dependent on the value of these factors. The relation of importance and effort has been calculated to decide the priority of user-story. They suggested to find some other factors which can impact the prioritization. [1]

4. Proposed Work

Product backlog management is very crucial and challenging. Product backlog items should be mature to be included into sprint backlog. A product backlog item will said to be fully matured if it satisfies the INVEST criteria. INVEST is acronym for I-Independent, N-Negotiable, V-Valuable, E-Estimable, S-small, T-Testable [8].

4.1 Product Backlog Item Maturity Model (PBIMM)

Product backlog item maturity model has been proposed to enhance the prioritization technique by adding a context factor called maturity of product backlog items. Product Backlog Item Maturity Model (PBIMM) also describes the growth of product backlog item in product backlog. As the product backlog item discuss among scrum team its growth goes on increase and its size becomes decrease so that it can be developed in days rather than months. It has been shown in Figure 1.

1) Level 1: Initialization

At this level the product owner collect the users' requests as product backlog items. User-story technique is used to write product backlog item.

Product backlog items are very big called epic. Epics require months to develop therefore cannot be included in sprint backlog.

No scrum event involve at this level. Only informal meeting takes place in product owner and customer.

User-stories are vague at this level.

2) Level2: Refined

Team members and product owner discuss the product backlog item. Discussion is related to effort and time required to develop the user-story. Refinement will repeat until development team agreement. User can add new stories at this level. In scrum vertical technique is used to split the user-stories.

At this level, the roles involved are product owner, team member, scrum master and customer.

3) Defined and Managed

At this level the product backlog items are complete and independent. These product backlog items are small and independent enough and ready to be discuss for the tasks require implementing.

At this level sprint planning meeting will held to manage the defined product backlog item. Product backlog item with high priority is selected and discussion are held to identify the tasks require to implement that product backlog items.

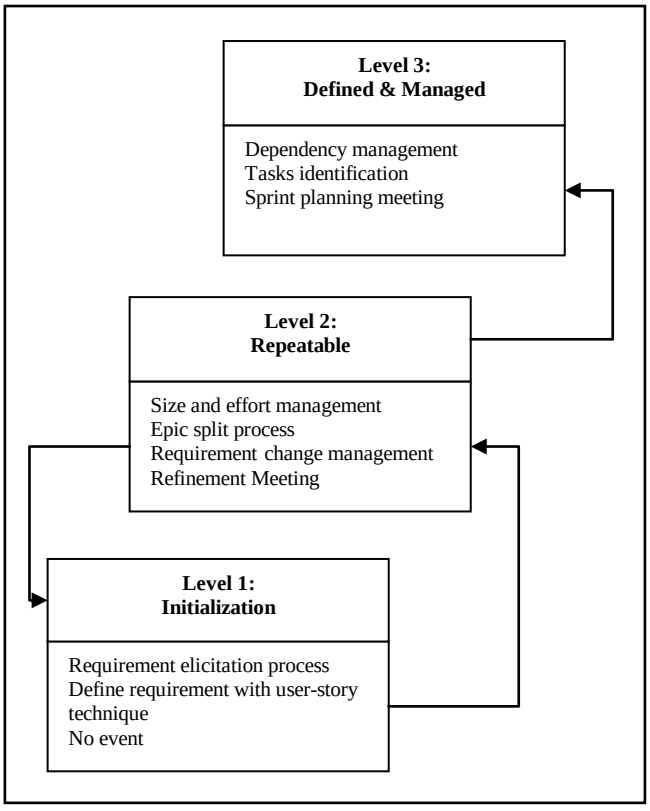

Figure 1: Product Backlog Item Maturity Model

4.2 Factors for Maturity

Three factors have been identified that can impact the maturity of product backlog item. These three factors are: -

1) Refinement

Refinement is the process of reviewing and revising product backlog item to ensure greater clarity and understandability in it. During refinement process team discus the product backlog item to update product backlog item description and acceptance criteria etc. Product backlog item should be refined enough to get include into upcoming sprint.

Priority of product backlog item will be high if it is refined enough.

Effect of Refinement on Maturity

$$M_p \propto R \quad (1)$$

Where:

R : Refinement

2) Bug

Bug include in product backlog item if it arise later in project. The prioritization of bug is also necessary as user-stories. The priority of bug would high if it is associated with high risk of its severity and hence can damage other functionality.

Effect of Bug on Maturity

$$M_p \propto B \quad (2)$$

Where:

B : Bug.

3) Reusable Component

Reusable component helps to reduce effort, development cost and save time. It will be more beneficial if reusability concept is used for selecting requirements for implementation in scrum. Reusable component can be code, templates, functions, framework, procedures, and objects.

Effect of Reusable Component on Maturity

Maturity of product backlog item will increase if the reuse component exists in repository.

$$M_p \propto R_c \quad (3)$$

Where:

R_c : Reusable Component.

4.3 Effect of maturity on Prioritization

Priority of product backlog item is directly proportional to maturity of product backlog item.

$$Piority_p \propto M_p \quad (4)$$

4.4 Proposed Algorithm for Priority

Input: Let us suppose that P is product backlog item, I is importance, T is type of product backlog item, M is the Maturity of P, R_{comp} is Reusable component which can have two values 1(exists) and 0 (not exists), E_{in} is effort to integrate the reusable component, E_{eff} is effort to find component, R_l is level of refinement, E_{efr} effort of refinement, E_{effix} is estimated effort to fix the bug, E_{efi} is estimated effort to find the bug.

Output: *Pri*

Algorithm:

Step 1: set P$\leftarrow P_i$ $\forall\ i$=1, 2, 3…….n

Step2: set I$\leftarrow I_i$

Step3: set T $\leftarrow T_j$ j=New Feature, Bug

Step4: if (T==New Feature) then

```
{
  if (R_comp==1) then
  {
  M= E_in / E_eff      ∀ E=1,2,3……..24
  }
  else{
     M= R_l / E_efr          l=1,2,3.
  }
}
else{
  M= E_effix / E_efi
}
```

Step5: Pri_i =I/M

Step6: End

5. Evaluation and Results

To evaluate the PBIMM, we have been considered a real project, that is, SRIS (Student Result Information System). To create a product backlog of SRIS, MS Excel has been used. In the table 1, only three columns of product backlog have been considered.

Table 1: Product Backlog of SRIS

ID	*Type*	*Product Backlog Item*
A1	Feature	As a user, securely use the system with login and logout functionality.
B1	Feature	As a user, I want to access student
C1	Feature	As a user, I want to access student's academic result information.
D1	Feature	As a user, I want to add/update/delete batch..
D2	Feature	As a developer, I want to create a database for batch.
A2	Feature	As a user, I want to be able to reset my password.
B2	Feature	As a developer, I want to create a registration functionality
B2.1	Feature	As a developer, I want to create a register database
B3	Feature	As a developer, I want to create a view student details functionality.
B4	Feature	As a user, I want to be able to update student details.
C2	Feature	As a user, I want to record the result of all students of a semester.
C2.1	Feature	As a developer, I want to create database where result can record.
E1	Bug	As a user, I want to sometimes I get a error "values cannot be inserted" when
E1.2	Bug	As a Tester, I analyze that when any cell remain selected it gives error

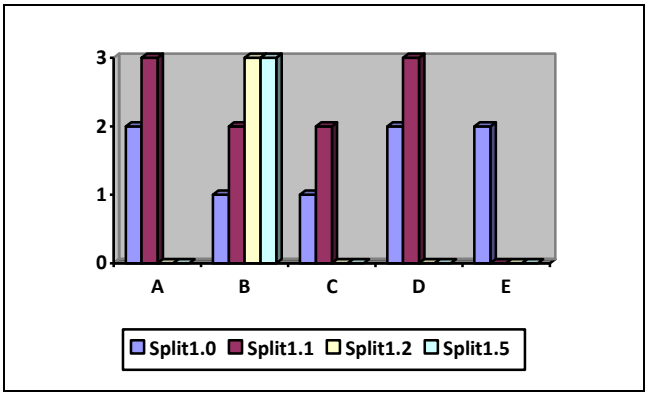

Figure 2(a): Maturity of product backlog of SRIS

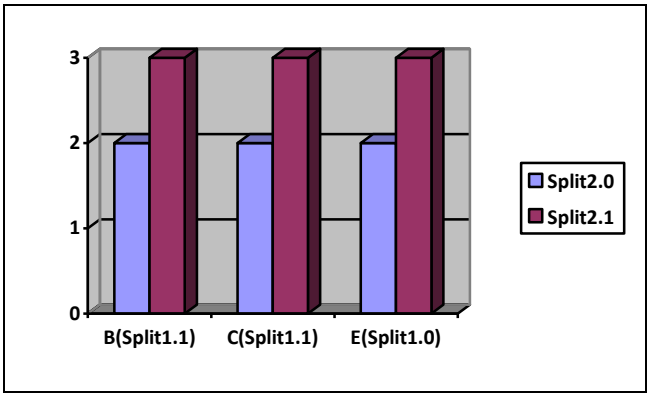

Figure 2(b): Maturity of Product backlog of SRIS

In figure 2(a) and 2(b), Levels of Maturity are plotted on X-axis while requirements are plotted on Y-axis.

5.1 Survey Results summery

An email survey through questionnaire has been done to evaluate the impact of three factors that are discussed in section 4.2. The summery of survey has been shown in figure 3 and figure 4. Number of respondents are plotted on Y-axis while Factors are plotted on X-axis of bar chart.

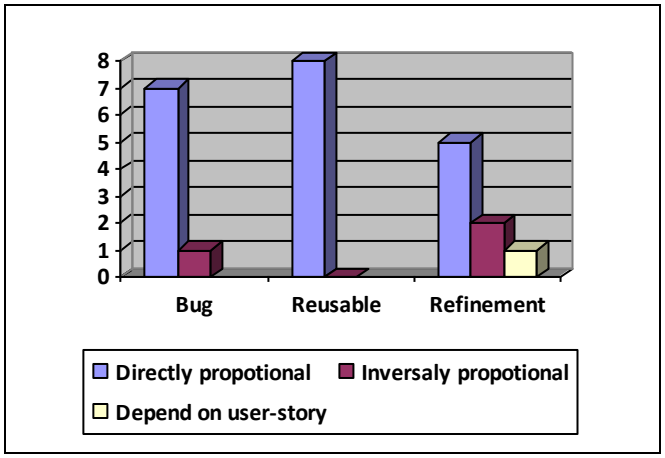

Figure 3: Impact of factors on maturity of product backlog item

Table 1: Summery of survey w.r.t. our assumptions

Factors	*Our Assumption*	*Number of Respondent Agreed*
Reusable Component	$M_p \propto Rc$	8(100%)
Refinement	$M_p \propto R$	5(62.5%)
Bug	$M_p \propto B$	7(87.5%)

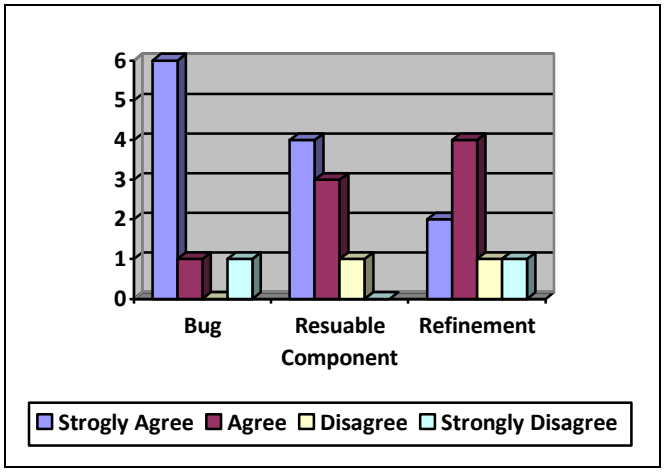

Figure 4: Impact of factors on priority of product backlog item

Table 2: Summery of survey w.r.t. our assumptions

Factors	*Our Assumption*	*Number of Respondent Agreed*
Refinement	$P \propto Rc$	6(75%)
Reusable component	$P \propto R$	7(87.5%)
Bug	$P \propto B$	7(87.5%)

5.2 Results with algorithm

In Figure 5 results of proposed algorithm has been shown. In this graph Y-axis represent the product backlog items shown in Table 1 and X-axis represents priority of product backlog items.

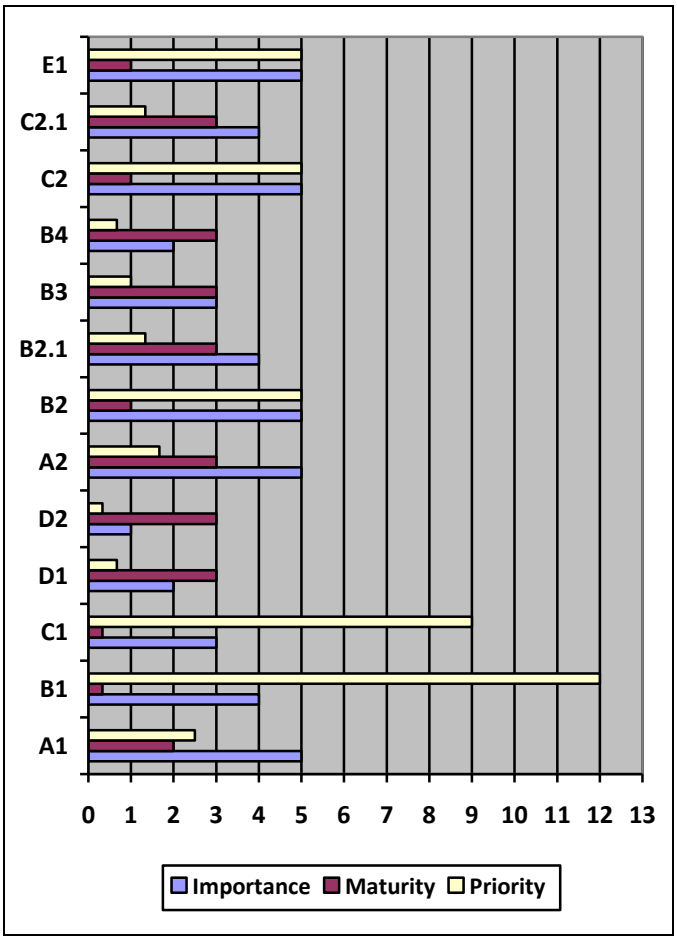

Figure 5: Priority of Product Backlog Items of SRIS

6. Conclusion and future work

In this paper, the impact of maturity factor on prioritization is proposed. From the survey summery, it has been concluded that the prioritization of user-story is directly impact by its maturity level. Therefore, an algorithm has proposed with the consideration of maturity of three factors such as bug, refinement and reusable component. By the importance to maturity ratio it has concluded that priority of product backlog items increases if the importance of product backlog item is high and its maturity is less. So that, more information can collect as early as possible.

This is approach is applicable for small level projects. In future work, other factors which impact the prioritization can also be considered.

References

[1] Rashmi Popli, Naresh Chauhan, and Hemant Sharma, "Prioritising User Stories In Agile Enviornment," in *Issues and Challenges in Intelligent Computing Techniques (ICICT), 2014 International Conference* , Ghaziabad , 2014, pp. 515 - 519.

[2] M. Varusai Mohamed, "Implementation of Scrum Framework of Agile Methodology for an Online Project," *International Journal of Emerging Technology and Advanced Engineering*, vol. 4, no. 7, pp. 435-440, July 2014.

[3] Aditya Falodiya and Ajay Jain, "A Decision Engineering Framework for Scrum Autonomy," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 3, no. 1, pp. 1-8, January – February 2014.

[4] V.Nithya, S.Lavanya, and G.Gokila Deepa, "To Ameliorate Quality in Software Development Projects By Using Contemporary Agile Bug Tracking System," *International Journal of Emerging Technology and Advanced Engineering*, vol. 3, no. 3, pp. 197-201, March 2013.

[5] Nirmal Pradeep Jeldi and Venkata Krishna Mohan Chavali, "Software Development Using Agile Methodology Using Scrum Framework," *International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013*, vol. 3, no. 4, pp. 1-3, Apr. 2013.

[6] Varun Gupta, D. S. Chauhan, Kamlesh Dutta, and Chetna Gupta, "Requirement Reprioritization: A Multilayered Dynamic Approach," *International Journal of Software Engineering and Its Applications*, vol. 7, pp. 55-64, 2013.

[7] Rami Hasan AL-Ta'ani and Rozilawati Razali, "Prioritizing Requirements in Agile Development:A Conceptual Framework," in *The 4th International Conference on Electrical Engineering and Informatics (ICEEI 2013)*, vol. 11, 2013, pp. 733 – 739.

[8] Luigi Buglione and Alain Abran, "Improving the User Story Agile Technique Using the INVEST Criteria," in *Joint Conference of the 23nd International Workshop on Software Measurement (IWSM) and the Eighth International*, Mensura, 2013, pp. 50-53.

[9] Sukhpal Singh and Inderveer Chana, "Enabling Reusability in Agile Software Developmen," *International Journal of Computer Applications*, vol. 50, no. 13, pp. 33-40, July 2013.

[10] Nupur Chugh and Aditya Dev Mishra, "Assimilation of Four Layered Approach to NFR in Agile Requirement Engineering," *International Journal of Computer Applications*, vol. 78, no. 5, pp. 25-28, Sep. 2013.

[11] Neha Sadana, Surender Dhaiya, and Manjot Singh Ahuja, "An Empirical Review On Factors Affecting Reusability Of Programs In Software Engineering,"

International Journal of Computing and Corporate Research, vol. 3, no. 4, July 2013.

[12] Chhavi Malhotra and Anuradha Chug, "Agile Testing with Scrum-A Survey," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 3, no. 3, pp. 452-459, Mar. 2013.

[13] Heba Elshandidy and Sherif Mazen, "Agile and Traditional Requirements Engineering: A Survey," *International Journal of Scientific & Engineering Research*, vol. 4, no. 9, pp. 473-482, Sep. 2013.

[14] Asma Batool, Yaser Hafeez, Sohail Asghar, Muhammad A. Abbas, and Muhammad S. Hassan, "A Scrum Framework for Requirement Engineering Practices," in *Proceedings of the Pakistan Academy of Sciences 50 (4)*, 2013, pp. 263-270.

[15] Vadivelan Sivanantham. (2012, Jan.) Scrum Alliance. [Online]. https://www.scrumalliance.org/community/articles/2012/january/is-documentation-really-wasted-effort

[16] Saravana. K.M, G. N. Basavaraj, Rajkumar, and Dr. A. Kovalan, "Case Study On Agile User Stories Prioritization Using Imaginative Standard," *International Journal of Engineering Research and Applications (IJERA)*, vol. 2, no. 5, pp. 472-480, 9-10 2012.

[17] Jason Moccia. (2012, Feb.) Scrum Alliance. [Online]. https://www.scrumalliance.org/community/articles/2012/february/agile-requirements-definition-and-management

[18] Alexandre Yin, Soraia Figueiredo, and Miguel Mira da Silva, "Scrum Maturity Model - Validation for IT organizations‟ roadmap to develop software centered on the client role," in *The Sixth International Conference on Software Engineering Advances*, 2011, pp. 21-29.

[19] Lv Yi, "Manager as Scrum Master," in *Agile Conference*, Salt Lake City, UT, 2011, pp. 151-153.

[20] Juha Savolainen, Juha Kuusela, and Asko Vilavaara, "Transition to Agile Development - Rediscovery of Important Requirements Engineering Practices," in *18th IEEE International Requirements Engineering Conference*, Sydney, NSW, 2010, pp. 289-294.

[21] Andrea De Lucia and Abdallah Qusef, "Requirements Engineering in Agile Software Development," *journal of emerging technologies in web intelligence*, vol. 2, no. 3, pp. 212-220, Aug. 2010.

[22] Z.Racheva, M.Daneva, K.Sikkel, and A.Herrmann, "Do we Know Enough about Requirements Prioritization in Agile Projects:," in *Requirements Engineering Conference (RE), 2010 18th IEEE International*, Sydney, NSW, 2010, pp. 147 - 156.

[23] Chetankumar Patel and Muthu Ramachandran, "Story card Maturity Model (SMM): A Process Improvement Framework for Agile Requirements Engineering Practices," *Journal of Software*, vol. 4, no. 5, pp. 422-435, july 2009.

[24] Malik Hneif and Siew Hockow, "Review Of Agile Methodologies In Software Development," *International Journal of Research and Reviews in Applied Sciences*, vol. 1, no. 1, pp. 1-8, october 2009.

[25] Aaqib Iqbal, Farhan M. Khan, and Shahbaz. A. Khan, "A Critical Analysis Of Techniques For Requirement Prioritization And Open Research Issues," *International Journal of Reviews in Computing*, pp. 8-18, 2009.

[26] Zornitza Racheva, Maya Daneva, and Luigi Buglione, "Supporting the Dynamic Reprioritization of Requirements in Agile," in *Software Product Management, IWSPM '08 Proceedings of the 2008 Second International Workshop on Software Product Management*, Barcelona, Catalunya, 2008, pp. 49 - 58.

[27] Lan Cao and Balasubramaniam Ramesh, "Agile Requirements Engineering Practices: An Empirical Study," *Software, IEEE*, vol. 25, no. 1, pp. 60 - 67, Jan.-Feb. 2008.

[28] Donald Firesmith, "Prioritizing Requirements," *JOURNAL OF OBJECT TECHNOLOGY Journal of Object Technology*, vol. 3, no. 8, September-October 2004.

[29] Matti Kokkola, "Arranging defect management in an agile development process," *SEMINAR IN SOFTWARE ENGINEERING, SPRING 2004*, 2004.

[30] Pekka Abrahamsson, Juhani Warsta, Mikko T. Siponen, and Jussi Ronkainen, "New Directions on Agile Methods:A Comparative Analysis," in *International Conference on Software Engineering*, Portland,Oregon, USA, 2003.

[31] Karlsson Joachim and Kevin Ryan, "A Cost–Value Approach for Prioritizing Requirements," *Software, IEEE* , vol. 14, no. 5, pp. 67 - 74, Sep/Oct 1997.