

The Experience of Enhancing Internet of Things System with Scrum Framework

A case study of Asian University in an Information Technology Curriculum

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ABSTRACT

Recently, the foundation of technology education is a significant part of growing up the country, especially for Asian countries. There are various technology curriculums which are provided by many Universities. In addition, Thai government has been updated the trend of technology which is called "Thailand 4.0 policies" and also effects the system of university to create an appropriate curriculum. The main issue is that the traditional Asian education culture focuses on theory more than practical term. It will be effected the students' capabilities such as self-learning. This research focuses the practical skill of software development process and software management framework such as scrum which is important skill for undergraduate student of information technology (IT) major. Moreover, the research information is compared to the technology curriculum in western universities and the culture of software companies. This research aims to find the benefit aspect of scrum process and the variety of technology platform such as Internet of things. To conclude, the scrum can be a part of variety software development platform and it is important to include into an IT curriculums. Furthermore, the beneficial aspect of using the scrum is to improve team communication which is an opposite way of an Asian developer behavior. Most people always work individually to get work completed. Another striking point between Asian culture and Western culture is that Asian people conversation stand by the side of compromise to avoid the argument. On the other hand, Western culture prefers the way of discussion and apply when faces new changes.

Keywords: Agile manifesto, Scrum framework, Internet of things

INTRODUCTION

Currently, Internet of Things Systems become more significant to grow business industry and quality of life such as smart sensor devices, smart city and smart farm. On the other hand, there are some issues related to hardware aspect, customer satisfaction and complex architecture with various technology.

Firstly, this research focuses on a benefit of agile process with a quick release to support stakeholder's expectation. Basically, IoT combines two different systems of hardware and software, agile process becomes a main tool to deliver task and open compunction between these two systems. Another benefit of agile process is to build a right product because agile is transparency task development and customer are able to work together.

Article history:

Received 17 September 2019; Received in revised form 2 October 2019;

Accepted 29 October 2019; Available online 27 December 2019

Secondly, this study aims to find a result of an effort of software productivity of Asian University Education based on student's senior IoT project with Scrum framework, faculty of technology and communication at University of Phayao. In this case, the study compares between two majors with the same field of IoT senior project. One major is software engineering curriculum which is contained a basic until advanced knowledge of software management process and another major has less experience of software management skills. The hypothesis of this research is seeking a balance spot of agile method which is appropriated to Asian University Education. The education is an important part to grow other business companies.

The Scrum framework will be broken down into each process such as User Story Estimation, Sprint Planning, Daily Scrum and Retrospective. This research study collects data on questionnaire survey by using the success factor adopting agile with two different groups, Software Engineering and Computer Science Students.

From an overall mentioned above, the research result can be another majority reason to suggest other information technology curriculums in Asian Universities to emphasize software project management skills.

Furthermore, this paper also aims to initiate a majority point of Agile framework for other Universities in Asia to apply each process into their own learning techniques that might be able to support local and international software companies in their own countries.

RELATED WORK

This section will be part of clarification to find out the correlation of the previous studies with this research. There are two significant topics mentioned in previous work about scrum for internet of things and agile methodology in other universities which are described below.

I. Scrum for Internet of Things

The technology trend in 2014-2019 (Russell, 2018), there are more than 15 billion devices such as smartphones and computers involved to people activities and also connected to internet as IoT System.

This trend can be found in several areas, for example in terms of smart farm, city and grid. In addition, there are the benefits in using IoT System which can be pointed at customer satisfaction. The devices that used the internet influence the relationship between customer and organization. There are many industries' expectations on getting more data to transfer to Data Analytics and Data security. IoT system can use sensor devices to monitor and track environment or human behaviors.

However, developers find themselves unfamiliar with IoT System and unprepared (Zambonelli, 2017). As the Zambonelli indicated that the new software industries supposed to guide new generation developers with tools of software management framework such as scrum, lean or extreme programming to hands on new software with variety of scale.

From an overall mentioned above, Scrum is a subset of software engineering process which can be adapted to the challenges of today's IoT, for example, software re-engineering, re-organize, software maintenance and re-configuring system. These are specific characteristics of the IoT platform.

II. Agile Methodology in other Universities

Another case study of Scrum framework from University of Ljubljana (Mahnic,2005), the university combined scrum framework with the students' project of maintenance code module such as various code tables, installation parameters and list of compulsory. The lectures divided students into teams and follow the concept of scrum role as a product owner, scrum master and team members. The team member can change to any proper role such as developer, database manager, full stack developer, network manager and software tester which depends on situations. The result of scrum had turned out to be very useful for a team. Scrum helps the team to improve their abilities in communication. Furthermore, scrum can inspire and motivate the team when they face obstacles and they can challenge themselves by finishing new issues from a new sprint and submit within or before the deadline (Sutherland, 2014). The goal of agile is to release each piece of project task to customer and to prepare with any changes. It can be concluded that if one of a team member gets in trouble, the another member can swap immediately which mean that another goal of agile process is to improve the team member's capability to work across each other which called hyper productivity.

There are two software development teams who are bachelor students in faculty of information and communication technology, Phayao, Thailand. One of a team is the students from major of Software Engineering (SE). In Software Engineering curriculum as mentioned above, the curriculum's objective is to change student mindset on soft skill and management skill by teaching agile development process at the beginning. So, the student's mindset is close to the way of western culture study such as discussion and meeting frequently. On the other hand, another comparison group from major of Computer Science (CS) who studies in the curriculum that focuses on development process more than software management process. The CS student's mindset will be close to traditional Asian culture style. Moreover, the data of student's experience by using Scrum framework were collected by giving a questionnaire via selected success factors of implementing agile method (Chow, 2008). These questions were broken down from success factor which are appropriated for this research area.

THEORY AND METHODS

In terms of theories, agile framework focuses on a communication part due to the lack of senior project progress of software engineering student at University of Phayao. There is a software management framework called Scrum which is the popular framework that use in Software Company. Scrum is a set of agile framework. The main point is to invisible task of software implementation between developer and customer which is meaning that the feedback or progress supposed to release frequently. These relationships can be described below:

A. Waterfall Model

The waterfall framework's feedback loop slower than agile framework. It can be illustrate that the waterfall model run each process such as analysis, design, implementation, test and maintenance sequentially. Each process will be released without overlapping each other which mean that each process is frozen until it is nearly success before jump to the next step. Another minority point of this framework is that when customer request to change their requirement, the change can be broken down a whole current process. From previous study of Balaji (Balaji, 2012) state that if the software project is large project with a clear requirement and few changes, the waterfall is one of selected choice shown in figure 1.

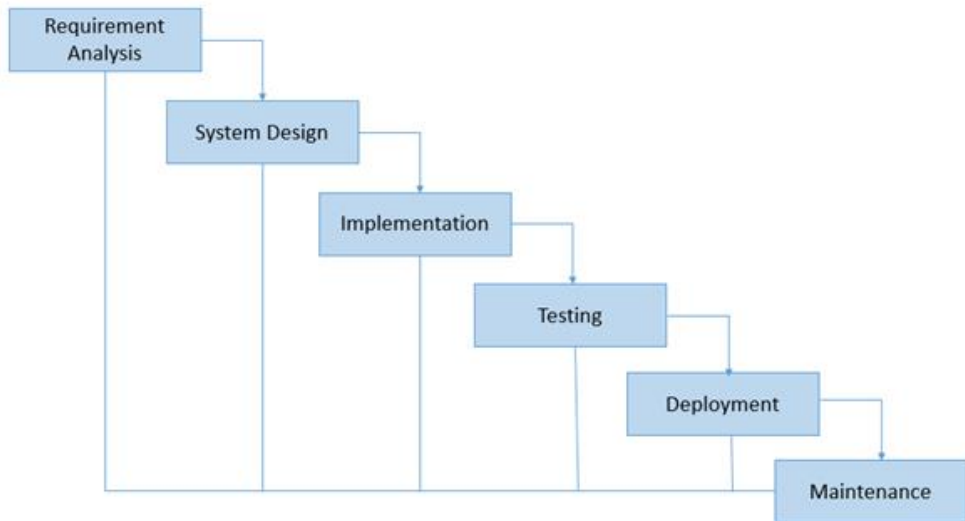


Figure 1: Water Fall Model

B. Agile Manifesto

According to a minority point of the waterfall model, the next model has been improved from failures called Agile. There are four main concept of agile framework represent as agile manifesto

1. Individual and interaction over process and tool
2. Working software over comprehensive document
3. Customer collaboration over contract negotiations
4. Responding to change over following plan

As the previous researches (Balaji,2012) found that the agile model is able to adapt itself while each process gaining change from customer requirement and also there are no fence between customer and developer because customer will stand on one position in a team to see each progress returning result frequently. In addition, Balaji has been concluded that the agile framework is an appropriate tool to use with a small software project that release product in a short period of time which is similar to this case study of software engineering senior project.

C. Scrum Activities

According to an Agile framework which is related to very small entities (VSEs) for limited 25 employees. Therefore a research aims to focus a subset of agile lightweight process framework called “scrum”. This lightweight framework broken down a software requirement into small pieces of task that will keep feedback response to customer and team frequently. There are three main Scrum role can be defined below

1.Product owner who is a represent person of customer can also making a commitment between customer and developer team

2.Scrum master who is a motivator of a team walk pass through, when the team face any type of obstacles such as technology change, requirement change and other detail within team.

3.Scrum team member including designer, developer, tester, etc., which concentrate on the same goal and the characteristic is multi-tasking or cross functional. Moreover, there are group of Activities and Artifacts which initiate at the beginning until the end of project shown in TABLE I.

Table I The result artifact items from scrum process

Scrum Activities	Scrum Artifacts
Daily Scrum	Burn down chart
Sprint Planning	Product backlog, Sprint backlog
Sprint Review	Burn down chart, Sprint backlog

In figure 2, the scrum process start at “Create Product Backlog”, combine all task from requirements then divided into the next step called “Sprint Planning”, to estimate how complicated for each tasks and put them to “Sprint Backlog” to assign to the team and tracking by setup a due date after that the customer will join in this process during a “Sprint Release” it can be done week by week or twice a month depend on the commitment and the two final process are “Sprint review” and “Retrospective” which is focus on what to do next or what to improve in the next release until the submission dateline.

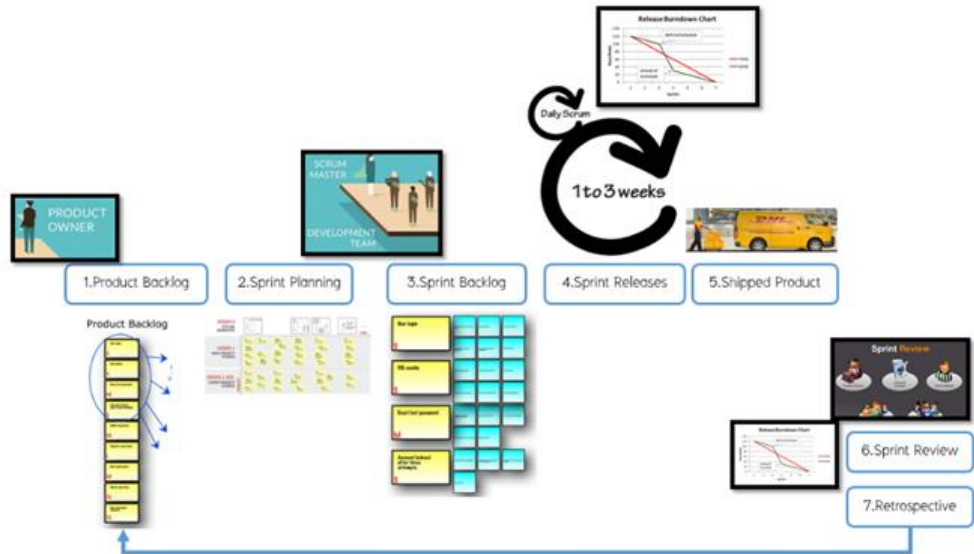


Figure 2: Scrum Process

D. Asian Education System

Asian education system in case study of Thailand Universities. There are an independence study provide after student finish primary school which are three selection groups, General high school, Non-Formal Education Centre and Vocational Certificate. In the first group general high school, student will follow the mandatory rule such as junior high school and senior high school and also they can decide which track is the most appropriate to their skill between science and liberal art. Moreover in Non-Formal Education is similar to the first group instead of student need to have self-learning abilities and self-management more than general high school. There are some student walk away from general high school with reason such as lack of money or lack of time. Lastly Vocation Certificate, student aims to contain basic knowledge from junior high school before walk in this curriculum. Vocational Certificate is separate education from another two groups above, it provide much more practical and focus on ability to work as soon as student complete course. It is meaning that student will lost their skill to apply into higher education but they will gain more professional practical skill to use as a real worker.

From an overall statement above, it can be seen that in Thailand education system provide a varieties curriculum to support and help student. However, at the end of each curriculum above student can access to company and industrial which is depend on their professional competency. One of the most important soft skill to work in any company is the skill of teamwork or team management. Agile is one of the most popular tool, in can be used in field of software and management together and also people in a team must be a teamwork. Due to a reason of varieties curriculum in Thailand education system provide many type of people characteristic and skill which is an obstacle relevant to agile objective.

In terms of the evaluation methodology process, it has been designed in figure 3 shows 4 main steps, Agile Training, Scrum Work Out, Implementation, Collect Data and Analysis Data base on success factor of adopting Agile.

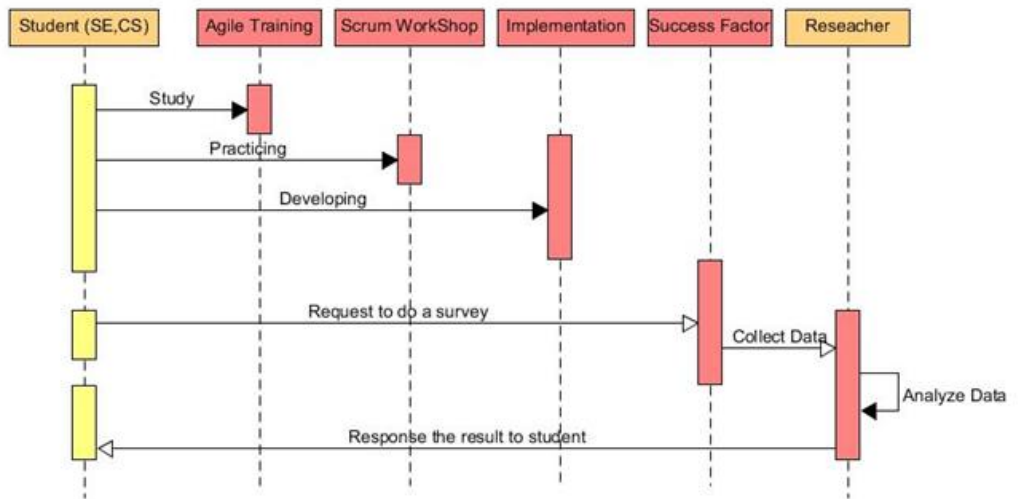


Figure 3: The Research Evaluation Process

In agile training that shows in figure 4 had been taken 2 days learning and 2 days practice, the point of this training is to get into a deep understanding of Agile process. After that the students can select their own suitable framework which is related to their project.

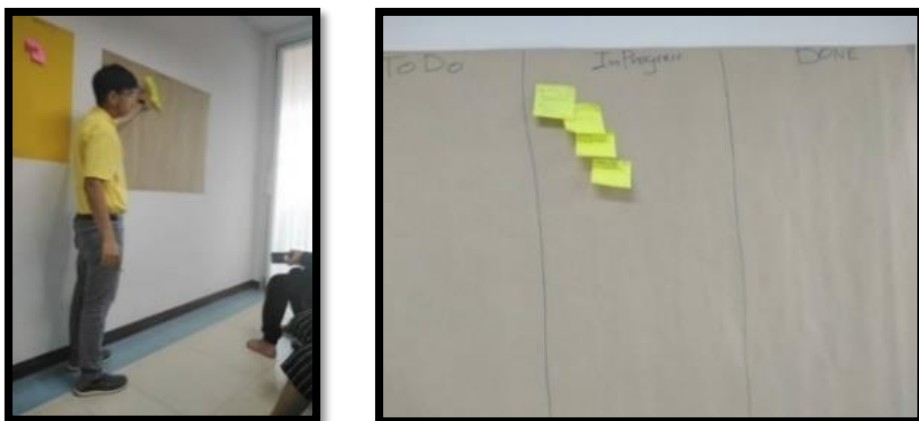


Figure 4: Agile Training

In Scrum work out, there are two software management tool options named Trello and Github represented below in figure 5. These tools can be merged into a source code.

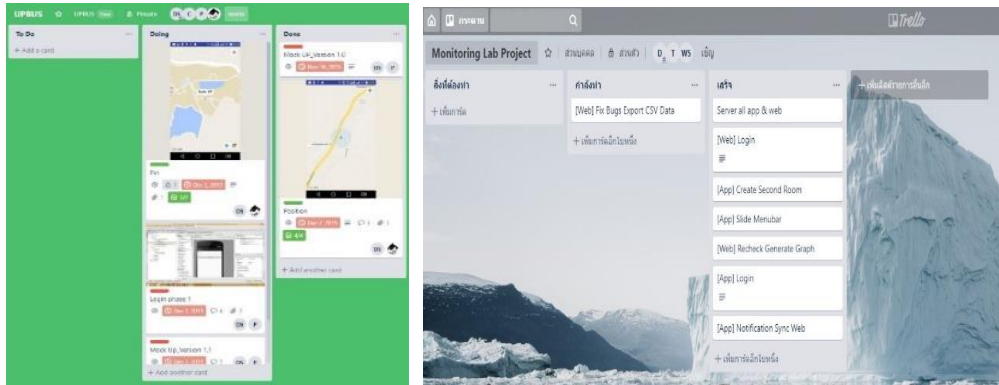


Figure 5: Tools for collaboration ‘Trello’ as Kanban board

In the implementation part, after the students gained software management knowledge then they can develop a software from a real requirement. Furthermore, the software requirement spec (SRS) is based on student’s senior project and collaborate with the a real project outside which is grant from University of Phayao research unit project called “Unit of Excellence on Sensors Technology” at an initial phase with a scope of Smart Farm: Sensors Technology Tracking and Monitoring Environmental for enhancing the agricultural production of Phayao. The result of software product is shown in figure 6 and figure 7 below.

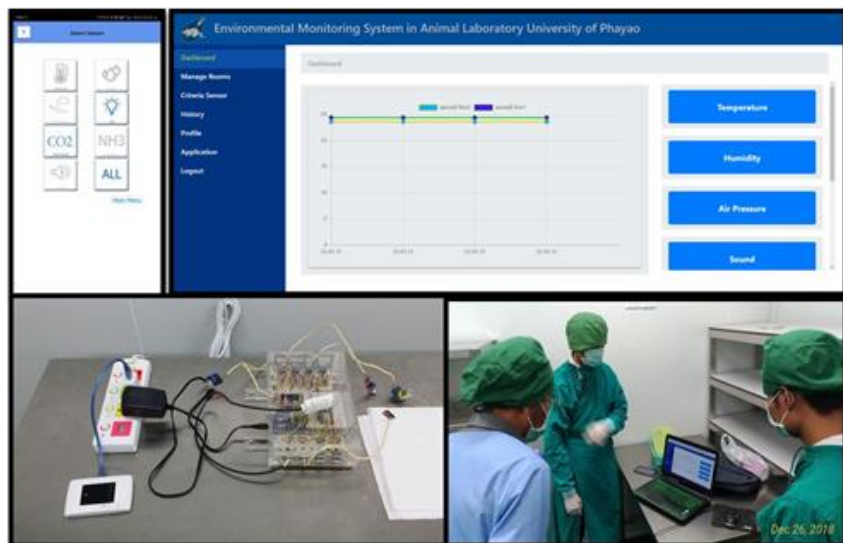


Figure 6: Computer Science Students Project

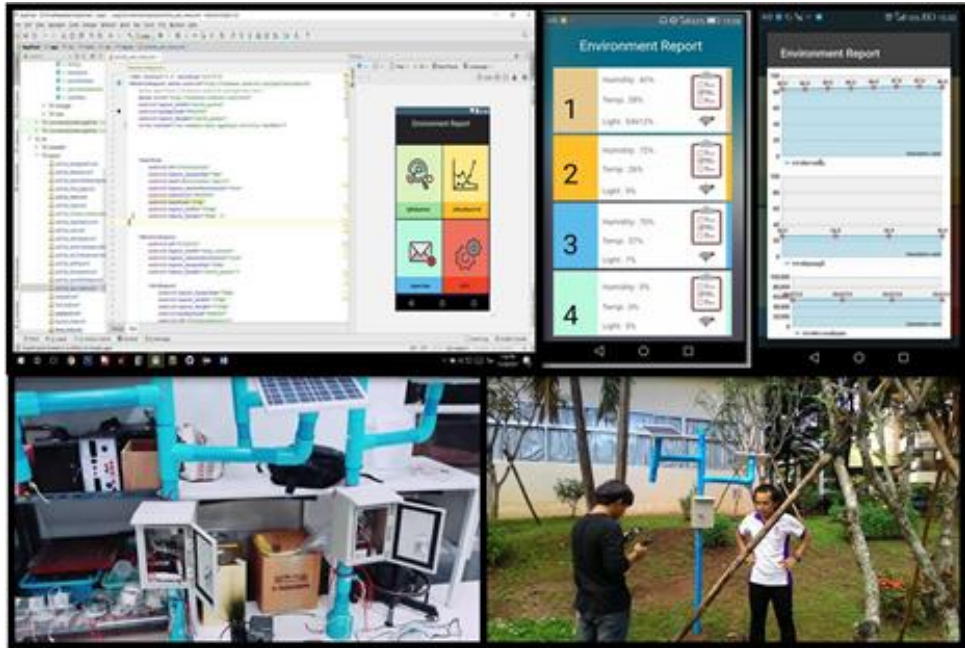


Figure 7: Software Engineering Students Project

There are various dimensions of success factor of agile method (Chow, 2008). In 4 dimensions named, Technical, Project, People and Process. On the other hand, there are some factors were not added into a test because of complicated information and difficulty of evaluation for student such as a dimension of organization. This research survey sets a type of Close-end questions base on student’s senior perspective between a range of scale 1 (Strongly disagree) to 4 (Strongly agree). After complete a survey part in Table 2, the data will be collected and the result for each dimension will be discussed in the next section below.

Table 2 The Survey questions based on success factors of adopting Scrum

Respondents	Dimensions	Agile Success Factors
10 Student	Project	Scrum framework is able to adapt with IoT System development.
		Scrum framework is suitable to add into curriculum of Computer Science and Software Engineering.
		Scrum framework is work more appropriate in small size project than a large project.
	Technical	The Code standard should be committed during an implementation process.
		Scrum can help the team to find a weakness point.
		The integration testing process can be improved by scrum.
		Scrum pursues an appropriate training for a team.

	Process	Scrum can release each feature in every sprint regularly.
		IoT's Tasks can be delivered on time by using Scrum tracking project progress.
		Students are able to predict and plan for a future task by using the result of daily meeting.
	People	Students improve their capabilities in term of project management skill.
		Scrum framework can motivate team members.
		Understanding a concept of scrum need an advance knowledge and experience.
		Scrum enhance team's relationship.

RESULT AND DISCUSSION

The overall result from 10 responders of Software engineering and Computer Science in figure 8 was done by the statistical method on open-ended survey questions. The final result shown that project dimensions are the highest positive feedback from students' aspect (1.83). On the other hand, the minority aspect noted at Technical dimension (1.48). However, there are several factor that have lowest/highest score for each dimension. Those are significant to consider in sections below:

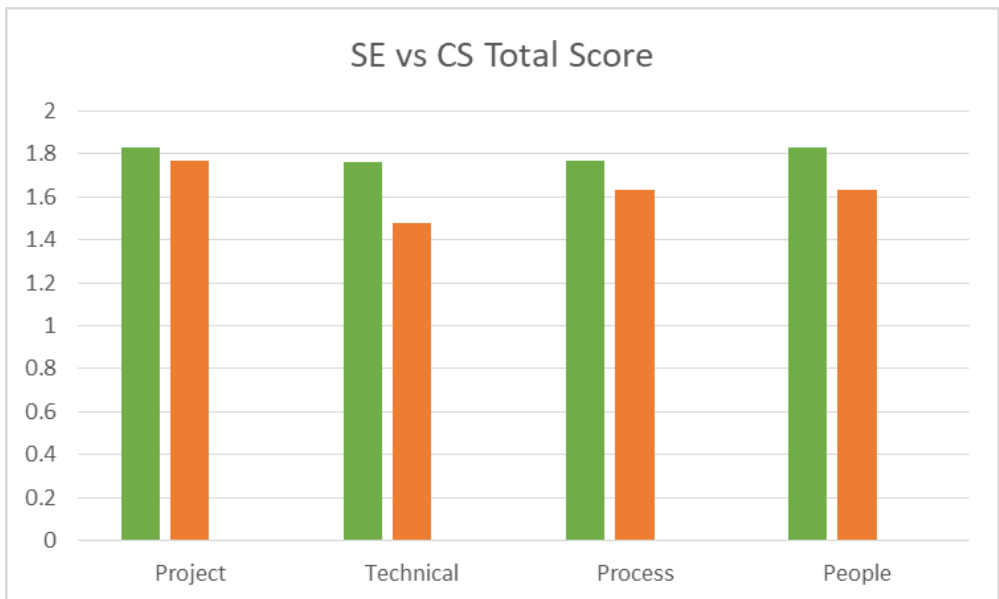


Figure 8: The overall result from 10 responders between Computer Science (CS) and Software Engineering (SE) students

I. Project Dimension

According to the highest score from the survey result, Scrum framework is an appropriate for a small number of people and small size of project such as the IoT system from senior students' project. Moreover, Scrum can monitor and track each member progress. Visible task, it is a significant moment to allow other members to know each other skills so that they can organize and improve specific skill by themselves. Another point is that, Scrum can be used to find out which is the weakness point by tracking the burndown chart result in every sprint release in figure 2 so that when any change occur the team will be able to prepare.

However, CS student indicated that "Limitation of time" as a drawbacks aspect in this case study. The CS students have not been taught in this type of course comparing to SE students. For example, the software process and the introduction to software engineer subject are combine some techniques of software project development and management so that when the students face the real world project, they will be able to apply better than another major students who have no basic knowledge of software process and management.

II. People Dimension

Both teams had similar positive result as "Team member are well prepared for every changes" and "Scrum can improve team communication and less data lose". Responses above mean that the feedback from customers in every retrospective is one of the most important method to repeat every requirement correctly. Furthermore, the way to follow a right track is a good communication during a team which mean that Product owner and Scrum master are supposed to talk to every team member from an overall picture until a small picture.

On the other hand, the negative feedback came from the CS students that "Management skill training is significant at this part". This negative aspect is similar to the discussion in Project Dimension's drawback above, it can support that the CS students considered that a significant point of software management skill can be a good feedback to improve a current curriculum.

III. Process Dimension

In the next advantage aspect of process in Table 3, CS students mentioned that "Sprint release date is the best method to motivate team for committing task on time". This is the capabilities in terms of management and self-organized by using Scrum techniques. As statement mentioned above, Scrum can find the weakness point to improve a specific skill.

Otherwise, the weak point in process dimension is that students have been concerned about other assignment tasks which is always interrupting a sprint release date for senior project.

IV. Technical Dimension

The striking point from students in Table 3 mentioned that “Everyone in a team learnt to work multiple task at the same time”. In this study dimension is clear that the Internet of Things (IoT) system is a complex architecture. The students need to learn how to develop in cross platform and different programming languages at the same time. This statement is another reason to support that the Scrum framework can find an issue for each team member. So another person who has the second skill will cooperate with multiple tasking skills until the task is complete. In addition, members who can do multiple tasks will become more professional. Next, the integration software testing is a significant method to correct every feature which should be done with user acceptance at the end of a project submission. It can run through scrum process properly.

In drawback perspective in Table 3, CS students complained at “Too variety of technologies and tools”. This feedback shown that CS students need to know more about basic knowledge of software testing and software management process tools before implementation in a real-world project.

Table 3 Response in Positive and Negative perspective between CS and SE Students

Dimensions	Evidences	
	Positive	Negative
Project	“Scrum is suitable for a small team”	“Limitation of time”
People	“Team member are well prepared for every change”	“Management skill training is significant at this part”
	“Scrum can improve Team Communication and less of data losing”	
Process	“Sprint release date is the best method to motivate team for committing task on time”	“There were interrupt tasks during an implementation part such another assignment from other subject”
Technical	“Scrum makes every process visibility”	“Too variety of technology and tools”
	“Everyone in a team learnt to work multiple task at the same time”	

CONCLUSIONS

The majority point of this research aims to find a significant success factor of Scrum framework that related to IoT Senior project between two groups of IT students, University of Phayao. One group has less experience of Software Process Management than another group which are CS and SE, respectively. The survey included four success factors of adopting agile as Project, People, Process and Technical. The data has been collected from 10 participants (SE, 5 students and CS, 5 students). The project dimension was the highest success factor score from both

groups. The small size of team member and project turned out to be positive for students. Another benefit was mentioned about transparency tasks, the students found that the Scrum framework can monitor and track each team member tasks by showing a current progress in daily meeting and retrospective meeting at the end of each sprint release. Moreover, the students found another positive aspect of Scrum which helping team to find the weakness point so that they can train and consult appropriately.

However, the minority aspect has been indicated in Technical Dimension. The result of CS students indicated that there were several tools in terms of software management process such as software version control and software process framework which are effected to their progress. It can be concluded that the basic knowledge of Agile in Scrum framework is another recommendation to comprise into other information technology curriculums.

ACKNOWLEDGMENTS

This research study was evaluated and supported by the participant in faculty of information technology and communication, University of Phayao. This research was also supported by Unit of Excellence on Sensors Technology Grant No. UoE62006, School of Science and University of Phayao.

REFERNCES

- Ayed, H., Vanderose, B., & Habra, N. (2017, May). Agile cultural challenges in Europe and Asia: insights from practitioners. In *2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Practice Track (ICSE-SEIP)* (pp. 153-162). IEEE.
- Balaji, S., & Murugaiyan, M. S. (2012). Waterfall vs. V-Model vs. Agile: A comparative study on SDLC. *International Journal of Information Technology and Business Management*, 2(1), 26-30.
- Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., ... & Kern, J.(2001). Manifesto for agile software development.
- Chow, T. & Cao, D. (2008). A survey study of critical success factors in Agile software projects. *The Journal of Systems and Software*, 81(6), 961–971. DOI:10.1016/j.jss.2007.08.020
- Kropp, M., & Meier, A. (2013, May). Teaching agile software development at university level: Values, management, and craftsmanship. In *2013 26th International Conference on Software Engineering Education and Training (CSEE&T)* (pp. 179-188). IEEE.
- Mahnic, V., & Drnovscek, S. (2005, June). Agile software project management with scrum. In *EUNIS 2005 Conference-Session papers and tutorial abstracts* (p. 6).
- Plengvittaya, C., & Sanpote, D. (2018, February). Scrumban for teaching at undergraduate program: A case study from software engineering students, University of Phayao, Thailand. In *2018 International Conference on Digital Arts, Media and Technology (ICDAMT)* (pp. 109-114). IEEE.

- Von Wangenheim, C. G., Savi, R., & Borgatto, A. F. (2013). SCRUMIA—An educational game for Teaching SCRUM in computing courses. *Journal of Systems and Software*, 86(10), 2675-2687.
- Sutherland, J., Downey, S., & Granvik, B. (2009, August). Shock therapy: A bootstrap for hyper-productive scrum. In 2009 Agile Conference (pp. 69-73). IEEE.
- Sutherland, J., Harrison, N., & Riddle, J. (2014, January). Teams that finish early accelerate faster: a Pattern language for high performing scrum teams. In System Sciences (HICSS), 2014 47th Hawaii International Conference on (pp. 4722-4728). IEEE.
- Russell, L., Goubran, R., Kwamena, F., & Knoefel, F. (2018). Agile IoT for Critical Infrastructure Resilience: Cross-modal Sensing as Part of a Situational Awareness Approach. *IEEE Internet of Things Journal*, 5(6), 4454-4465
- Zambonelli, F. (2017). Key abstractions for IoT-oriented software engineering. *IEEE Software*, 34(1), 38- 45.