

ENHANCING AGILE DEVELOPMENT WITH SECURITY INTEGRATION: INTRODUCING THE HSSCRUM FRAMEWORK FOR OPTIMIZED AND SECURE SOFTWARE DEVELOPMENT

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ABSTRACT

We proposed an agile software process model with security integration. It is known as “HSScrum” framework that is an integration of traditional Scrum model being used widely as process model for software development and a security process which is hybrid and flexible to leverage productivity and optimize the development process. HSScrum has Scrum based functions with security provisioning and a novel security process that is seamlessly integrated with the Scrum model to realize HSScrum. As the traditional Scrum with security provisioning contains necessary phases in the System Development Life Cycle (SDLC), it needs integration of security process that is more beneficial and ensures that the development process is optimized. HSScrum realizes this objective with the loosely coupled (in the sense of flexibility) security process integrated with Scrum with security provisioning. HSScrum has a risk identification process that not only finds risk and rank the user stories based on risk, it also has provision to know whether risks are specific to a backlog item or multiple backlog items (cross-cutting security concern). The mapping and delegation process has mapping of security concerns to backlog items and also a hybrid approach in delegation is preferred. Based on the security expert availability and cost analysis, the delegation may be immediate delegation or deferred delegation. This brings about balance between cost and faster intermediate deliverables to client. Our empirical study has revealed its faster convergence and security capability.

Keywords : *Agile Process Model, Software Engineering, Security Framework, Agile With Security, Software Process Mode*

1. INTRODUCTION

Software engineering is the discipline that is required for industries of all domains. Though software development approaches were initially based on trial and error basis, there has been substantial improvement in the field of software development. Software engineering has emerged with many matured processes that are systematic in nature and globally usable. In the process of evolution of software development phenomena, there have been several process models that came

into existence. They include waterfall model, spiral model, V model, iterative and incremental model and so on. However, the list is incomplete without including agile process models such as Scrum, Extreme Programming (XP), Adaptive Software Development (ASD) and Dynamic Systems Development Method (DSDM).

The agile models are based on agile principles that lead to higher customer satisfaction, flexibility in incorporating new changes, frequent delivery of working software, opportunity to get live

customer feedback, developers and other stakeholders working together, sustainable development, continuous improvement and efficient usage of human potential [1]. Each agile process model has its approach but followed agile principles and practices. Scrum[22] is one such agile process model that maximizes communication and sharing of information and knowledge besides minimizing overheads. It has process patterns such as backlogs that reflect prioritized list of requirements, sprints (work units), Scrum meetings (characterized by quick and efficient meetings that do not waste time) and demos (intermediate deliveries to customers, taking feedback and evaluation) [3].

Over a period of time, there is research carried out on agile process models with security integration. It does mean that the sprints need to consider security requirements (non-functional) as well [4]. In this paper Scrum is considered as it is widely used by software industry. Since every agile process model has its own approach, security integration is to be done accordingly. The existing security models that are used along with Scrum suffer from either the cost increment due to the presence of security expert in agile team or delay in deliverables when special security sprint is used for security implementations. HSScrum overcomes this problem with hybrid delegation approach that brings about flexibility into the development process that involves Scrum with security provisioning and security process. It has provision for efficient delegation and security implementation in such a way that it strikes balance between cost and faster deliverables to customer. HSScrum thus optimizes implementation of non-functional requirements such as security in the agile process model.

The remainder of the paper is structured as follows. Section 2 reviews literature on existing agile models and security. Section 3 presents the proposed HSScrum framework. Section 4 presents experimental results. Section 5 concludes our work and gives scope for future work.

2. RELATED WORK

This section reviews literature on different aspects of agile models and importance of secure life cycle. Rashina et al. [1] explored the utility of agile model, its rise in the course of time and evolution process of the same. They studied different variants of agile model came from different researchers over time. Sibonile et al. [2]

investigated on software development procedures that consider security principles as well. Danilo et al. [3] proposed an integrated agile process model for developing mobile applications. It has better features for mobile application development. Özcan-Top et al. [4] investigated on software regulations pertaining to mobiles and the agile process model dynamics. Karina et al. [5] focused on the requirements engineering involved in agile process model. Arcos-Medina et al. [6] studied the software quality aspects that can be incorporated with agile process models. Woubshet et al. [7] discussed about rapid development possibilities with agile models and also procedures to manage quality requirements. Dulhare U.N. et.al [8] provide a map reduce framework infrastructure for large data Muhammad et al. [9] opined that in cloud computing environment, application development can follow agile process models while Aslam et al. [10] and Patanakul et al. [11] focused on agile model transition from time to time and application to application.

Christian et al. [12] focused on the technology innovations and agile model. Particularly, they found that smart contract development associated with blockchain technology can be done using agile models. Shadi et al. [13] discussed about cloud security engineering and the utility of a software process model. Valentina et al. [14] investigated on the concept of security by design and incorporated procedures to assess level of security with qualitative research. Karhapää et al. [15] explored different strategies involved in quality requirements in agile process models. Other significant contributions include quality aware agile model [16], pros and cons of agile models [17], scrum advantages [18], process model for DevOps development [19], intelligent software engineering [20] and regression testing with agile [21]. From the review of literature, it is observed that there is need for agile mode with security integration. [23],[24],[25] they found that smart contract development for anomaly detection and classification in the IIoT environment. [26], [27] They investigated the concept of security using machine learning and deep learning methods for malware detection, as well as android malware detection with classification based on hybrid analysis and N-gram feature extraction. [28] Comparative Analysis on Deep Learning Models for Detection of Anomalies and Leaf Disease Prediction in Cotton Plant Data. [29] Rumour Detection Model for Political Tweets Using ANN. [30] A Machine Learning Framework for Automatic Detection of Malware.

[31] Innovative Deep Learning-Based Medical Report Analysis for Timely Diagnosis and Improved Healthcare.

We proposed a framework known as HSScrum. It is meant for agile based software development process with flexible and hybrid approach towards security integration into traditional Scrum which is one of the agile models.

3. PROPOSED FRAMEWORK

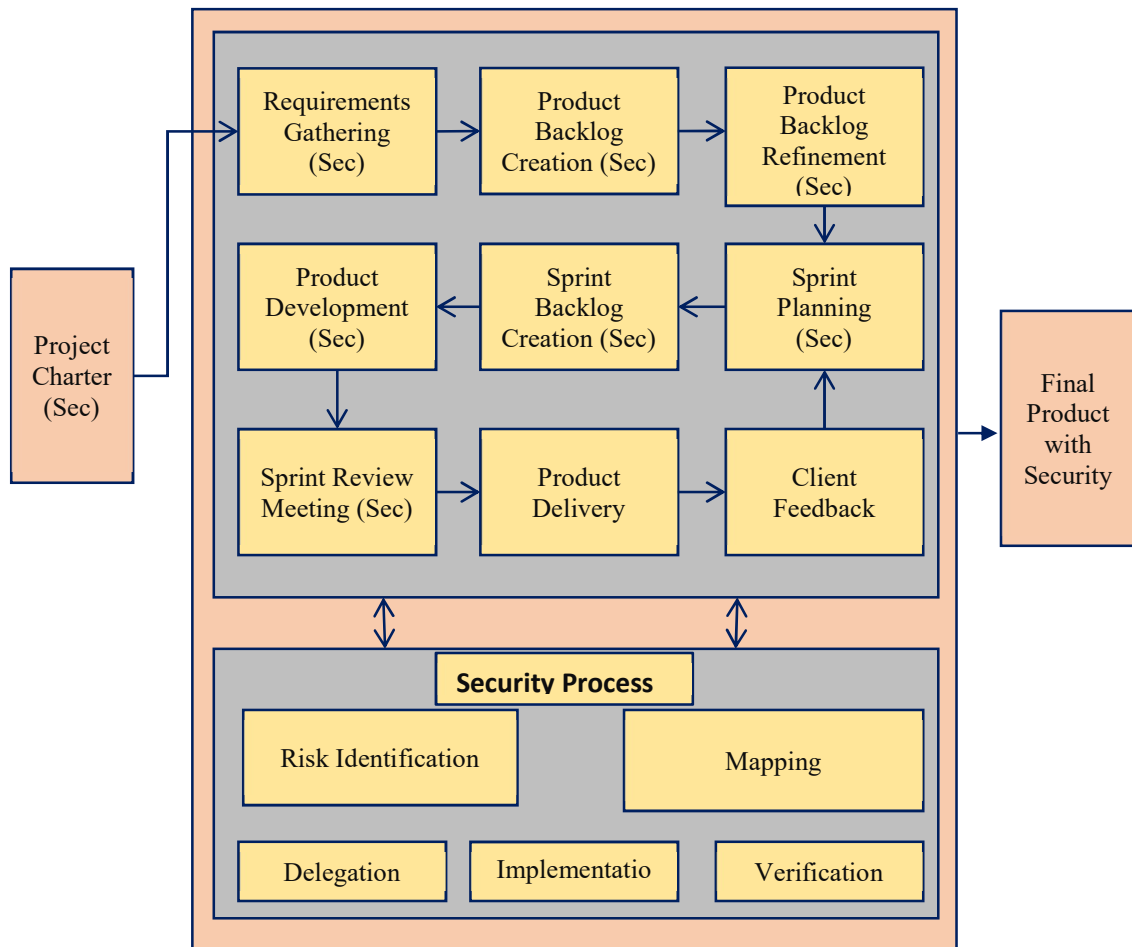


Figure 1: Proposed framework known as HSScrum

Referring to Figure 1, it illustrates the overview of proposed framework HSScrum that has traditional Scrum functionalities and additional security process that is integrated with the agile model. The integration has several novelties such as provisions for delegation (immediate / deferred), mapping and verification. It also considers the discrimination of a security concern to be either specific to a backlog item or cross-cutting concern across many backlog items. It has provision for requirements gathering that also includes security aspects, product backlog creation, product backlog refinement, sprint planning, sprint backlog creation, product development, sprint review meeting, product delivery to customer, getting customer feedback, and continue the cycle

with sprint planning and implementation. This process continues for all the sprints. However, the HSScrum has provision for security implementation with a hybrid approach that supports both immediate delegation or deferred delegation based on the availability of security expert in the agile team and based on cost analysis as the presence of security expert incurs more cost to the development process. This hybrid approach brings about flexibility without compromising at fulfilling security requirements. The security process involves security risk identification in all user stories, mapping them to sprint/backlog items, delegation with a hybrid approach, implementation and verification.

Figure 2, shows risk identification process associated with the HSScrum. It takes all user stories of Scrum (agile) process model and analyses them to ascertain the details of the user stories that are associated with security concerns. Once user stories that have security concerns are marked, there is an iterative process involved in the risk identification process. It takes each user story with security concerns, performs risk analysis and rank user story based on security risk. By the end of the iterative process, there is a list

of ranked user stories that are having security risks associated. Then another iterative process is initiated to identify whether security risks are specific to backlog item or cross-cutting concern across backlog items. Each ranked user story is taken and analysed to know whether the security risk is associated with one specific backlog item or multiple backlog items (cross-cutting). If the risk is specific to one backlog item, only that particular user story is updated, else multiple user stories are updated.

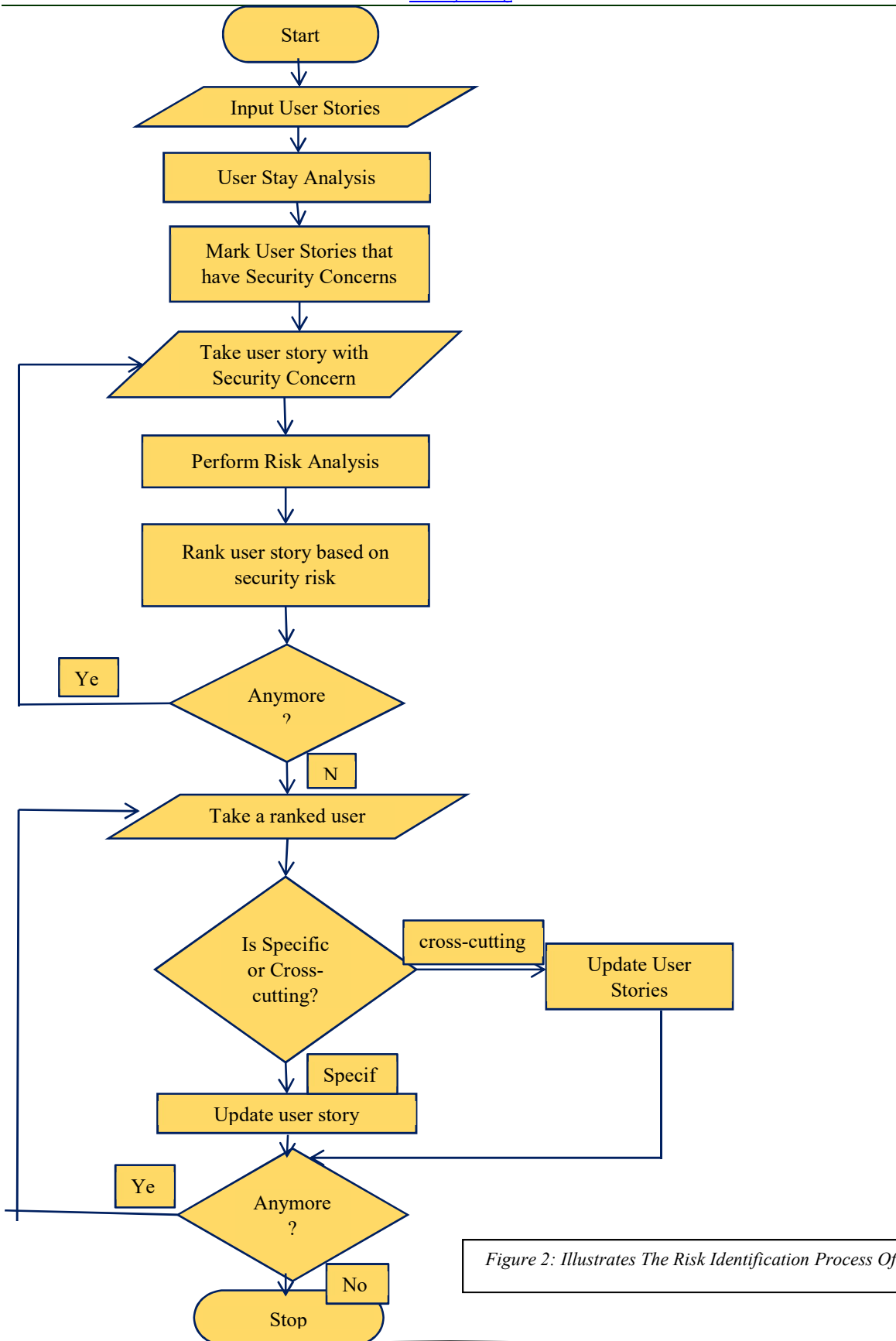


Figure 2: Illustrates The Risk Identification Process Of Hsscrum

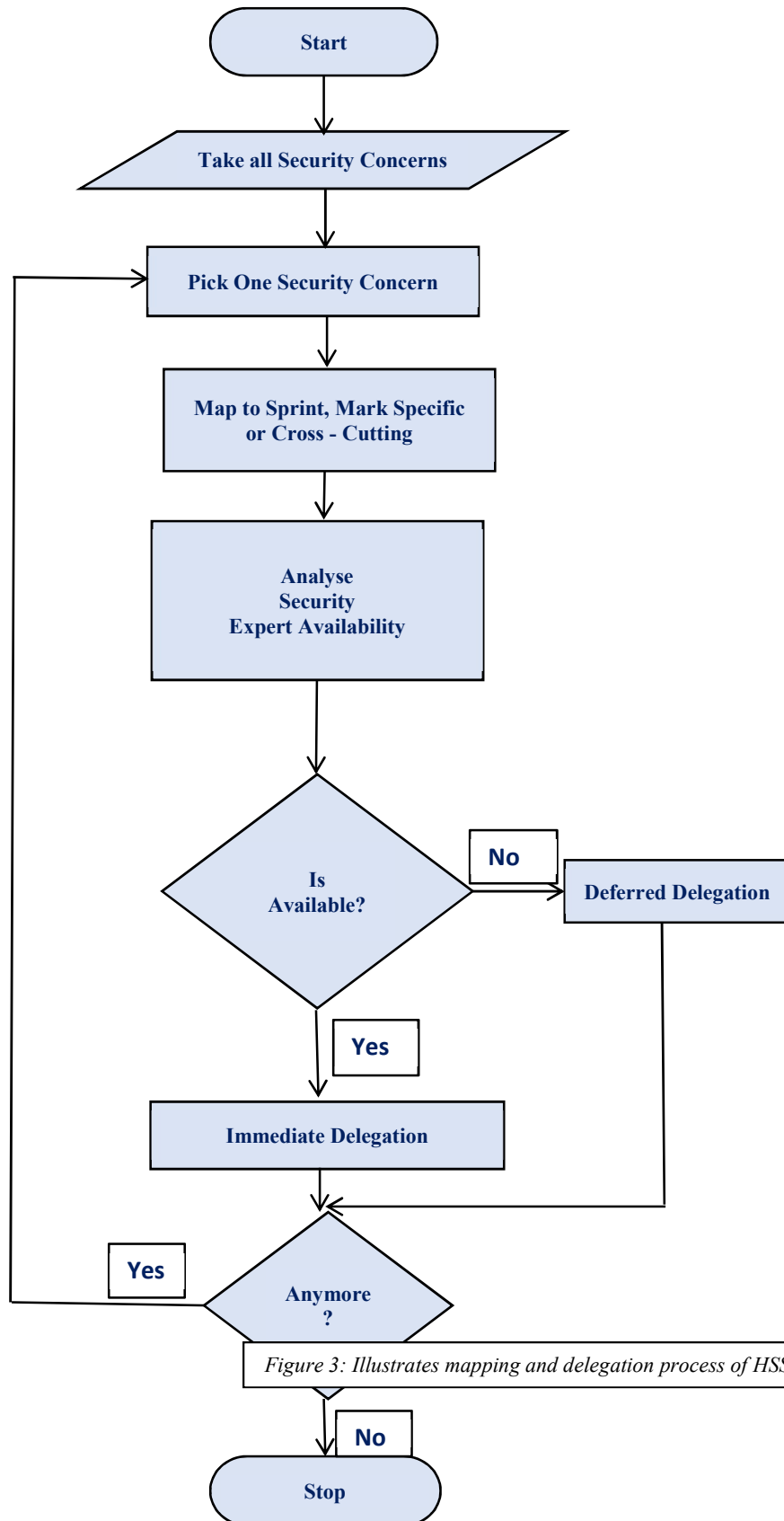


Figure 3: Illustrates mapping and delegation process of HSScrum

Figure 3 shows mapping and delegation process as part of security process in the HSScrum. It takes all security concerns and starts an iterative process for each concern. Each security concern is mapped to specific sprint and also marked to know whether it is specific or cross-cutting. An important process involved in this is the provision for flexible delegation of implementation work. If there is security implementation mandatorily associated with every sprint, it incurs higher development costs. If the security concerns are delegated to separate sprint, it causes delays in deliverables. In order to overcome this approach, a more flexible and suitable approach is included in HSScrum. It has provision for analysing security expert availability and the cost incurred

and allow both models such as immediate delegation and deferred delegation. This tuning helps to have balance between incurring more costs and faster delivery of intermediate outcomes to customer.

4. EXPERIMENTAL RESULTS

We implemented a case study application known as Vehicle Registration Process Monitoring (VRPM) which can be used by RTO office in order to track vehicle registration process and status. This system is implemented with proposed agile model and incremental models. Important observations are recorded.

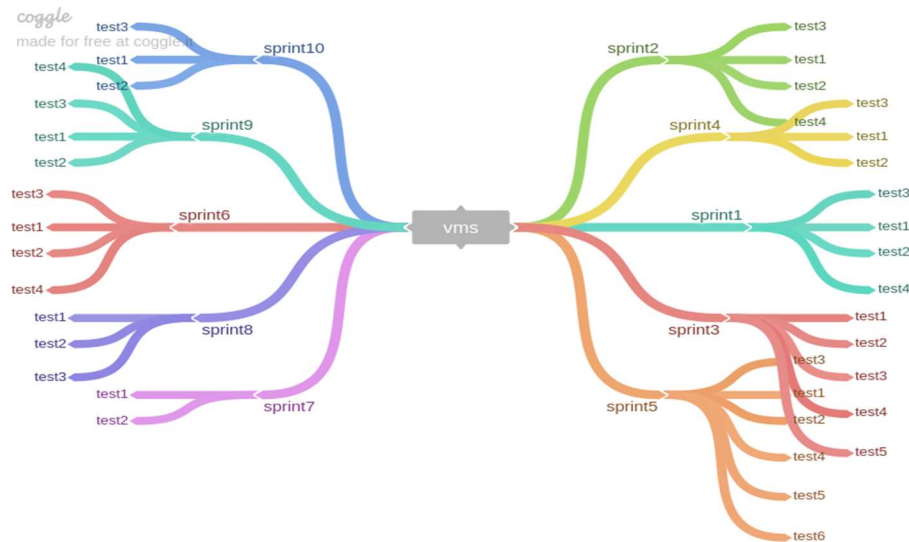


Figure 4: Shows Mind Map Of Tasks As Per Proposed Agile Model

As presented in Figure 4, the proposed agile model is applied to develop VRPM system and its advantages over traditional incremental models are observed. It has 10 sprints and mind map is

provided for all sprints. When compared with traditional incremental models, the proposed HSScrum model could provide many advantages.

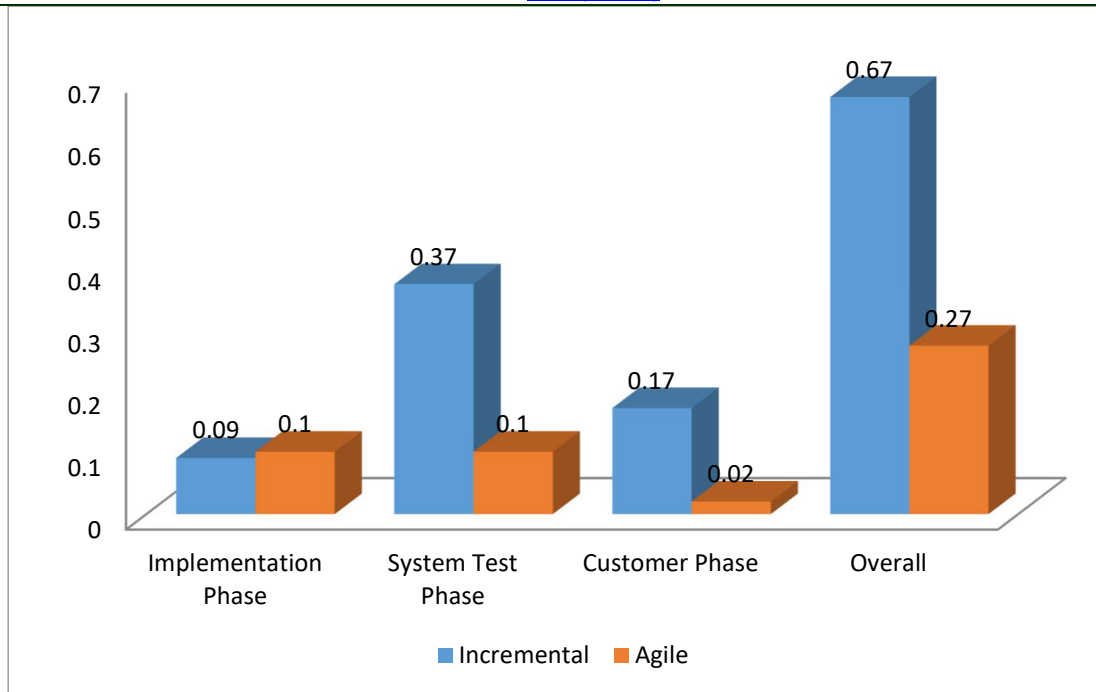


Figure 5: Risk Identification Dynamics At Various Phases Of Development

As presented in Figure 5, risk identification is done as per the procedure presented in Section 3 of this paper. The risk identification is made at different phases of the development. It is observed

that the proposed model has significant advantage in risk identification and improving prototypes in agile model.

Table 1: Performance Comparison In Terms Of Productivity

Sprint #	Number of Days			
	Testing Time of Incremental Model	Testing Time for HSScrum	Productivity of Testing	Productivity of Delivery
1	7	6	1	1
2	10	8	2	2
3	11	8	3	3
4	11	8	3	3
5	11	8	3	3
6	11	8	3	3
7	11	8	3	3
8	11	8	3	3
9	11	7	4	4
10	11	7	4	4

As presented in Table 1, there is productivity improvement evident with HSScrum in terms of testing and also delivery. Observations are made with 10 sprints. Each sprint has its testing time As presented in Table 2, the proposed agile model is found to have benefits in terms of productivity.

measured using incremental model and also proposed agile model. The proposed model outperformed existing model.

Table 2: Advantages Of The Proposed Agile Model

Sprint	Time Saved in Development (hours)	Time Save in Testing and Delivery (hours)	Total Productivity (hours)	Cost Saving (in Dollars)
1	2	4	6	108
2	1	5	6	108
3	1	5	6	108
4	3	4	7	126
5	2	5	7	126
6	1	6	7	126
7	2	7	9	162
8	3	6	9	162
9	3	6	9	162
10	2	7	9	162

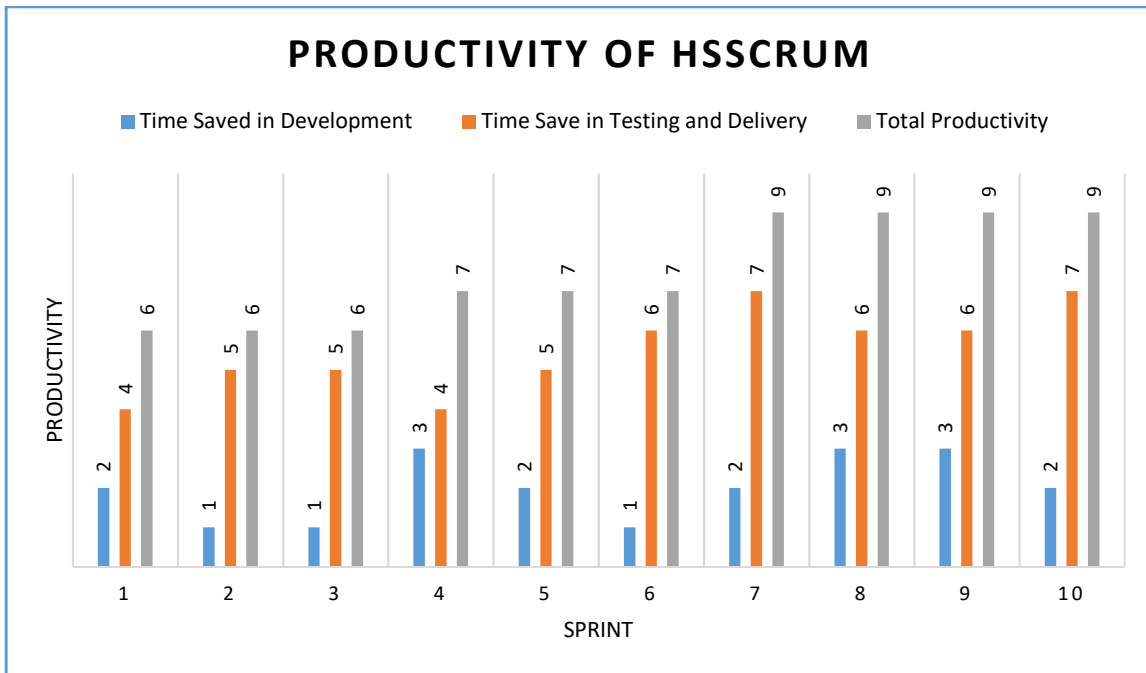


Figure 6: Productivity Of The Proposed Agile Model

As presented in Figure 6, the proposed agile model is found to be efficient in dealing with development process. It could save time in development, testing and also delivery. Total productivity of each sprint is observed in terms of

hours. There is 6 to 9 hours productivity observed in each sprint. It is thus evident that the proposed agile model has potential to save time when compared with traditional models.

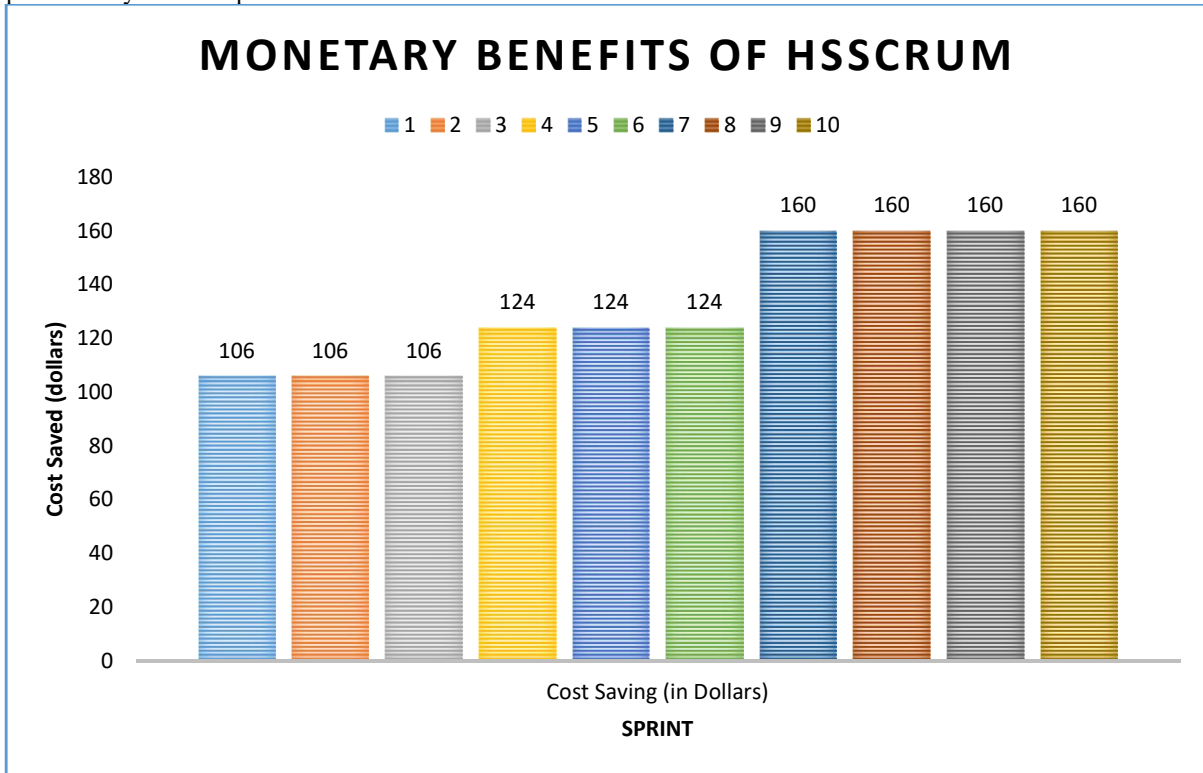


Figure 7: Productivity Of The Proposed Agile Model In Terms Of Cost Saving

As presented in Figure 7, the proposed agile model is found to be efficient in dealing with development process leading to cost saving. It could save money in development, testing and also delivery. Total money saved, in dollars, of each sprint is observed. There is 106 to 160 dollars productivity observed in each sprint. It is thus evident that the proposed agile model has potential to save money when compared with traditional models.

5. CONCLUSION AND FUTURE WORK

We proposed an agile software process model with security integration. It is known as “HSScrum” framework that is an integration of traditional Scrum model being used widely as process model for software development and a security process which is hybrid and flexible to leverage productivity and optimize the development process. HSScrum has Scrum based functions with security provisioning and a novel

security process that is seamlessly integrated with the Scrum model to realize HSScrum. As the traditional Scrum with security provisioning contains necessary phases in the System Development Life Cycle (SDLC), it needs integration of security process that is more beneficial and ensures that the development process is optimized. HSScrum realizes this objective with the loosely coupled (in the sense of flexibility) security process integrated with Scrum with security provisioning. HSScrum has a risk identification process that not only finds risk and rank the user stories based on risk, it also has provision to know whether risks are specific to a backlog item or multiple backlog items (cross-cutting security concern). The framework is evaluated with a case study and the results revealed that it could provide high level of risk identification and also result in monetary benefits. In future we evaluate our framework with different kinds of projects to generalize its advantages.

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