

## **Adopting the UAT Scrum Framework for Systematic Quality Assurance**

Wantana Sisomboon<sup>1,\*</sup>, Nuansri Denwattana<sup>2</sup> and Nuttaporn Phakdee<sup>3</sup>

Software Engineering, Faculty of Informatics, Burapha University, Conburi,  
20131, Thailand

\* Corresponding author. E-mail: wantanasi@buu.ac.th

### **ABSTRACT**

Currently, competition in the software organization business is rapidly increasing especially in systems that are essential instruments and which have a direct effect on an organization's survivability. Software companies must place importance on quality assurance activities in order to ensure the quality of products and information. The tests must focus not only on software products, but also on the accuracy of information shown. The aim of this study is to introduce the UAT Scrum framework, which is an application of a Software development method called Scrum together with UAT methodology called the PEF framework. In addition, "User stories" were used to express the "Definition of Done" in UAT testing to ensure all stakeholders understand the goals. The User stories were used to complete the outline of the tasks for the entire team. Three Nursing Colleges within Thailand were selected as test sites for this research. Twenty-nine nurses, five administrators and ten members of the QA and software development team were included as a sample. The average result of the experiment was 3.97. Participants were satisfied with the UAT Scrum framework for the UAT testing process. The end users and the UAT team improved their communication. User stories on the Kanban board provided comprehensive information on the work for which they were responsible and showed completeness of the information clearly. Utilizing the Scrum UAT framework also vastly improved the QA team and software developers' working processes, relieved time constraints, and assisted in producing software of a higher standard.

*Keywords: Agile, Scrum, UAT, Testing, PEF framework*

### **INTRODUCTION**

One objective of Thailand 4.0 is Economic Prosperity. It aims to build a value-based economy driven by creativity, technology, and innovation. In addition, the Office for National Education Standards and Quality Evaluation (ONESQA) (Kuldeep, 2018) has the objective of representing the quality of education. It issued guidelines leading to the improvement of their standards to raise the quality of national education, which is in fact the public service needed by the State. Therefore, to align Thailand's government economic model and ONESQA policy, the "The Thailand higher education Dashboard System (TheDB)" was produced to assist the Public Health Ministry's Nursing College in administration and decision-

---

Article history:

Received 20 January 2021; Received in revised from 09 June 2021;

Accepted 10 June 2021; Available online 21 June 2021.

making. In addition, “TheDB” is an essential instrument that assesses the organization's efficiency and effectiveness. The results it provides have a direct effect on the organization's survivability.

“TheDB” was produced by Information System Engineering Research Laboratory (ISERL), a software development laboratory. ISERL placed importance on quality assurance activities in order to ensure the quality of the product and the information it manages. The tests must focus not only on the software product, but also on the accuracy of data that is shown by the system.

As part of the laboratory experience of deploying “TheDB”, we decided to run the process of the UAT test altogether with the deployment process at a client site in order to reduce cost and human effort. “TheDB” Dashboard system” was produced for administrative staff at the Public Health Ministry's Nursing College. The information in the aid decision making system is presented in a form of graphs, bar charts, and summary reports. The system consists of more than ten sub-systems which are divided into five main menus: administration undertaken, graduate performance, research study, academic services to the society, and art & culture preservation. The group responsible for deployment and UAT testing was divided into five teams, one for each of the five main menus mentioned before. Moreover, the users refused to accept the system if incorrect information was shown on the system. Behind the scenes, the support staff and testing teams worked hard together to completely many among of data.

We adopted the UAT Scrum framework, which is the application of a software development method called Scrum together with the PEF framework. The framework is an effective UAT test methodology, which increases user satisfaction while reducing both development time and cost. Furthermore, Scrum methods have benefits to allow collaboration between the QA Team, users, and other stakeholders. In addition, one of the main elements of a Scrum approach is “User story”. A clearly identified User story will make a task transparent to the entire team. In this experiment, User stories were used to express the “Definition of “Done” in UAT testing to ensure all stakeholders understood the goal. It can be used to complete the outline of tasks for the entire team. The combination of those two methods increases the quality assurance activities during system deployment and testing at a customer site.

The remainder of this paper discusses the research methodologies and related work, then presents a brief history, and then our case study. Finally, the paper discusses issues and challenges and their impacts on the effectiveness of Scrum in UAT which were discovered during our in-depth case study

## **LITERATURE REVIEW**

In this paper we present the use of the UAT Scrum framework as a tool to allow collaboration between the QA Team, users and other stakeholders to validate business functionality on the final integrated code prior to deployment at a customer site. The related research methodologies are explained in the following subsections.

### **National Education Standards and Quality Assessment**

Thailand has changed from a predominantly agricultural society over the past several decades to become a middle-income country with a relatively diversified economy. Thailand has made sweeping changes to its education system in recent years, in particular with the National Education Act of 1999 (Thailand - National Education Act, B.E. 2542. (Borvornsakulcharoen Direk, 2014). It has been adopted by all educational institutions, mentions that an internal and external academic quality assurance mechanism is included in Chapter 6 (Section 47-51).

Internal Quality Assurance (IQA) is a framework and process designed to create, inspect and review the performance of institutions to verify compliance with the policies, goals, and quality standards set by the institutions themselves. This occurs every year and is reviewed once every 3 years by the Commission on Higher Education-CHE (Bureau of Standards for Higher Education, 2014).

External Quality Assurance (EQA) is an assessment of the quality of education which audits and verifies the quality of education and the standards of institutions based on the governance of education. The external quality assurance process is carried out by the Office for National Education Standards and Quality Assessment (Public Organization) or by ONESQA. This is done at least once every 5 years.

### **Scrum methodology**

Scrum incorporates a short-term development life cycle, adopting an iterative and incremental process. Three roles - Product Owner, Scrum Master, and Development Team Member, are characteristic of Scrum. Product Owners motivate the team and get user feedback for changing or improving the product based on the users' goals. Scrum Masters are leaders and coaches for a Scrum Team. Development Team Members are professionals who work at the end of each Sprint to produce a potentially releasable "Done" product increment. Projects are broken down into sprints using Scrum project management methodologies. A sprint is a time-box of 1 to 4 weeks. A daily scrum focuses on the progress of the task assigned for the day at the end of each day. At the end of the Sprint, the Sprint Review collects feedback on what the team has done (Srivastava et al., 2017). The Sprint Retrospective occurs after the Sprint Review and prior to the next Sprint Planning session. In addition, a retrospective sprint meeting is held to determine what the team's tasks are and if "things" are doing well, what activities can be continued, and what more can be done to make the next Sprint more productive or effective.

### User Acceptance Testing (UAT)

User Acceptance Testing (UAT) is described as “formal testing carried out to determine whether a software system meets business requirements and can be used by the end user” (Pandit et al., 2015). The application should be assessed during UAT instead of depending only on a specification written at the beginning of the development process. UAT recognizes the need for formal testing and the value of acceptance requirements, and it emphasizes of understanding the real needs of the users.

There are multiple models of acceptance testing, including the User Acceptance Test, Operational Acceptance Test, Contract Acceptance Test, Compliance Acceptance Test, Alpha Testing, and Beta Testing (Ruchi et al., 2014). In this experiment we selected Beta Testing which involved real users.

Moreover, a study in Denmark shows that UATs often address the wrong problems in a negative user experience (Sebastian et al., 2019). Known issues are: 1) according to the legal contract, unnecessary test cases were produced in the UAT testing, 2) the UAT test cases address the wrong user problem according to user satisfaction analysis, 3) users hide their actual feelings and feedback during the UAT process, and, 4) negative feedback was collected according to bias caused by culture factors.

### User Acceptance Testing (UAT) in Scrum

In 2016, K.V. Jeeva Padmini et al, presented a paper “Applying agile practices to avoid chaos in User Acceptance Testing: A case study”. This research analyzed the applicability of the scrum process to a large-scale system for User Acceptance Testing in a public sector organization. They created a framework for UAT from analysis of users’ personal information and knowledge of UAT for those who were involved about UAT. The framework detail is shown in Figure. 1.

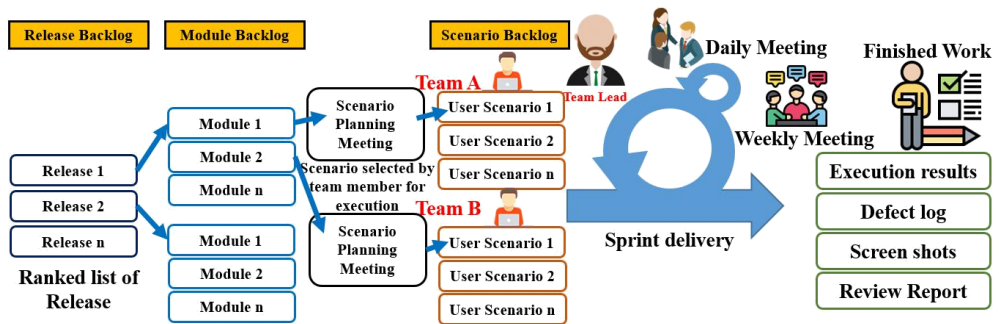


Figure 1. Tailored framework for UAT.

The framework starts with a release backlog which came from the discussion between vendors and project leadership. Some of the releases were modified and the release backlog was ordered by the priority. The Second step is

about the module backlog. The releases were divided into modules and scenario tests were created for each selected module. Next, UAT team members selected scenarios for test execution in the following step. In UAT execution, each team provides deliverables such as execution results, defect log, screen shots, and review reports.

**PEF framework**

In this experiment, the PEF framework was applied for the UAT test in our environment. The framework shown in Figure. 2 was proposed in the Sultanate of Oman (Al-Hurmuzi et al., 2018). In this framework, standard steps which each software development company may later customize to meet its needs are shown. It can assist with off-the-shelf software customization. It is the most effective UAT test methodology for increasing user satisfaction while simultaneously reducing both development time and cost.

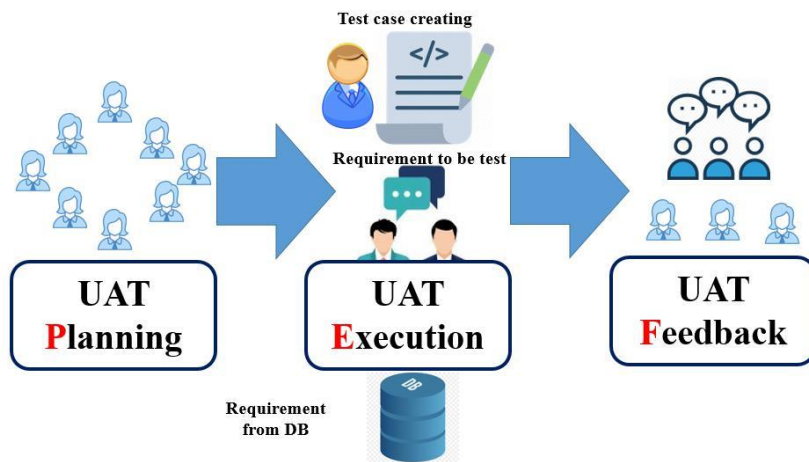


Figure 2. PEF Framework.

The stages of the PEF framework are divided into three stage as follows:

**UAT Planning:** UAT planning is where the correct user role will be assigned. At the end of the stage, the planning result will be stored in the database.

**UAT Execute:** This process utilizes the gathered acceptance results from the users. A list of UAT test cases that are not different from standard system test cases is given to users by the QA team.

**UAT Feedback:** Defects and new items will be collected from user feedback in this stage.

## RESEARCH METHODOLOGY

Before the UAT process, there are some things to consider. For instance, user specifications must be available, code must be fully developed, unit testing, integration testing, and system testing must be completed, and recorded defects must be corrected and validated. The UAT environment must be completed to start UAT, so that when a contact from the system testing team receives information that the system is ready for UAT, the team will be prepared for the UAT testing. (Al-Hurmuzi et al., 2018).

Finally, the environment for the testing process for user acceptance must be ready. That means that all the appropriate software and hardware infrastructure should be in place.

In this research we applied Scrum methodology to the UAT process to foster high collaboration from users. The PEF framework was adopted to generate an effective testing result. In addition, unnecessary test cases were removed to achieve a better quality of testing.

### Design Framework

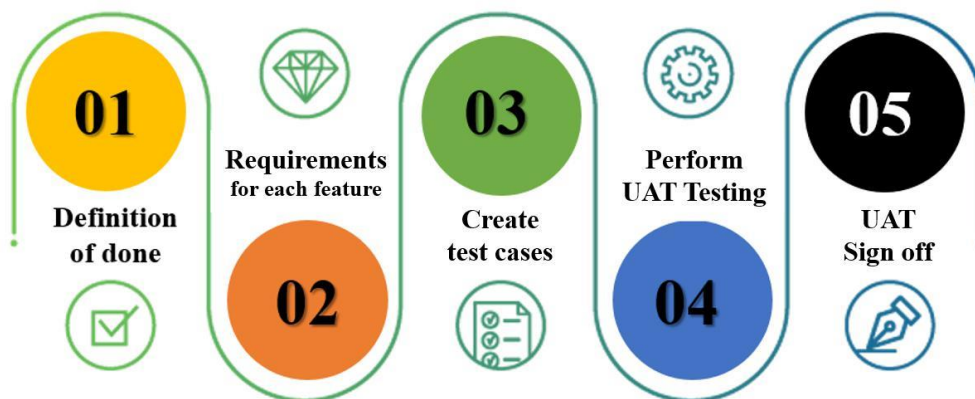


Figure 3. User Acceptance Test Steps.

In this research, we designed and created UAT steps shown in Figure. 3, blending them with the Scrum process. To create the new framework, we started by considering the five following UAT steps:

**Definition of done:** Agreement on acceptance criteria where UAT stakeholders understand what “Done” means.

**Requirements for each feature:** The UAT test strategy establishes the technique to be used to ensure that an application meets its business requirements.

**Create test cases:** In reference to the high-level business process, identify appropriate test scenarios and build test cases with specific test steps.

**Perform UAT Testing:** Execute the test cases with real-world scenarios and data and report bugs.

**UAT Sign off:** After UAT testing and the resulting bugs have been fixed, the UAT team formally accepts the software application as Done.

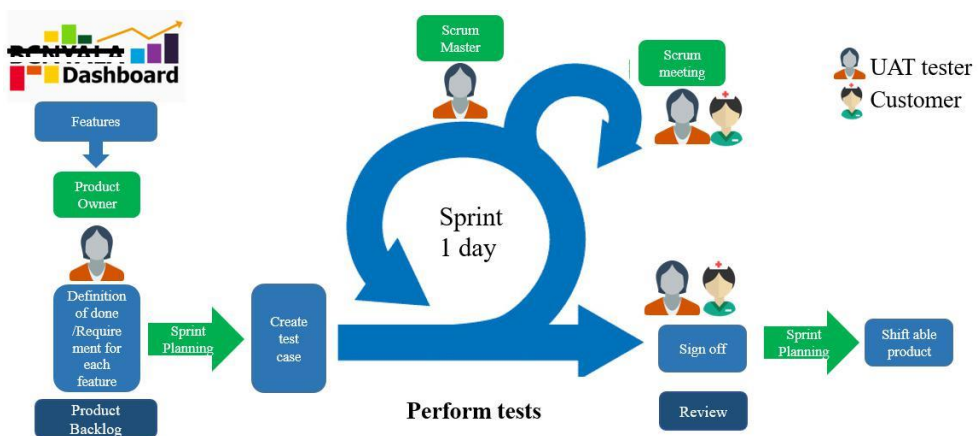


Figure 4. A diagram of the UAT Scrum framework.

In addition, the UAT Scrum framework was designed to be used in the acceptance test process. The PEF framework was applied to complete the UAT process with efficiency.

In Figure 4. Starting with the UAT planning, user roles were assigned before the first Sprint started. A list of UAT test cases were created in the UAT execution step, and UAT Feedback from users occurred in the Sprint Review stage. In addition, we considered the practice of User Acceptance Testing in Scrum from the research of K.V. Jeeva Padmini. Moreover, a study from Sebastian and Team in 2019 shows that UATs often address the wrong problems in a negative user experience. Therefore, while creating User stories, meeting the needs of end users, and selecting stakeholders in the UAT, planning should consider the above conditions.

**UAT Planning:** In this stage, the user roles were assigned before the first sprint started. Important roles for the Scrum UAT process such as “Product owner” should be selected from those who have experience with UAT, the Scrum approach, and the software product. The second role was UAT tester who need to someone who has knowledge of UAT testing and the Scrum approach. The most important

group of people are end users. All stakeholders defined in this stage will work together to produce and arrange User stories with “The definition of done”.

**UAT Execute:** A list of UAT test cases were created in the UAT Execute step. Each test case was started from the release backlog, then divided into modules or subsystems. The test scenario was produced from the subsystems by selecting the right features to be tested. Finally, UAT test cases were created and put “Definition of done” in the User stories as appropriate. The User stories were then put on a Kanban board. The UAT tester team and end users collaborated to complete test cases in a sprint. A Daily Scrum was adopted to discuss what must be done in this sprint. Finally, a “Done” test case was required for the Sprint Review. Accepted test cases were signed off by the end user at the Sprint Review.

**UAT Feedback:** Feedback from users was gathered in the Sprint Review stage. The feedback included new features of software or bugs from the system and the User stories which were not accepted by end users. The bugs which involved data accuracy needed to be fixed immediately while the unaccepted User stories needed to be corrected in the next sprint.

## **Experiment Tools**

In this chapter, work related to TheDB and STM system is discussed.

**TheDB:** The Thailand higher education DashBoard System (TheDB) was introduced at the Public Health Ministry's nursing college. Open source technology such as the PHP CodeIgniter framework was used. MySQL 5.5 was used as the database management system, and CentOS 6.7 was adopted as the operating system platform. “TheDB” is illustrated in Figure. 5 and is divided into five main menus: administration undertaken, graduate performance, research study, academic services to the society, and art & culture preservation.



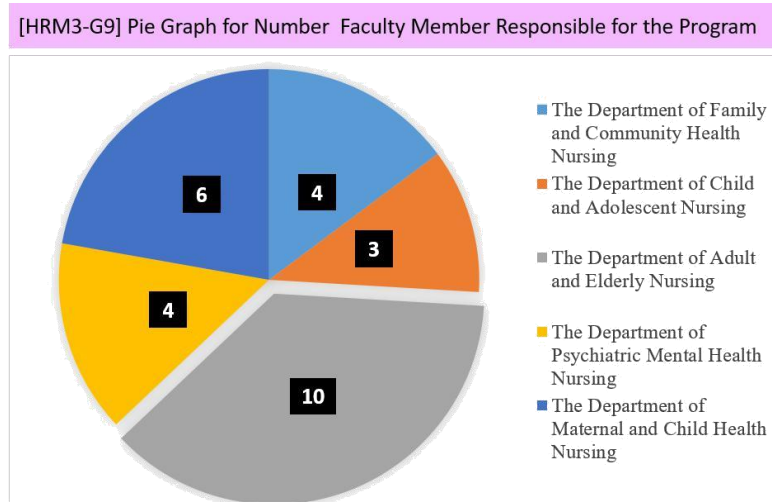


Figure 5. TheDB: Academic staff profile pie graph.

**STM system:** The Software Testing Management (STM) system illustrated in Figure. 6 was developed to assist the Quality Assessment (QA)Team in the ISERL Laboratory in testing software. The system consists of three modules: settings, creating manual software testing project, and testing results.

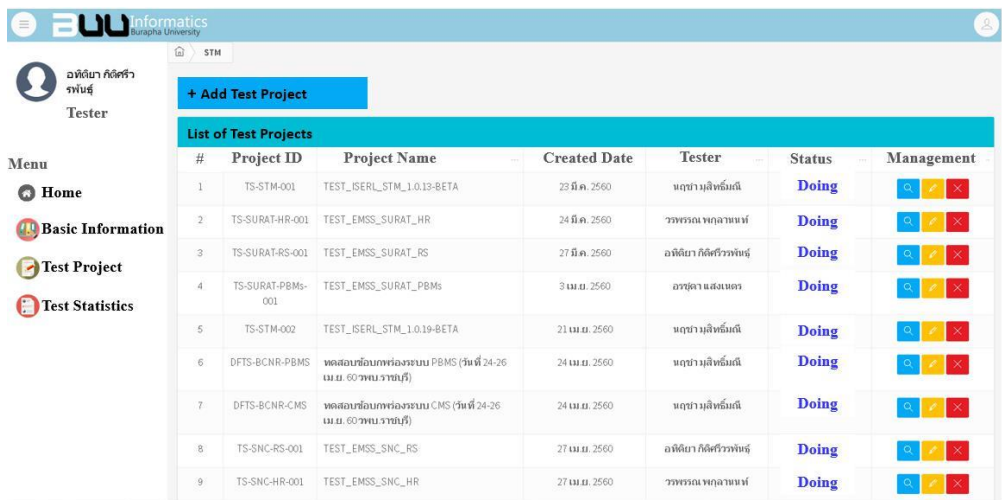
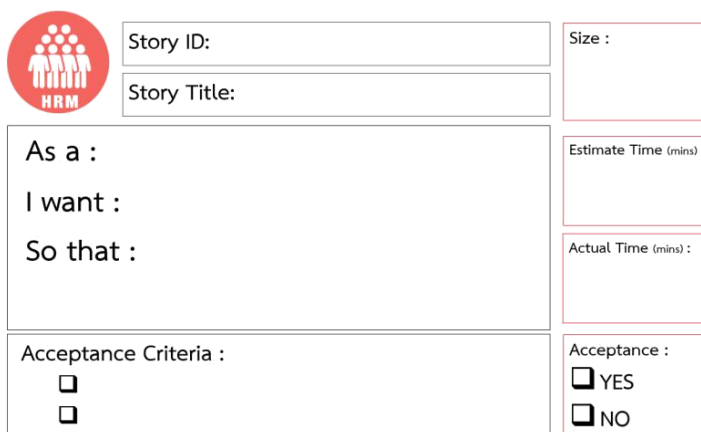


Figure 6. Software Testing Management System (STM) for ISERL.

**UAT User story:** In the Agile environment, User stories are composed of a Product Backlog. User story specify the targeted user, the function he/she wants to use, and ultimately the reason he/she needs it. A User story is illustrated in Figure. 7:




	Story ID:	Size :
	Story Title:	
As a :		Estimate Time (mins):
I want :		
So that :		Actual Time (mins):
Acceptance Criteria :		Acceptance :
<input type="checkbox"/>		<input type="checkbox"/> YES
<input type="checkbox"/>		<input type="checkbox"/> NO

Figure 7. An example of UAT - User story entry form.

## Data Collection

The ISERL laboratory is a small organization with a staff of 15 people. For the UAT Phase, between 10 and 15 staff worked on site at any time throughout the project. “TheDB” consists of 11 subsystems: Human Resource Management System, Human Resource Development System, Academic profile, Research system, Registration System, Academic Service System, Plan and Budget management System, Equipment System, Cultural Management System, Academic Output Management System, and Thailand Qualifications Framework System. The “TheDB” system was installed on a personal computer and portable devices.

The UAT involved four stakeholders: UAT and Scrum specialists and those with “TheDB” experience as Product owners, Customers or Users, Quality Assurance (QA) or UAT Testers, and system Developers. In addition, a sample group of people was selected from support staff, teaching staff, and administrators in the selected nursing colleges who were responsible for Internal and External Academic Quality Assurance.

This research was conducted at three nursing colleges in Thailand which were located in Yala, Suratthani, and Ratchaburi. The experiment was held at the customer sites for three days. Users were divided into the five groups according to their responsible role (as categorized by five menus of the “TheDB”) for the process of deployment and the UAT test. There were three sprints for the Scrum UAT experiment. Each sprint lasts approximately 12 hours.

This research explored the qualitative observational research methods using semi-structured interview techniques, participant observation, and online questionnaires to evaluate user satisfaction. A sample of fifteen people were interviewed. Ten were from the UAT teams and developers from ISERL laboratory and five were administrators from three nursing colleges. Twenty-two participants were support and teaching staff from the three nursing colleges who answered the

online questionnaires to evaluate their satisfaction in using the Scrum UAT framework. In addition, the quality of the system was evaluated by using the number of defects found and the number of accepted User stories as shown in the next section.

## Data Analysis

The UAT process followed the UAT Scrum framework illustrated in Figure. 4. Data accuracy influenced the acceptance criteria decisions for the users. Defects or bugs were reported during this session. New requirements could be raised. A low level of defects was discovered and those issues were solved before the system was uploaded to the server. Users then saw the system with the modified information already incorporated.

**1. Definition of done:** In this stage, user roles were assigned before the first sprint started. The Product owner was selected from ISERL staff who have more than one year of experience with UAT, the Scrum approach, and “TheDB”. The UAT tester team consisted of ISERL staff who are the “TheDB” developers and have knowledge of UAT testing and the Scrum approach. The most important group of people were administrators and support staff from the three selected nursing colleges. There were twenty-nine nurses involved in this process. “The definition of done ” was created by the “Product owner” and the UAT tester team working together with the users. “Done” in this experiment meant the accuracy of the data shown on each element on the dashboard was acceptable. The “done” of each task was written in “Acceptance criteria” below the “UAT User story” illustrated with number 1 in Figure. 8.

For instance, “Acceptance criteria” of card no. HRM3-G9 in Figure. 5. Says development will be considered done if the number of faculty member responsible for each program is correct. All “UAT User stories” entries were produced and put on the “Product Backlog” following the “Scrum with UAT framework”.


	Story ID:	Size :
	Story Title:	
As a : I want : <span style="float: right;">2</span> So that :		Estimate Time (mins):  Actual Time (mins):
Acceptance Criteria : <input type="checkbox"/> <span style="float: right;">1</span> <input type="checkbox"/>		Acceptance : <input type="checkbox"/> YES <span style="float: right;">3</span> <input type="checkbox"/> NO

Figure 8. User Story for the UAT Scrum framework.

**2. Requirements for each feature:** The QA people and the developers perform the role of a Scrum Product Owners to work with the users to define the Product Backlog. After that, estimation of time needed and prioritization of requirements are done so that they can be presented at the Sprint Planning meeting. This step was produced together with the “Definition of done” process. The requirements were written in the following form:

AS A ...(USER)  
 I WANT ... (Specify the requirement that user wants for this task)  
 SO THAT... (Define the reason for completing this task)

“Requirement for each feature” was written in a form of the “UAT User story” as shown with number 2 in Figure. 8.

**3. Create test cases:** A list of UAT test cases were created in the UAT Execute step. The Product Backlog was broken-down into test cases. Each test case was started from one of the five menus from the system, and was divided into 11 sub-systems. The test cases produced were different from those of other products. The end users who were college administrators would not accept the completed User stories if the dashboard did not show the correct output that followed internal and external assessment guidelines. Then we decided to apply quality criteria from a QA guidebook to select the right features to be tested. As shown in Figure 5, the number of academic staff and the details of their profiles in the pie graph must have had exactly the same information as the paper report. We wrote test cases that were necessary to complete an “UAT User story”.

**4. Perform UAT Testing:** Test cases were executed with real-world scenarios by Users and UAT testers.

The user acceptance testing process included data entry and correction. Next, UAT test cases were created and “Definition of done” was put in the User

stories following the conditions described previously. Finally, the User stories were put on a Kanban board and into the STM system.

Test cases or testing User stories were selected to work on in each Sprint. Scrum sprints are basic units of development in the scrum methodology. Generally, Sprints are limited to one calendar month, but for UAT, the sprints lasted only one day. A Scrum sprint is followed by a sprint review. At 8 pm, a sprint review was set up. The feedback from users occurred in the Sprint Review stage. The feedback included new feature requests and bug reports from the system and the User stories which were not accepted by end users. The bugs which involve the correctness of data need to be fixed immediately while the unaccepted User stories need to be done in the next sprint. At the end of each Sprint, a Sprint Burn down Chart is produced in graph form which highlights outstanding work remaining to be done.

**5. UAT Sign off:** A Sprint Retrospective meeting follows the sprint review. This meeting reflects on how work was done during the sprint period. It gives the team a chance to discuss the sprint and identify alternatives which are more efficient. In addition, User stories from the last process must be checked and accepted by users in this process. A “Sign off” was written in a form of the “UAT User story” as shown with number 3 in Figure. 8.

## RESULTS

Participant observation and semi-structured interview techniques were adopted to evaluate user satisfaction. Fifteen people were interviewed. The interviews provided an opportunity for respondents to raise issues. Ten participants were from the UAT team and the software development team. The interviews occurred after the experiment and concluded that the Scrum UAT framework vastly improved working processes, relieved time constraints, and assisted in producing a higher standard of software. The other five participants consisted of three directors and two deputy directors from the nursing colleges. Before the interviews started, the interviewer divulged information with reference to what work had been done. The questions focused on the directors’ understanding of the process, the importance of the dashboard effects on the organization administration, and user satisfaction. One hundred percent of interviewees responded with similar answers. “TheDB” was deemed to be an advantage for their organization management. “TheDB” was adopted as a tool to track work and present the progress of work in monthly meetings.

In addition, Participant observation was used as a tool to check for nonverbal expression of feelings to determine interactions and check how much time was being spent on the UAT test activity. With the collaboration of the director of the organization, related staff were utilized in the UAT Scrum framework. The Scrum process highlighted problems in the system and motivated staff to respond positively to their work.

Table 1: Satisfaction with the Scrum UAT framework on a scale of 1 to 5, with 5 the best.

<b>No.</b>	<b>Operations</b>	<b>Average</b>	<b>Explanation</b>
1.	The duration of the UAT testing is reasonable.	3.93	Good
2.	UAT testing tools improve communication between users and the UAT team.	3.99	Good
3.	UAT testing tools show the completeness of the information clearly.	3.98	Good
4.	The tools used in the UAT testing provide comprehensive information on the work in which you are responsible.	3.97	Good

Furthermore, the satisfaction of UAT testing using the Scrum UAT framework has been validated by means of online questionnaires, which use a 5-point Likert scale to be answered (values go from 5: very satisfied to 1: totally dissatisfied). Twenty-nine nurses from three nursing colleges replied. Table 1. shows the results for the Satisfaction of UAT testing. The average result of the experiment was 3.97. Participants were satisfied with the UAT Scrum framework for the UAT testing process.

The framework assisted to provide the knowledge about Scrum to supporting staff, teaching staff, and administrators of the colleges. The users and the UAT team improved their communication during the UAT and deployment process. That led to the successful in completing of the User stories together. In addition, User stories on the Kanban board provided comprehensive information on the work for which they were responsible, and showed the completeness of the information clearly.

Table2: Task Point Comparison.

#	Task Point Comparative			
	Nursing College Site	Commitment	Accepted	Percent
1	Yala	1,007	984	97.72
2	Suratthani	673	656	97.47
3	Ratchaburi	979	974	99.49

Moreover, information from Table 2 indicates that the UAT Scrum framework prompts people to cooperate in the working process. System acceptance achieved a high level.

Table 3. Testing Summary.

#	Testing Summary			
	Nursing College Site	#Test Cases	#Defects found	Percent
1	Yala	132	14	10.60
2	Suratthani	132	14	10.60
3	Ratchaburi	132	13	9.84

Figure. 9 shows a sample of the Summary Report from the STM System for ISERL. Nineteen test cases from the Human Resource Management System were tested. 36.84% passed while 52.63% did not pass, and 10.53% were canceled. Furthermore, as shown in Table 3, the percentage of defects found from the first to the last site were alike. Due to the fact that the time range of UAT testing in each site was not very different, the developers cannot afford to solve the critical level of defects. A low-level of defect was solved during the testing process. On the contrary, most of the critical levels of defects occurred due to new requirements or specific conditions for the college which affected other systems. These defects cannot be fixed without permission from the system architect.

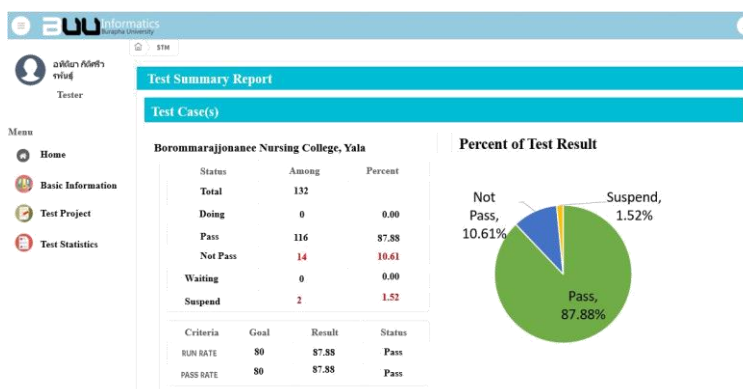


Figure 9. Sample of Summary report from STM system for ISERL.

## CONCLUSIONS

The Scrum UAT framework was created to be a recommended practice in a UAT testing process which requires all stakeholder's collaboration. The tests not only focus on the software aspect but also on information accuracy. The framework benefits users without much Scrum skill or experience. "Definition of done" which was written in User stories will makes the understanding of the goal clear to all stakeholders. In addition, the Kanban board assists inexperienced users in easily understanding their tasks. For the QA team and software developers, utilizing the Scrum UAT framework vastly improved their working processes, relieved time constraints, and assisted in producing software of a higher standard. On the contrary, there are points to consider for future work such as Internet and network reliability which are important criteria that directly affect user acceptance. These should be focus on future experiments.

## ACKNOWLEDGMENTS

I would like to express my sincere gratitude to Faculty of Informatics, Burapha University to provided funded for this research and Information System Engineering Research Laboratory (ISERL), for letting me be part of this experiment.

## REFERENCES

- Al-Hurmuzi, S., Al-Khanjari, Z. and Al-Kindi, I. (2018). Proposed Feasible PEF framework for User Acceptance Testing. *8th International Conference on Computer Science and Information Technology (CSIT)*. 242-248. <https://doi.org/10.1109/CSIT.2018.8486225>.
- Bureau of Standards for Higher Education. (2014). *Manual for The Internal Quality Assurance for Higher Education Institutions*, Office of the Higher Education Commission Ministry of Education (OHEC). 208. <http://www.mua.go.th/>
- Borvornsakulcharoen, Direk. (2014). Analysis of Legal Problems Arising from National Education Act B.E.2542 in Term of Educational Decentralization. *Naresuan University Law Journal* 7, 1, 104-121. <https://doi.org/10.14456/lawnjournal.v7i1.98752>
- Emeritus K. W. (2014). Manual for the Internal Quality Assurance for Higher Education Institutions 2014. *Office of the Higher Education Commission (OHEC)*, Bangkok, 23-80. <http://qm.kku.ac.th/downloads/hbMUA14en1.pdf>
- Kuldeep, N. (2018). Integrating STEM and Skill Development (SD) for Thailand 4.0 Means, Methods and Challenges. *iSTEM-Ed 2018 KX KMUTT, Bangkok, Thailand Jul*, 11-13. <http://repository.au.edu/handle/6623004553/21340>



- Padmini, K.V.J., Perera, I., & Bandara, D. (2016). Applying agile practices to avoid chaos in User Acceptance Testing: A case study. *Moratuwa Engineering Research Conference (MERCon)*. 96-101. [https:// doi: 10.1109/MERCon.2016.7480122](https://doi.org/10.1109/MERCon.2016.7480122).
- Pandit, P. & Tahiliani, S. (2015). AgileUAT: A Framework for User Acceptance Testing based on User Stories and Acceptance Criteria. *International Journal of Computer Applications*,120. 16-21. [https:// 10.5120/21262-3533](https://doi.org/10.5120/21262-3533).
- Ruchi, G. & Namita G. (2014). Survey on Acceptance Testing Technique. *Journal of Software and Web Sciences (IJSWS)*,8(1). 20-23. [http:// https://www.semanticscholar.org/paper/Survey-on-Acceptance-Testing-Technique-Goel-Gupta/94bd57be619457f40e8fa67241514e1dc2b9c417](http://https://www.semanticscholar.org/paper/Survey-on-Acceptance-Testing-Technique-Goel-Gupta/94bd57be619457f40e8fa67241514e1dc2b9c417)
- Ruchira, P., Perera, S., Jeeva P. & Dilum B. (2018). Adopting Design Thinking Practices to Satisfy Customer Expectations in Agile Practices: A Case from Sri Lankan Software Development Industry. *Moratuwa Engineering Research Conference (MERCon)*. 471-476. [http:// doi: 10.1109/MERCon.2018.8422006](http://doi.org/10.1109/MERCon.2018.8422006).
- Sebastian, L., Raffaele F. C. & Jürgen C. (2019). Beware of Disengaged User Acceptance in Testing Software-as-a-Service. *IEEE/ACM 41st International Conference on Software Engineering: Companion Proceedings (ICSE-Companion)*, 298-299. [http:// doi: 10.1109/ICSE-Companion.2019.00123](http://doi.org/10.1109/ICSE-Companion.2019.00123).
- Sowri R. P., Rani H., Padmavathy. V & Nasrin. S. (2019). Framework for Multiple User Acceptance Testing to Avoid Chaos. *IEEE International Conference on System, Computation, Automation and Networking (ICSCAN)*, 1-6. [http:// doi: 10.1109/ICSCAN.2019.8878803](http://doi.org/10.1109/ICSCAN.2019.8878803).
- Srivastava, A., Bhardwaj, S. & Saraswat, S. (2017). SCRUM model for agile methodology. *International Conference on Computing, Communication and Automation (ICCCA)*, 864-869. [https://ieeexplore.ieee.org/stamp /stamp.jsp?arnumber=8229928](https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8229928)
- Zahra A. A. (2012) Challenges and Weaknesses of Agile Method in Enterprise Architecture. *International Journal of Computer Science & Engineering Survey (IJCSES)*3, 6, 37-45. [https:// 10.5121/ijcses.2012.3603](https://doi.org/10.5121/ijcses.2012.3603).