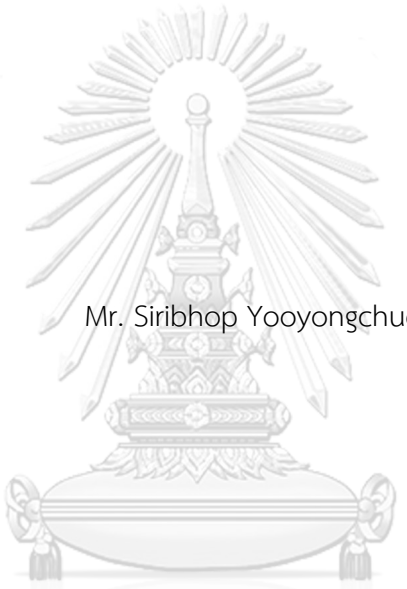
COMPARISON OF DASHBOARD DEVELOPMENT BETWEEN WATERFALL MODEL AND AGILE METHODOLOGIES

Mr. Siribhop Yooyongchuen



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นายสิริภพ อยู่ยงชื่น

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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By	Mr. Siribhop Yooyongchuen
Field of Study	Industrial Engineering
Thesis Advisor	Associate Professor Natt Leelawat, D.Eng.

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..... Dean of the FACULTY OF ENGINEERING

(Professor SUPOT TEACHAVORASINSKUN, Ph.D.)

THESIS COMMITTEE

..... Chairman

(Associate Professor JEERAPAT NGAOPRASERTWONG)

..... Thesis Advisor

(Associate Professor Natt Leelawat, D.Eng.)

..... Examiner

(Assistant Professor NANTACHAI KANTANANTHA, Ph.D.)

..... External Examiner

(Associate Professor Chawalit Jeenanunta, Ph.D.)

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Agile Methodology คือแนวคิดในการทำงาน ที่ให้ความสำคัญกับการสื่อสารระหว่างผู้พัฒนาผลิตภัณฑ์และผู้ใช้งาน เพื่อให้การพัฒนาผลิตภัณฑ์สามารถตอบสนองความต้องการของผู้ใช้งานได้อย่างมีประสิทธิภาพและสามารถ พัฒนาผลิตภัณฑ์ได้อย่างรวดเร็ว การศึกษานี้มีจุดประสงค์คือการเปรียบเทียบการพัฒนาแดชบอร์ดด้วย Agile methodology กับการพัฒนาแดชบอร์ดด้วย Waterfall Model โดยเปรียบเทียบทั้งหมด 3 ด้าน ได้แก่ ความรวดเร็วในการพัฒนาแดชบอร์ด ความพึงพอใจของผู้ใช้แดชบอร์ด และประสิทธิภาพในการใช้งานของแดชบอร์ด ใช้รูปแบบวิจัยเชิงพรรณนา ร่วมกับการวิจัยเชิงทดลอง กลุ่มตัวอย่างที่ใช้ในงานวิจัยคือผู้ใช้แดชบอร์ดของบริษัท L การเก็บรวบรวมข้อมูลนั้นทำโดยการบันทึกไทม์ไลน์การพัฒนาแดชบอร์ด การสัมภาษณ์แบบกึ่งโครงสร้าง (Semi-constructed interview) และแบบสอบถามที่ประยุกต์มาจากทฤษฎีการยอมรับเทคโนโลยี (Technology Acceptance Model) และทฤษฎีพฤติกรรมตามแผน (Theory of Planned Behavior) ผลการศึกษาพบว่า แดชบอร์ดที่พัฒนาด้วย Agile Methodology ถูกพัฒนาได้รวดเร็วกว่า สร้างความพึงพอใจให้กับผู้ใช้มากกว่า และมีประสิทธิภาพในการใช้งานดีกว่า เมื่อเทียบกับแดชบอร์ดที่พัฒนาด้วย Waterfall Model การศึกษานี้สามารถให้คำแนะนำกับผู้พัฒนาและผู้ใช้แดชบอร์ดหรือซอฟต์แวร์ด้วยวิธี Agile Methodology และ Waterfall Model ในกรณีที่จะต้องเลือกพัฒนาผลิตภัณฑ์ด้วยวิธีใดวิธีหนึ่ง อย่างไรก็ตามการศึกษานี้มีข้อจำกัดเนื่องจากการพัฒนาแดชบอร์ดทั้งสองวิธีไม่ได้ถูกพัฒนาพร้อมกัน ข้อเสนอแนะสำหรับการศึกษาหรืองานวิจัยในอนาคตคือการพัฒนาและสร้างแดชบอร์ดด้วย Agile Methodology และ Waterfall Model แบบคู่ขนาน เพื่อให้ผลลัพธ์ของการศึกษามีความเที่ยงตรงมากขึ้น

สาขาวิชา	วิศวกรรมอุตสาหการ	ลายมือชื่อนิสิต .....
ปีการศึกษา	2564	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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KEYWORD: Dashboard, Agile, SCRUM, Technology Acceptance Model

Siribhop Yooyongchuen : COMPARISON OF DASHBOARD DEVELOPMENT BETWEEN WATERFALL MODEL AND AGILE METHODOLOGIES . Advisor: Assoc. Prof. Natt Leelawat, D.Eng.

Agile Methodology is a concept that focus on communication between product developers and users. The objective is to make product be rapidly developed and effectively meets users' needs. Objective of this study is to compare dashboard development method between agile methodology and waterfall model. There are 3 dimensions in comparison; speed of development, users' satisfaction, and efficiency of dashboard. The study used descriptive and experimental research. The sample is dashboard users in Company L. The study is conducted by establishing timeline of dashboard development, semi-constructed interview, and survey applying Technology Acceptance Model and Theory of Planned Behavior. The result of this study showed that dashboard developed by agile was developed faster, provided more users' satisfaction, and provided higher efficiency compared to dashboard developed by waterfall model. This study is resourceful for developers or users those need to choose or compare between agile methodology and waterfall model. Nonetheless, this study had limitation that dashboards were not developed in parallel. To improve future study, agile dashboard and waterfall dashboard could be developed simultaneously to prevent bias.

Field of Study: Industrial Engineering Student's Signature .....

Academic Year: 2021 Advisor's Signature .....

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Siribhop Yooyongchuen

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Technology Acceptant Model Questionnaire

Gender: ☐Male ☐Female Age: .....

Position: .....Department: .....

Education background: ☐Junior High School ☐Senior High School ☐Vocational Certificate

☐High Vocational Certificate ☐Bachelor's Degrees ☐Master's Degrees or above

Faculty: .....

Question

No	Measure Definition	5 (Strongly Agree)	4 (Agree)	3 (Neutral)	2 (Disagree)	1 (Strongly Disagree)
1	The system can input easily.					
2	The system can show the information real time					
3	The system is back bone of factory.					
4	I think I would like to use this system always.					
5	I intend to know the product information.					
6	This system is easy to use.					
7	The system can conduct the result easily.					
8	The system has completely information and can use to analyze quickly					
9	Many department have to use this system					
10	I think this system has many data.					
11	I intend to know the problem and error in the process.					
12	This system help to know the problem and error in process quickly.					
13	The system can display directly and clearly.					
14	The system alert real time if the processing area have some problem					
15	Have to use the information from this app					
16	I think I can know the problem immediately if I use this system.					
17	I intend to solve the problem in process quickly.					
18	This system help to solve the problem immediately.					
19	The system can be evaluate quickly.					
20	The system help to know the problem immediately					
21	The most of information in factory is from this system.					
22	I think this system can help me to solve the problem quickly					
23	This system has the truly and precisely data.					
24	The system is easy to learn and easy for first using person.					
25	The system help to solve the problem in processing area immediately					
26	I think this system is easy to use and export the data					
27	The system is easy to export the data.					
28	The system has big data which can be useful in the future					

Chapter 1

INTRODUCTION

The logistic industry is the industry in that Thailand has the advantage in geography because Thailand is located in the center of the ASEAN. The transportations and logistics are comparabled to the blood vessel that transport the products to the customers. Therefore, logistics management directly affects the cost of products.

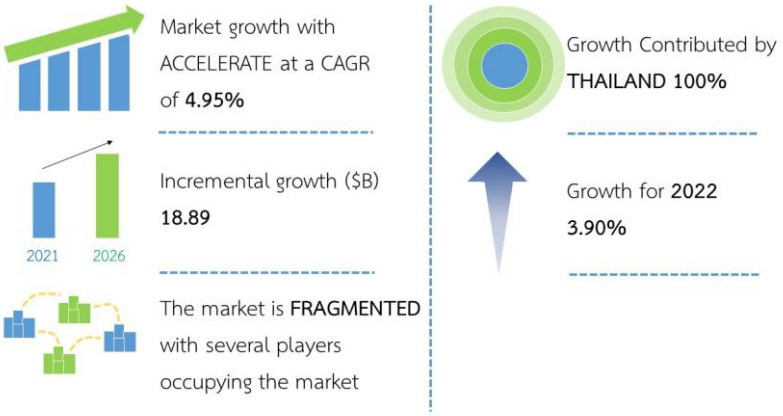


***Figure* 1** Attractive Opportunities in Logistics Market in Thailand by End-user and Function - Forecast and Analysis 2022-2026

Adopted from: Technavio (2022).

According to Figure1, the growth in the logistics business came from the exponential growth of technology that change consumer behavior. Many people order the products or services via E-Commerce, so the logistics business must transform to logistics 4.0. Customer satisfaction in the logistics business can be divided into two types. First, the physical products must be sent within lead time and with no defect. Another is the data that customers can trackable any time after ordering the products.

1.1 Background of study company.

Company L is a large third provider logistics company in Asia that serves many types of logistics to the customer such as Distribution Center Management, Transportation Management Services, E-Commerce fulfillment, Value-Added services, etc. This company can deal with many industries such as fashion, FMCG, Food & Beverage, Beauty & Wellness, Electronics, and Healthcare.

The network of this company has more than a million customer orders per week and has 223 distribution centers. In Thailand, this company has four services. There are Distribution Center Management, Transportation Management Services, E-Commerce fulfillment, and Value-Added Services. This study was focusing only on the Transportation Management Services.

1.1.1 Transportation Management Services in Thailand

More than 20 business units of customers which use the service of transportation management in Thailand. Company L has three main distribution centers which are located in Bangna, Bang-pa-in, and Ladkrabang. In addition, these distribution centers are the consolidation centers which the headquarter of transport management services is located in Bangna. Since the covered all area in Thailand transportation, there are 8 hubs in Thailand located in Chiangmai, Nakonsawan, Khonkaen, Udonthani, Nakornratchasima, Ubonratchatani, Suratthani, and Songkla.

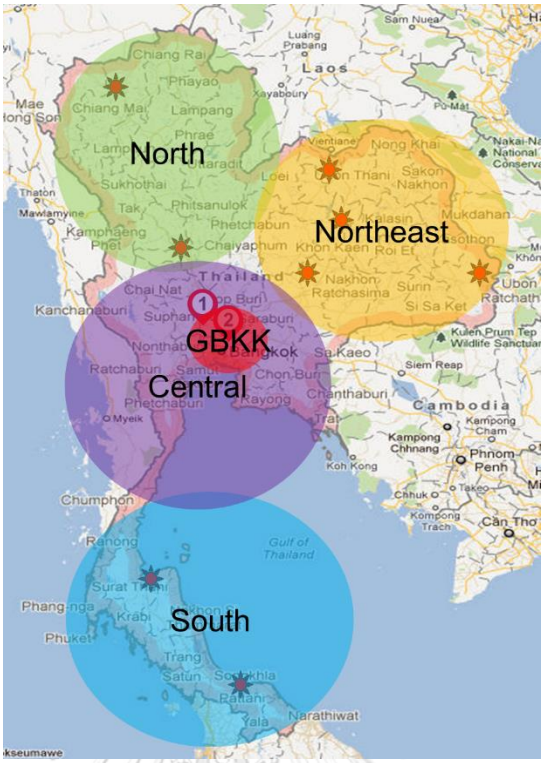


Figure 2 The location of Company L's hubs and covered area

There are two main types of transportation in company L that customers can choose to use the service. First, dedicated delivery is to transport the products only one business unit to the destination for less lead time. This type of delivery is suitable for the high volume of parcels. Second, consolidated delivery is to transport products with consolidated other business-type units. It is cheaper than dedicated delivery but it has much lead time.

1.1.2 The data flow and visualization

The orders from customers have the interface between the system of customers and the Company L system. The first system of company L is the warehouse Management System(WMS). When customers order on their system, the interface will order to WMS. The picker will pick up the items in the warehouse and ship them to the transportation department. The data will interface from WMS to Transport Management System(TMS). This system handles all functions of transportation. The delivery status tracking is included.

The customers can access to delivery status tracking module via the web browser. The delivery status came from the driver who transports each shipment. The driver will update the delivery status via TMS mobile application. However, it was not one-hundred percent of drivers update the delivery status. Therefore, the transportation department would like to have a dashboard of TMS mobile tracking status usage.

1.2 Problems

Since Company L in Thailand has no in-house developer, this company must hire an outsource to develop the dashboard. The first dashboard that the transportation department required was dedicated TMS mobile tracking status usage. The outsourcing was developed the dashboard with Waterfall Model and found the problems below:

-The transportation department wanted to change the requirements after the dashboard was delivered.

-The transportation department had feedback in the user-hostile dashboard.

-The dashboard delivery date was delayed from the plan because outsourcing found some bug in the system testing phase and must redo the dashboard from the beginning

1.3 Objective

- To compare the software project management between the Waterfall model and Agile methodologies.

- To use the Technology Acceptance Model (TAM) and Theory of Planed Behavior (TPB) to explore the behavioral intention to use the actionable data visualization of transportation department staff.

1.4 Scope of Study

This thesis is studied only the transportation management service of Company L. This study will develop an actionable data visualization for Company L. This visualization will be the consolidation of TMS mobile tracking status usage which

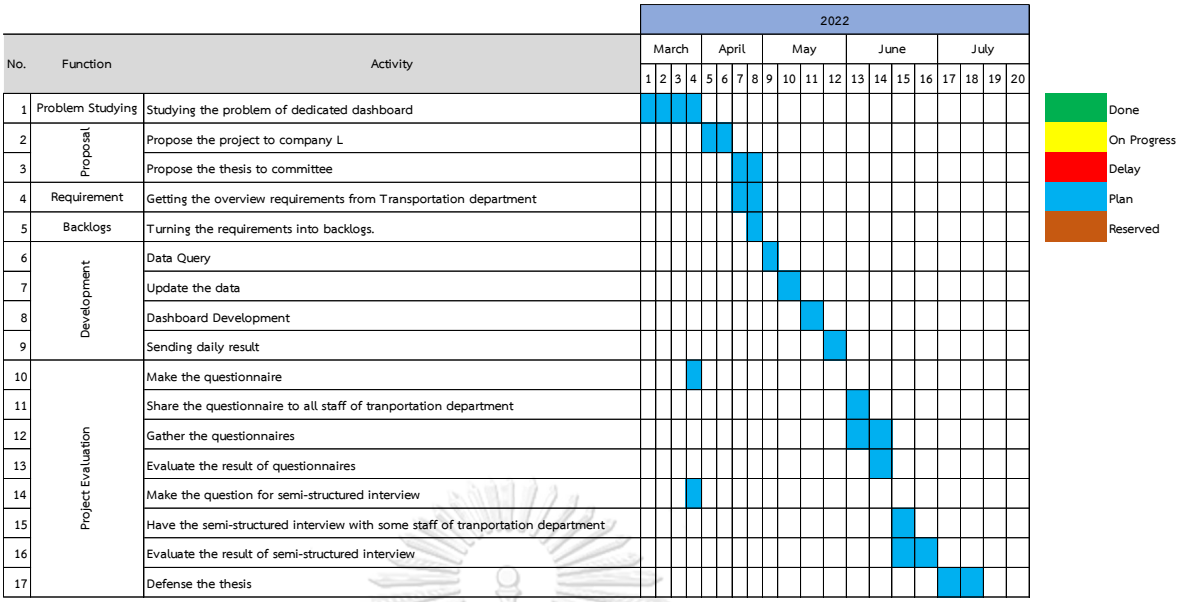
can refresh the updated data every 15 minutes by using Robot Process Automation (RPA). The project management that uses for this study is Scum Model. The software that is used to create the dashboard is Microsoft 365.

1.5 Expected Benefits

- The outsourcing delivers the software project on time.
- The outsourcing makes more customer satisfaction on a software project.
- To increase the percentage of delivery status report to meet the customer requirement.

1.6 Timeline

For the process of dashboard development, this study uses the Agile Methodologies. In addition, the methodologies of Agile used for this study is Scrum. Therefore, the timeline of this study has iterative tasks. This iteration can make more satisfaction of customers because every iteration must get any feedback from users.



No.	Function	Activity
1	Problem Studying	Studying the problem of dedicated dashboard
2	Proposal	Propose the project to company L
3		Propose the thesis to committee
4	Requirement	Getting the overview requirements from Transportation department
5	Backlogs	Turning the requirements into backlogs.
6	Development	Data Query
7		Update the data
8		Dashboard Development
9		Sending daily result
10	Project Evaluation	Make the questionnaire
11		Share the questionnaire to all staff of tranportation department
12		Gather the questionnaires
13		Evaluate the result of questionnaires
14		Make the question for semi-structured interview
15		Have the semi-structured interview with some staff of tranportation department
16		Evaluate the result of semi-structured interview
17		Defense the thesis

Figure 3 Timeline of Thesis

Chapter 2
Literature Review

Before making the application, this study must mention the methodology of project management that is suitable for software projects. In addition, this study must contain other ways to reduce the finished goods inventory. After implementation, the team project must survey the opinion of users regarding this application acceptance using Technology Acceptance Model.

2.1 Agile Methodologies

For making the application of the statistical process control dashboard real-time, this study used the methodologies of Agile to be the main application project development.

There were many software development life cycle models, but Agile methodologies were very popular in software project management because the customer could see the project progress every partially incremented software delivery and feedback to the project management in that part of the software. Hence, this strategy affected good customer satisfaction in faster development and lower defect rate (Tena, 2020).

2.1.1 Background of Agile Methodologies

The meaning of “Agile” from the dictionary is “able to move quickly and easily”. The root word of “Agile” came from agility. In 1994, the software engineer team found the problem of Waterfall Model that each process must wait for the job from the previous process as shown in Figure 4. For example, the implementation process must wait for the design. In 2001, seventeen software engineers had a meeting, and the summarizing of the meeting was the Agile Manifesto (Novac, 2018).

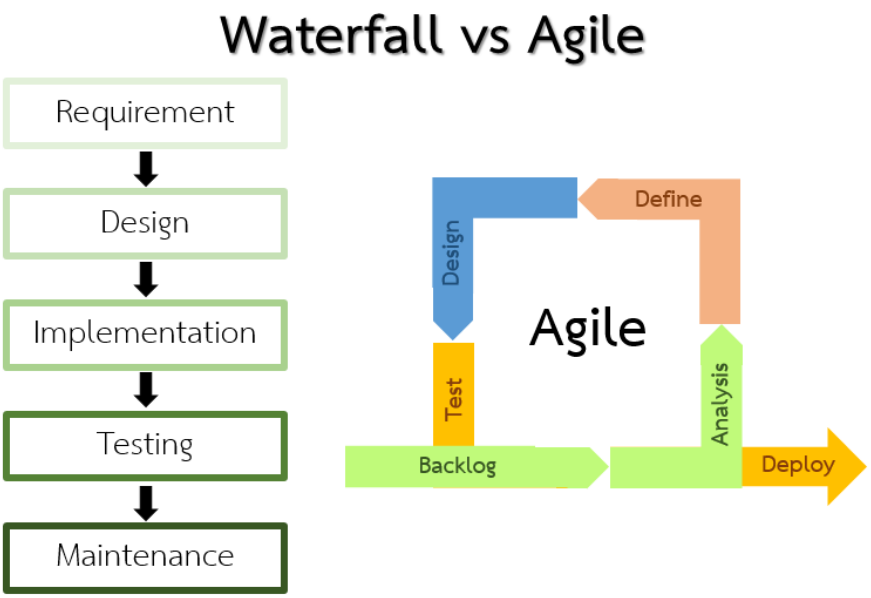


Figure 4 Waterfall Model vs Agile Methodologies
Adopted from Mohamed (2019, p.3).

Figure 4 shows 4 core values of the Agile Manifesto. Firstly, the interaction between persons was more important than processes and tools. Secondly, the software that could use in real life was more important than the documents. Thirdly, corresponding with the customers was more important than the negotiation in the contract. Finally, flexible work was more important than working with a plan (Pratt, 2020).

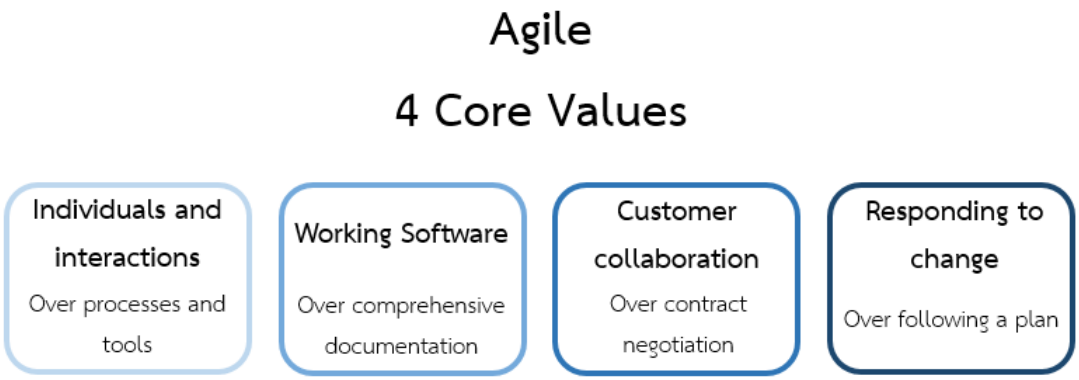


Figure 5 Four Core Values of Agile Methodologies
Adopted from Ågerfalk (2006, p.4).

2.1.2 Concept of Agile Methodologies

The agile methodologies were the iterative methodology in software development. The iteration was composed of receiving the requirements, requirement analysis, designing the flow of software working, coding the software, testing the software with the team, delivering the partial software to the customer, and getting the feedback. Thus, the customer requirement was changeable to respond to the real customer need as shown in Figure 6. Since customer satisfaction was very important, Agile methodologies always considers them the priority of software project management (Sharma, 2012).

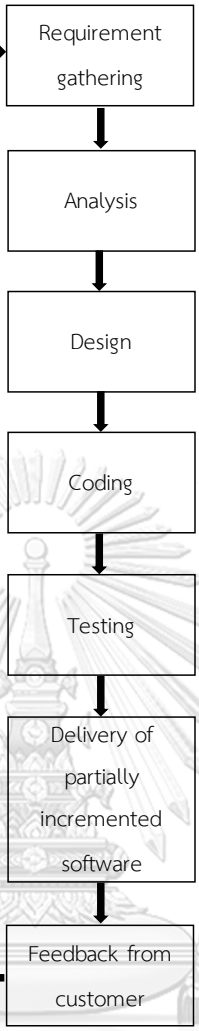


Figure 6 The iteration of Agile Methodologies

Adopted from Sharma (2012, p.2).

2.1.3 Methodologies of Agile

There are many methodologies of Agile. However, there are the top 3 main Agile Methodologies those are widely used in software management projects. The difference between methodologies of Agile is in the aspect of focusing.

2.1.3.1 Scrum

The project management which used Scrum as a methodology of Agile Methodologies were to reduce the complexity of the problems, reduce the step of work processes, and able to work with flexibility. Although the position in business

was classified as the level of work, people in the team must help to do the project in Scrum methodology (Finlay, 2021).

There are three main positions of Scrum as shown in Figure 7. First, the Product Owner had the main responsibility in the evaluation of every process in the project and arranging the priorities of work. In addition, this position must assign each task of work to everyone in the team. Second, a Scrum Master was the person who solves every problem in the project. That made the process flow without interruption and focused on how to work better. The last position was developed the team. Everyone in the project worked with self-management. Moreover, this team had all positions in development such as designer, programmer, and tester, so the team of the project can do the project from the beginning date to the project's end (Sommer, 2011).

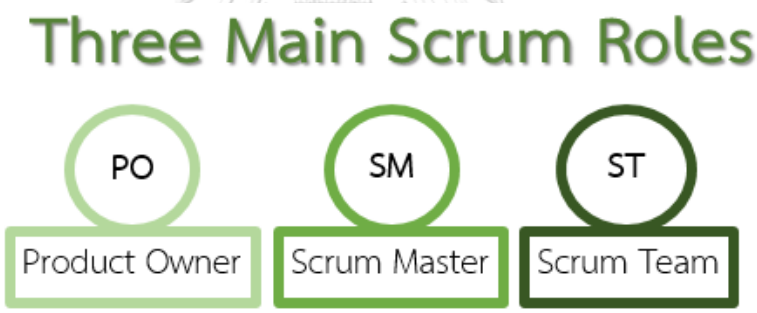


Figure 7 Three positions in Scrum
Adopted from Sverrisdottir (2014, p.4).

The beginning step of Scrum was collected the user requirements, but these requirements were not necessary to come out from the customers. They could add or remove some requirements at the end of a sprint. The Product Owner transformed the requirements of the customer into the User stories and arranged the priorities of tasks. This story described the requirement that is mentioned type of development, what technologies that customers need, and the benefits of this requirement. Then, the planning sprint meeting was organized at least 1 time per month. This meeting was made to plan what functions or products will be sent to

the customer and how to make those functions or products. The next step was Sprint backlog. The team develops the product or software in the sprint phase. This sprint phase had a short daily meeting to update the progress and took some feedback from the team called Daily Scrum Meeting. The period of each sprint must not be more than 30 days. The iteration happened between the phase of backlog and sprint. Finally, the iteration was ended with the satisfaction of customers. A review of the sprint meeting will be organized after the sprint phase. The purpose of this meeting was to send the developed function or task and get feedback and more requirements from customers. The final step was Sprint Retrospective. This step was to send all functions and products of each sprint to the customers. If the customers were not satisfied with something, the product owner must re-do the Product Backlog and do every step again (Zikopi, 2019). The summary diagram is shown in Figure 8.

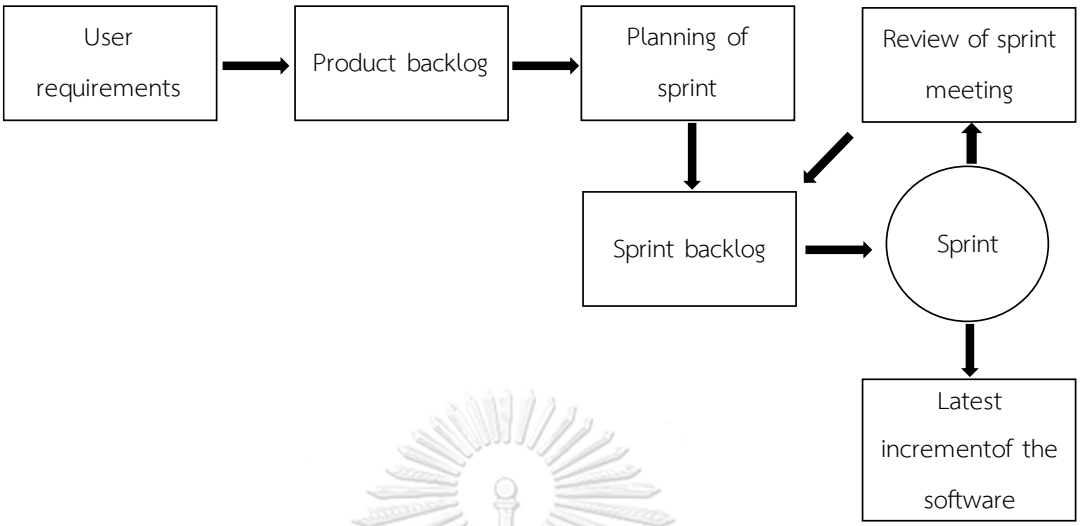


Figure 8 The step of Scrum Methodologies
Adopted from Sharma (2012, p.4).

There were many advantages to Scrum. A big project could manage easily by this methodology. The efficiency of development was very high because Scrum Master could eliminate the problem of project duration. From the daily Scrum meeting, the team knew the progress and problem of development. In addition, the team always receives feedback from customers after the Sprint phase and improved that product or software until the customer was satisfied (Chandana, 2021).

On the other hand, the daily Scrum meeting could make the team feel bored. The danger of this kind of methodology was that someone left the team. It could affect all projects because the complexity of the design was complicated.

2.1.3.2 Extreme Programming (XP)

Extreme Programming methodology was used to improve the software quality and respond to the changing requirements of the customer. The development of software had a short cycle as shown in Figures 9-12. This cycle had a lightweight process composed of Planning, Design, Coding, and Testing. After that, the software was released with a small feature because the developed software could be sent to the customers and got feedback to add or remove some functions, so the

communication of all stakeholders was very important. Moreover, the customers could send new requirements at any time during the project (Yadav, 2019).

This methodology had 5 principles. The first principle was communication. The developer must communicate with the customers and other developers. Simple was the second principle. That meant the developers must do simple code, flow, and design. The third principle was feedback. The developers must respond to the customer needs and test that function early. The fourth principle was respect. Every person was assigned to a project contributes to a common goal. Finally, Courage meant the developers must present the software as soon as possible for getting feedback and improve that software (Altexsoft, 2021).

The XP methodology could use when the requirements of customers are uncertain. Sometimes, the customers do not know their exact requirements ,especially for new technologies. (Wood, 2013).

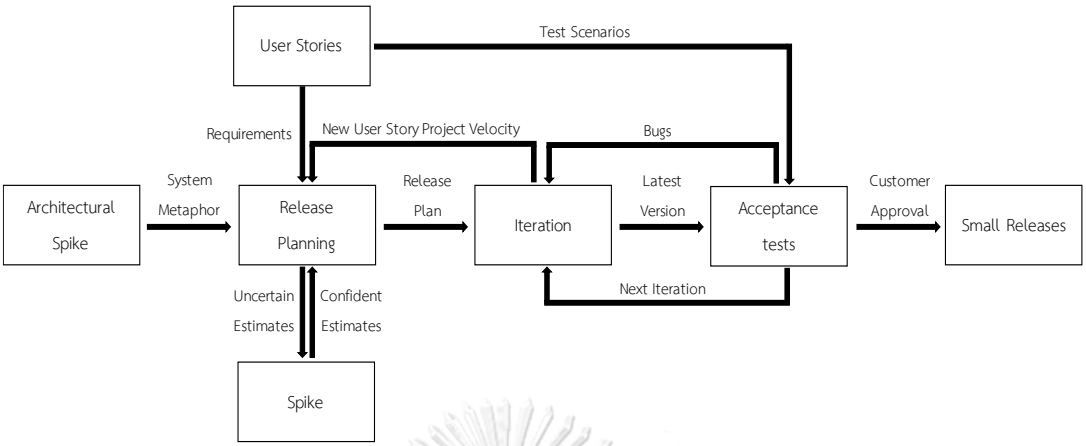


Figure 9 The implementation diagram of XP: Overview
Adopted from Wells (2009).

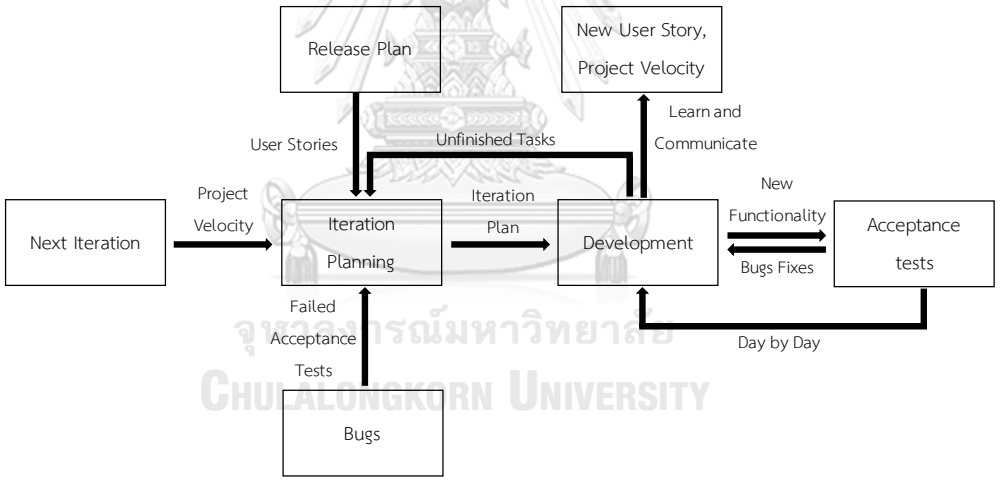


Figure 10 The implementation diagram of XP: Iteration
Adopted from Wells (2009).

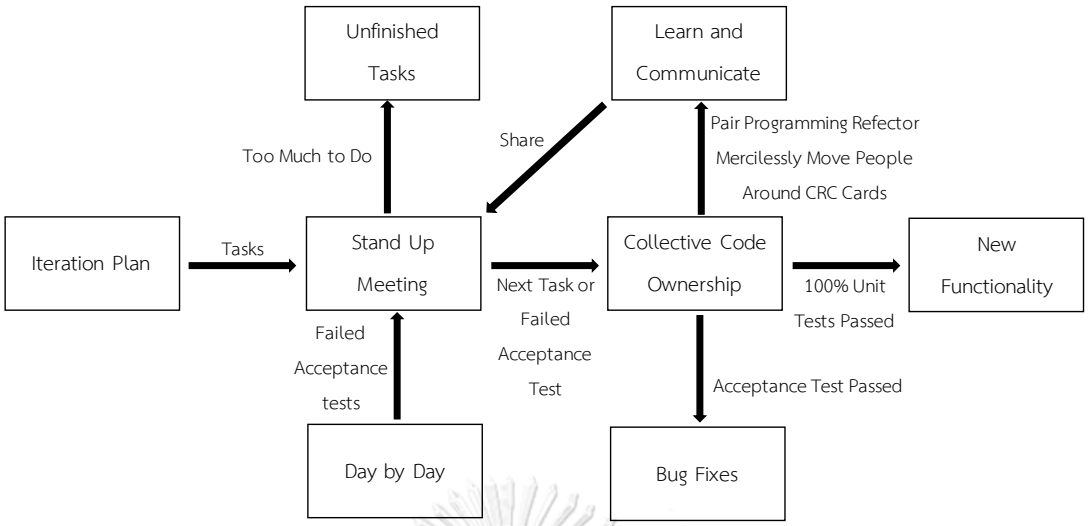


Figure 11 The implementation diagram of XP: Development Adopted from Wells (2009).

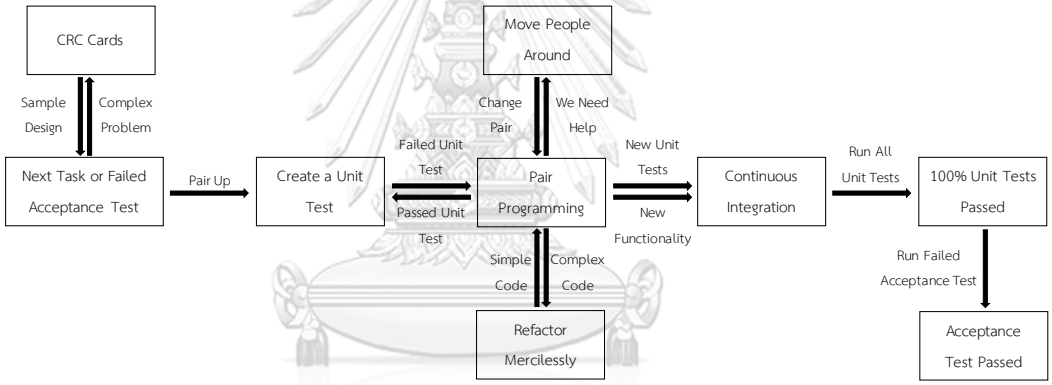


Figure 12 The implementation diagram of XP: Collective Coding Adopted from Wells (2009).

There were 12 practices for this methodology (Sbasu06, 2015):

1. Pair Programming: Two developers did code together.
2. Planning Game: There was released planning and iteration planning. Releasing Planning was taking the requirement of customers, but iteration planning was the development plan.

3. Test-driven development: the step of testing in each part.
4. The whole team: The corresponding came from the users and developers.
5. Continuous integration: The continuous development of software was important, but the adding of new functions could be a new problem.
6. Design Improvement: The design must be simple and easy to adjust in the future.
7. Small Release: After finishing each function, the developers must send it to the customer for getting some feedback.
8. Coding standard: Developers must code with the standard format.
9. Corrective code ownership: Developers must allow others to edit their code.
10. Simple Design: The design must be understood by others easily.
11. Metaphor: The naming of a variable or function must have meant.
12. Sustainable pace: The team should not do work more than 40 hours a week.

XP methodology was dominant in on-site customers. The software was always developed with the customer's needs. Customers could participate in the design and making of the user stories. In addition, the coding was simple, so the team can continuously code when someone left the team. Although the code was simple, the other developers still took much time to read all code. This methodology could not affect the small project because it did not focus on designing. It was a good thing for customers that always adjust the requirements, but it was not good for the project cost because all changes had pricing (Kukhnavets, 2018).

2.1.3.3 Kanban

The meaning of Kanban was the signal or sign. Kanban was improved by Toyota in the 1940s. The project was divided into small tasks. Then, all tasks were put into the card with one task per card. After that, the cards were structed on the board which this board was divided into the status of the work column. For example, the board was divided into the To-Do column, the doing the column, and the done

column as shown in Figure 13. If task 1 was finished already, the card of task 1 will be stuck on the done column (Ahmad, 2013).

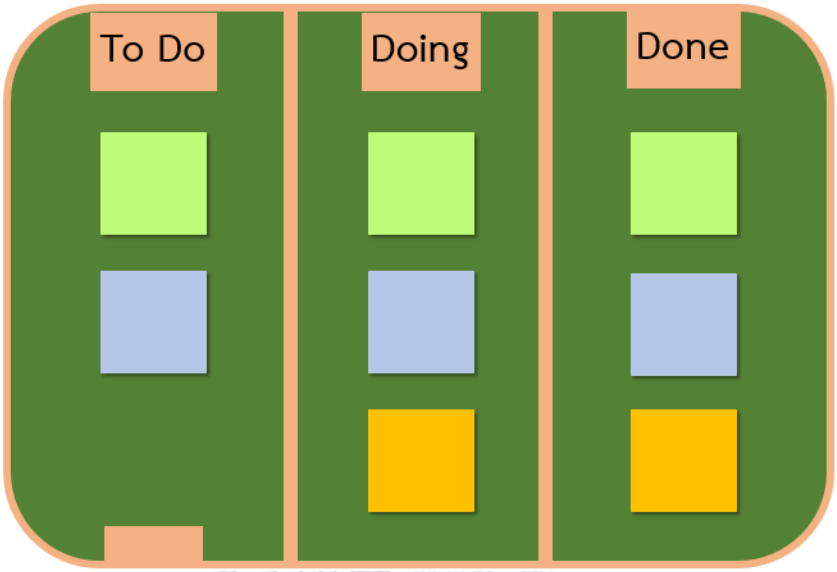


Figure 13 Kanban board

Adapted from Bass (2016, p.5).

For the software developed management, the name of the column was the software development status such as Backlog, Developing, Testing, UAT, and Done as shown in Figure 13. The tasks put in the cards are the user story or user requirements.

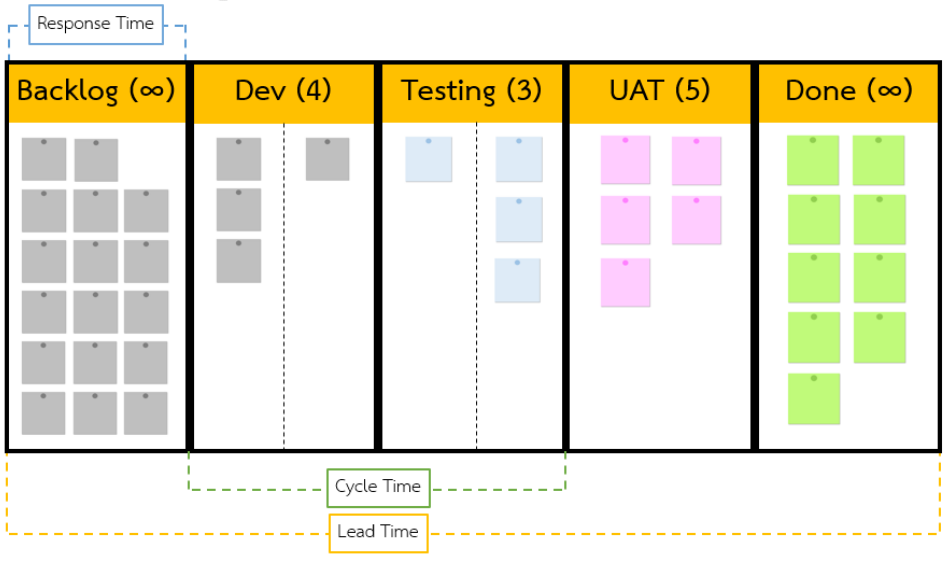


Figure 14 Kanban of software development management

Adapted from Bass (2016, p.5).

There were 5 main principles and benefits of Kanban (Sarandeska, 2019).

1. Visualize the workflow
2. Limit Work in Progress (WIP)
3. Make Policies Explicit
4. Measure and Manage Flow
5. Identify Improvement Opportunities

2.1.3.4 Comparison of top 3 Agile Methodologies

Table 1 shows the comparison between Scrum, Extreme Programming, and Kanban.

Table 1 Comparison of Scrum, XP, and Kanban.

Parameters	Scrum	XP	Kanban
Principle of Design	Complex	Simple Code	Limit WIP
On customer site	Optional	Necessary	Optional
Complexity of Design	Complex	Simple	Simple and Visual
Project Coordinator	Scrum Master	XP Coach	The team
Role	Product Owner Scrum Master Development Team	Not Assigned	Not Assigned
Process Ownership	Scrum Master	The team	The team
Product Ownership	Product Owner	The team	The team
Collaboration	Cross Function Teams	Self-Organizing Teams	Specialist
Workflow	Sprints	Task Flow	Short iterations
Delivery	End of sprint	Continuous	Continuous
Coding	No standard	Standard Format	No standard
Testing	No Formal	Acceptance Test	Testing each work product
Requirement Change	Cannot Change in Sprint Phase	Change in Development Phase	Change is allowed at anytime

Note. Adopted from Matharu (2019, p.5).

2.1.4 The methodology of this study

According to the top three Agile Methodologies, this study is to develop an application that turns the Q plan parameters into statistical process control for real-time. Now, the requirement of the customer is cleared, and the team has the limitation for on-site work. By the way, the organization can meet via an online platform. Therefore, this study is proper to use the Scrum methodology.

2.2 Technology Acceptance Model (TAM)

Many companies had the problem that the companies investing the new technology to increase work performance, but this investment had no return because the user did not use that technology. Some companies either hired the trainer of new technology to train their users or made the KPI use new technology, but the user still could not use this technology. The Technology Acceptance Model (TAM) was the primary theory that made to understand the user to accept or decline the technology.

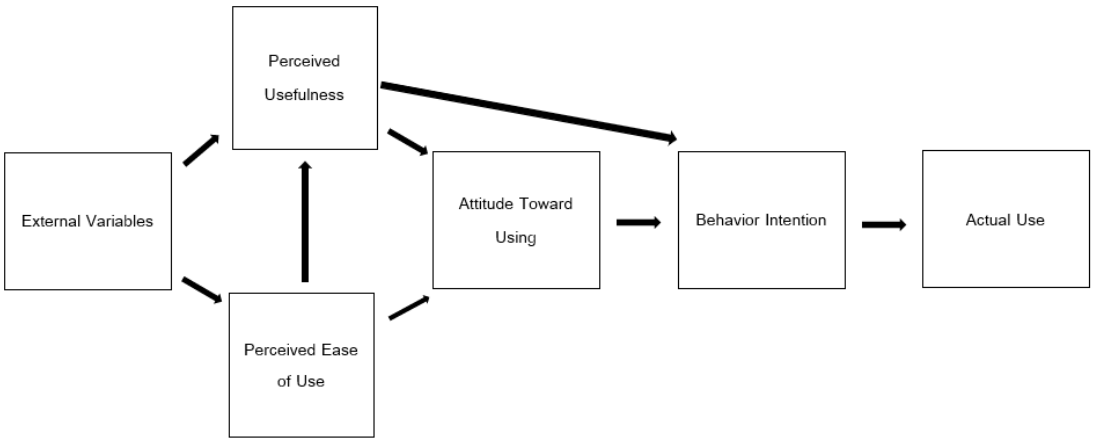


Figure 15 Technology Acceptance Model

Adopted from Miller (2010, p.3).

In Figure 15, users will accept new technology when users had the behavioral intention to use this technology (Ma, 2005). The intention to do something for a human was made of a positive attitude. Therefore, the user must have the attitude toward using to have the behavior intention to use new technology. On the other hand, the usefulness perceiving of technology was more effective to make the using

technology intention than the attitude toward using. For example, when new technology could help users to eliminate some unnecessary work of the user, the behavioral intention to use this technology had suddenly happened. Perceived ease of use in technology affected perceived usefulness and attitude toward using the technology. Humans did not like difficult things, so the technology must be designed for ease of use for users. The other things that could affect the perceived technology usefulness and ease of use of technology were the external variables. There were many external variables such as the beauty of the interface, the training of the system, and the work instruction.

For successful implementation of new technology in the companies, the companies must consider these factors before investment. Moreover, the prototype making could receive the feedback of users to develop the actual new technology.

2.3 Theory of Planned Behavior (TPB)

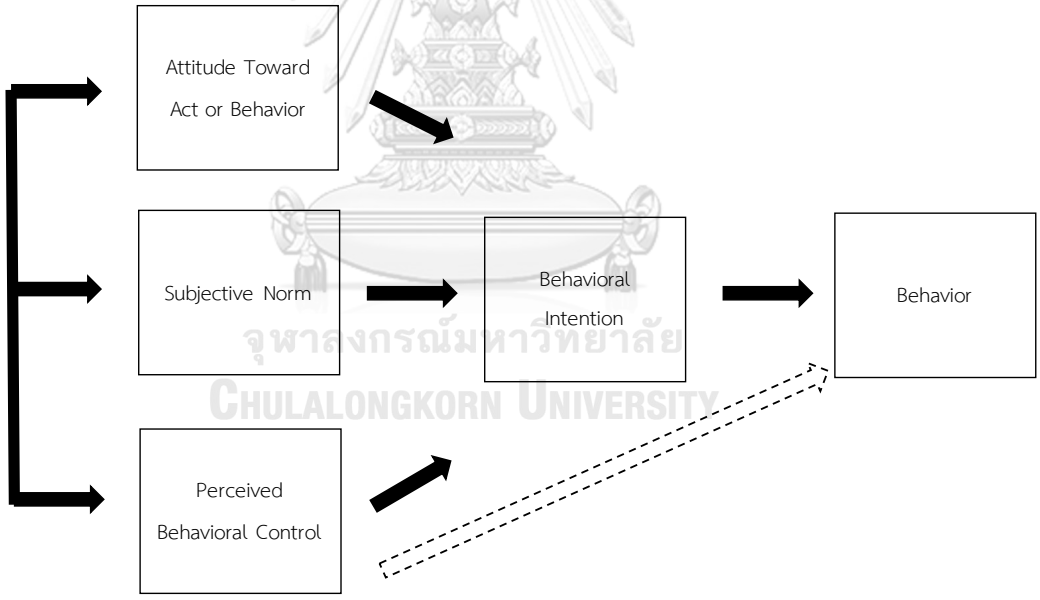


Figure 16 Theory of Planned Behavior

Adopted from Ajzen (1991, p.4).

Figure 16 shows the theory of Planned Behavior which mentions that the behavior of humans was influenced by behavioral intention. This intention consisted of 3 factors. There were Attitude Toward Act or Behavior, Subjective Norm, and

Perceived Behavioral Control. Especially in the factor of Perceived Behavioral Control, this factor directly affected the behavior of humans (Ajzen, 1991).

Attitude Toward Act or Behavior was made of behavioral beliefs. When humans did something that consequent a positive result, they will have a good attitude toward acts or behavior. A good attitude will make the intention of behavior.

Subjective Norm was made of normative beliefs. When the people that they were believed or trusted to do something, they will have the opportunity to do the same thing. In addition, most humans will have the same behavior with the social normative.

Perceived Behavioral control was made on personal beliefs. This control was a personal assessment of the difficulty to show some behavior in each situation. In addition, humans will do something when they believe that they can show that behavior in the situation.

Therefore, this theory could be combined with the Technology Acceptance Model because they had the same variables. There were Attitude Toward Act or Behavior and Behavior intention.

2.4 The questionnaire approach based on Technology Acceptance Model

(Abu-Dalbouh, 2013) Conducted the questionnaire survey which was designed for asking the technology acceptance model for the user should be the quantitative questionnaire because it could show the trends of population or relationship between each variable. Moreover, the result of a quantitative questionnaire was easier to conduct than the qualitative questionnaire.

(Joshi, 2015) conducted the questionnaire survey with a Likert scale was designed to receive the result of how strongly subjects agree or disagree with that statement. (Russo, 2020) There were many reasons to use 5 points Likert scale such as less confusion, higher reliabilities, increase response rate, and reduced frustration level. There were (1) strongly disagree, (2) disagree, (3) nature, (4) agree, (5) strongly agree.

(AL-Omari, 2012) applied the sampling technique was the technique that how to use a small number for users to be the substitute of all users. The sample will be

the subset of the population. Therefore, the result of the small number of users will be the result of all users.

(Abu-Dalbouh, 2013) mentioned three purposes of the data analysis. The first purpose was to get an overview of the sample data and attributes. The next purpose was the testing of data goodness. The last purpose was to validate the hypotheses.

(KANTHAWONGS, 2018) conducted questionnaire should contain personal information, perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention.

Each factor must have several questions to evaluate the effectiveness of the technology.

The proposed methodology was not specific only to the technology acceptance model but also based on the combination of other literature and the experience of the author.

2.4.3 Development of Technology Acceptance Model Questionnaires

(Abu-Dalbouh, 2017) suggested that the set of questions should be created to answer only one variable. For instance, one set of questions can only specify the perceived usefulness of technology, while other sets of questions can only specific to each other.

The questionnaire should ask about the educational background, and the department of their work because the knowledge of technology directly affected the perceived ease of use and perceived usefulness.

The technology acceptance model questionnaire should be surveyed before technology implementation. It could be the decision of the technology implementation. For example, if the result of the questionnaire was not good, the implementation of this technology can be failed. Moreover, wrong IT tools can affect productivity decreasing, profit loss, etc.

Chapter 3
Research Methodology

For company L, the delivery status is important. It is not only to increase customer satisfaction but also to meet the requirement of customers. Since the contract between company L and customers always mentions the delivery status that must report to every company L's customers more than 99 percent, company L must monitor the TMS mobile tracking status usage. However, the data is updated every 15 minutes which company L's server can automatically send by email to administrators. On the other hand, they can only gather all data and make a graph for the manager once a day because of their workload. The actionable data visualization can solve this problem because this program will refresh the data on the dashboard automatically in a minute. The outsourcing was used to develop the dedicated truck type TMS mobile usage tracking status dashboard with Waterfall Model but it had many problems such as the delay of dashboard delivered, user-hostile dashboard, and changing requirements after the dashboard was delivered. Therefore, a consolidated truck type TMS mobile usage tracking status dashboard will be developed with the Scrum Model by outsourcing. After the dashboard is delivered, the outsource will send the questionnaire to all users for testing the Technology Acceptance Model and Theory of Planned Behavior. Finally, the outsource will interview some of the users to compare between Waterfall Model and Scrum Model.

3.1 Assigning the team

According to Chapter 2, that scrum is composed of three positions. There are Product Owner, Scrum Master, and the Scrum Team. For this study, the Product Owner will be assigned to the technical sale of outsourcing because this position is the specialist in this business and has the basic knowledge in data visualization. This

position is also well known in the user requirements and all stakeholders as shown in Table 2. In addition, this position must arrange the priorities of tasks or the backlogs in which the most important task will come first.

Table 2 Comparison of Scrum Role and Project member

Scrum Role	Responsibility	Outsource Position	Skills and Knowledge
Product Owner	Transforms the requirements of the customer into the User stories and arranges the priorities of tasks.	Sale	Transport management and data visualization
Scrum Master	Solves every problem in the project. That makes the process flow without interruption and focus on how to work better	Software Project Manager (Author)	Project Management, Software Background, Production basic Knowledge
The team	Develop the software and application	Developers	Coding and making the dashboard

Scrum Master will be assigned to the software project manager. This position will manage the overview of this project to align the plan with Scrum methodology and eliminates the problem that happens during the period of this project. By the way, this position cannot order to the Product Owner or the Scrum Team

The Scrum Team or development team is everyone in the team. This team can program the application with self-organization. The member of the team has a different skill. For example, someone is outstanding in application programming, and another is outstanding in business intelligent dashboard making.

Table 3 The developer team

Developer Team	Responsibility
The RPA team and Author	Create the auto bot to save the data that come from the email.
The queries team and Author	Transform the received data to readiness data.
The dashboard team and Author	Making the dashboard that able to show customer requirements.
The notification team	Coding the email notification follow the setting rule.

3.2 Getting the requirements

After studying the problems, the Product Owner gets the requirements from the company L and transforms them into user stories. The first story automatically downloads the CSV file from the email attachment. According to the automatic email with CSV file attachment from the server, the administrators must download to the local drive manually. The outsourcing team must find a way to eliminate that manual process. Since the data that come from the server is raw data that is not ready to make a dashboard, the second story is about transforming raw data and gathering them into one file for readiness data before dashboard data importing. The third story is making the dashboard to fulfill the satisfaction of Company L users. Finally, automatic email sending is the necessary function because it can report directly to company L's manager. This report will only be sent when any shipment did not use the TMS mobile application after 24 hours from picking up the parcel to last-mile delivery.

3.3 Understanding all user stories

Product Owner transforms all stories into product backlogs. Each product backlog must contain the information of the story, the software testing, the evaluation, and the duration of development. Then, the Product Owner does the Sprint planning or arranges the priority of backlogs. These are arranged into 4 tasks. There are attachments downloading from email by RPA, querying the data, making a dashboard, and automatic email sending. In addition, each task will be divided into small backlogs. The development team can monitor the status of each backlog with Sprint Backlog.

3.4 Attachment downloading from email by RPA

The Product Owner and the team divide this task into 4 backlogs. There are the comparisons between robot process automation programs, coding, testing, and meeting with Company L. The priority of backlog is respectively as shown in Figure17.

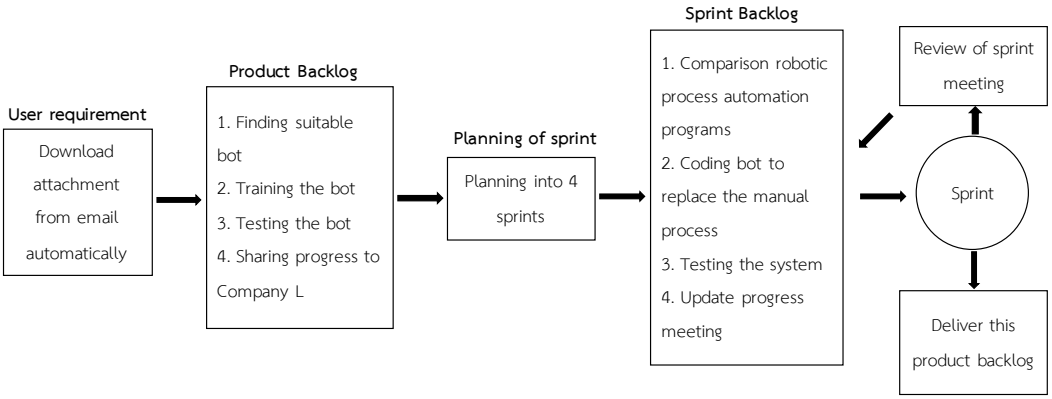


Figure 17 The step of Attachment downloading from email by bot Adapted from Sharma (2012, p.4).

3.4.1 Comparison robotic process automation programs

Robot Process Automation (RPA) is a software robot that can copy the human are done a computer. The developer will code the robot by process designing and workflow creation so that the robot can automatically decide to do something. It is suitable for iterative work or routine work (Gami, 2019).

There are many programs of RPA. Scrum Master made the Table for the RPA program comparison and presented it at the Scrum meeting. As mentioned in Chapter 2, all positions have the daily Scrum meeting for 15 minutes. This meeting has three questions. What the team was done yesterday? What things to do for today? And what is the problem that the team found?

Figure 18 Quadrant for Robotic Process Automation
Adopted from Muller (2021).

The minute of the daily Scrum meeting was choosing the RPA of Microsoft. Although Figure 18 showed the RPA that had high completeness of vision and ability to excuse which there are UiPath, Automation Anywhere, and Microsoft respectively, this RPA must connect with another program of Microsoft. The email attachment downloading will use through the Outlook program. Therefore, the RPA of Microsoft (Power Automate) can connect to Outlook directly.

3.4.2 Coding bot to replace manual process

Product Owner contacted Company L to request the video of downloading the attachment file process by administrators. The team listed the step of downloading. There were three main steps. First, the administrator found the email with the name of the subject. Then, the administrator opened the email and save the attachment on a local drive. The administrator must set a loop in more than 90 times to collect all emails in a day (1 email per 15 minutes) and presented them at Scrum Meeting.

Table 4 Comparison between Old process and reprocess

Process No.	Old Process	Reprocess
1	Find the email by searching	Create the rule on Outlook
2	Open the email	Trigger by new email received
3	Save the attachment	Save the attachment by RPA
4	Loop the process	Loop when have the trigger

The minute of the scrum meeting was to reprocess and combine with the RPA. First, the team created the rule on Outlook. If the name of the sender is the server name and the subject name is the TMS mobile usage tracking status report of dedicated truck type, it will be kept in a specific Outlook folder. That folder name is “Auto e-mail Dedicated Report”. Then, the team will code the RPA that can

download attachments from a new email which the email is in the “Auto e-mail Dedicated Report” folder. The summary of reprocessing is shown in Table3. The testing result and partial software delivery will be in Chapter4.

3.5 Query the data

Since the raw data was separated into 15 minutes data per CSV file and the data was not ready to import to the dashboard, the team must gather all data into 1-day data per CSV. Then, the team will delete the unnecessary column. In addition, this CSV file is a text column, the team must change the column type to the correct type. For example, the column of a timestamp is the text data type, so the team must change to the time data type. The program to query all data is Power Query. Company L has the license of Microsoft 365, the team will use Microsoft 365 for all processes.

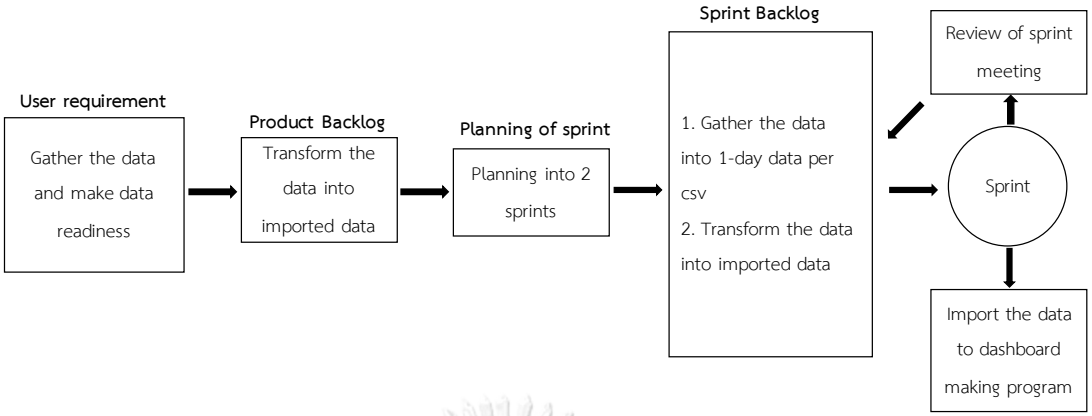


Figure 19 The step of query the data
Adapted from Sharma (2012, p.4).

The team plans to put the imported data on the cloud because Company L can utilize the 1-day data which has transformed already into the future.

3.6 Developing the Dashboard

The team must make the business intelligence dashboard so that the users can understand the data easily. In addition, the business intelligence dashboard will be made by Microsoft Power BI with the Microsoft Power Automate. Microsoft Power BI is a dashboard-making program that can publish online. Moreover, it can create an authorized person who can access a published dashboard. For Microsoft Power Automate, it can refresh the data on the dashboard automatically by triggering after a new email arrived in a specific folder name. The Product Owner plans as shown in Figure 21 to finish this task in 7 days. On the other hand, the sprint depends on the satisfaction of the Quality Assurance Team.

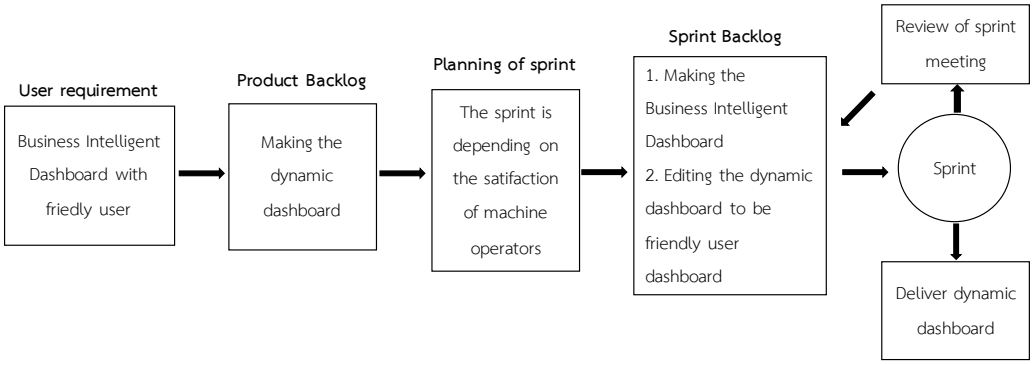


Figure 20 The step of making TMS Mobile Usage tracking status of dedicated truck type dashboard

Adapted from Sharma (2012, p.4).

This dashboard should be able to filter the date and supplier of company L that users would like to watch and follow to the supplier with shipment ID as shown in Figure 21.

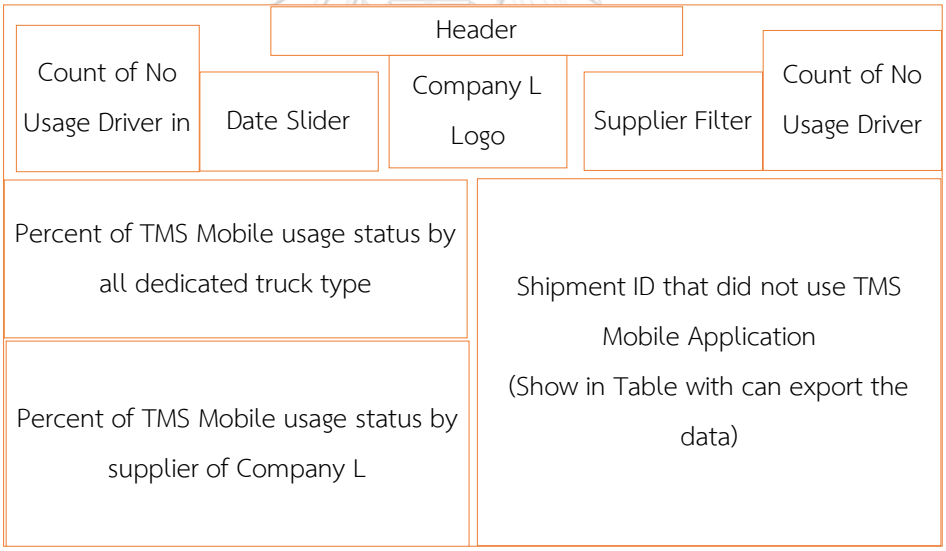


Figure 21 The draft dashboard of TMS Mobile Usage tracking status of dedicated truck type dashboard

3.7 Email Notification

This is the final part of dashboard development. The team had a meeting to develop the email notification by using RPA. The flow of notifications will continue after the process of data refreshing. This email notification will happen when the updated data still have the shipment ID which did not use the TMS mobile

application. The Product Owner planned to sprint 3 backlogs. There is coding, testing, and the project delivering.

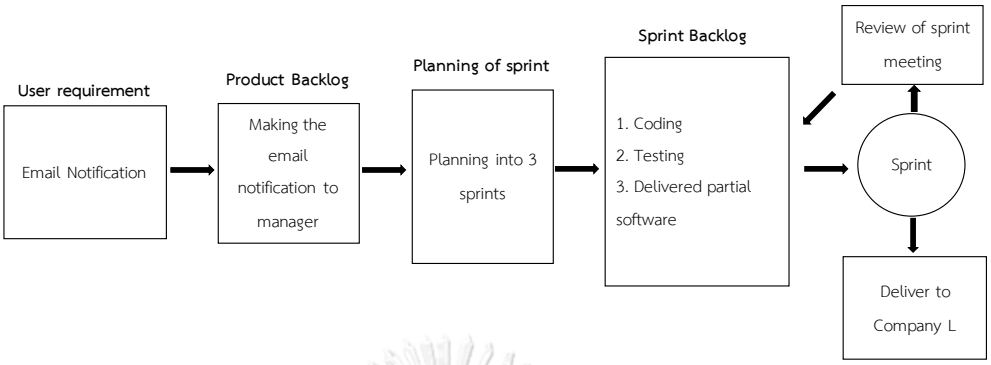


Figure 22 The step of making the Share Point List
Adapted from Sharma (2012, p.4).

The notification email will be included the link to access the dashboard and the file. This file contains the data that shows the shipment ID which did not use the TMS Mobile application. The involved user can use this report to find the shipment delay.

3.8 Overall of dashboard development

In conclusion, the flow of the data is starting from the arrival of a new email with a specific sender name and subject and automatically downloads the attachment to the local drive by Power Automate. Then, Power Query will gather and transform the data into the imported data and save it into a shared drive on OneDrive. After that, the team will link imported data with the Business intelligent dashboard by using Power BI which will refresh the data by Power Automate. Finally, the notification will happen when the imported data can find any shipment ID that did not use the TMS mobile application that will notify all involved users.

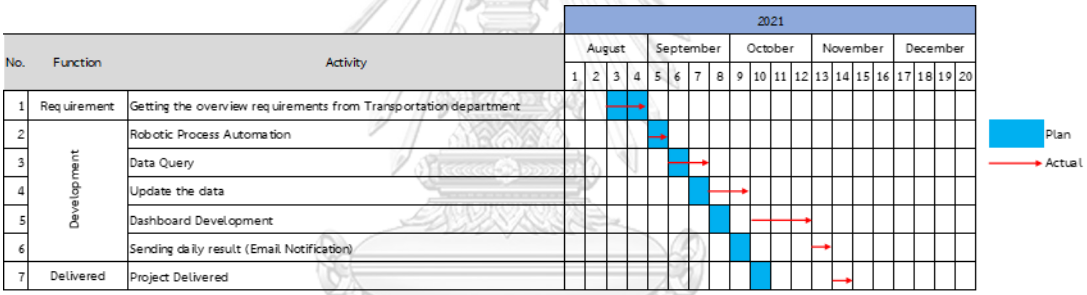
3.9 Comparison between Waterfall Model and Agile Methodologies

For this study, the outsource will compare the management between Waterfall Model and Agile Methodologies in 2 dimensions. Firstly, the comparison on the speed of dashboard development which will be compared by the dedicated

dashboard development timeline and the consolidated dashboard development timeline. Secondly, the comparison the satisfaction of company L between Waterfall Model and Agile Methodologies.

3.9.1 Comparison the Speed of Dashboard Development between Waterfall Model and Agile Methodologies

According to the delayed delivery of dedicated dashboard because of Waterfall Model, this study has the comparison in speed of dashboard development. The team had the timeline of dedicated dashboard development in Figure 23 which delivered the dashboard late for a month. On the other hand, the team has the hypothesis that the dashboard development with Agile Methodologies could delivered on time with customer satisfaction



The Timeline of Dedicated Dashboard Development

3.9.2 Comparison the Satisfaction of Customers between Waterfall Model and Agile Methodologies

The method of the comparison is based on the interviews with the users and the team project. There are 2 managers and 10 involved users. Those people have experience in software implementation with the Waterfall Model and Agile methodologies.

The interview is a semi-structured interview that has consisted of questions that mention finding a better method for software management. There are many dimensions of questions such as reducing the time of each task, speeding up all

work, flexibility to modify the software when requirements are changed, user-friendly interface, and process improvement increasing.

Table 5 Semi structured interview

Dimension	Question
Personal Information	What is your name?
	What is your position and department?
	What is your education background?
Scrum Methodology	Do you agree to have a daily Scrum meeting?
	Is it necessary to get feedback from user every sprint?
	Do you agree to have an updating progress meeting by weekly?
	Does Scrum increase the corporation between the team and other departments?
Advantage of Scrum	Did Scrum reduce the time of each task or backlog?
	Did Scrum speed up the project?
	Did Scrum more flexible than Waterfall when users change their requirements?
	Did Scrum make the user interface friendlier?
Disadvantage of Scrum	Did you feel more pressure than old style management?
	Did scrum make more conflict between the team?
	Did Scrum make more work load?
	Did Scrum make the project late?

Note. Adapted from Ellis (2013, p.4)

3.9.3 Limitation of Comparison between Waterfall Model and Agile Methodologies

Since the dedicated dashboard and consolidated dashboard are developed to track the TMS mobile application usage of drivers, the involved users could have the experience of dedicated dashboard using. In addition, the developer team could gain the skill of TMS mobile application usage of driver dashboard development. The team will add the information of Truck Utilization of consolidation fleet in the consolidated dashboard which the team has no experience for this kind of dashboard. That could close the gap of learning curve of users and the developer teams.

3.10 Combination of Technology Acceptance Model and Theory of Planned Behavior

The outsource will use the questionnaire to survey and analyze the combination of the Technology Acceptance Model and Theory of Planned Behavior with the hypothesis as shown in Table 6.

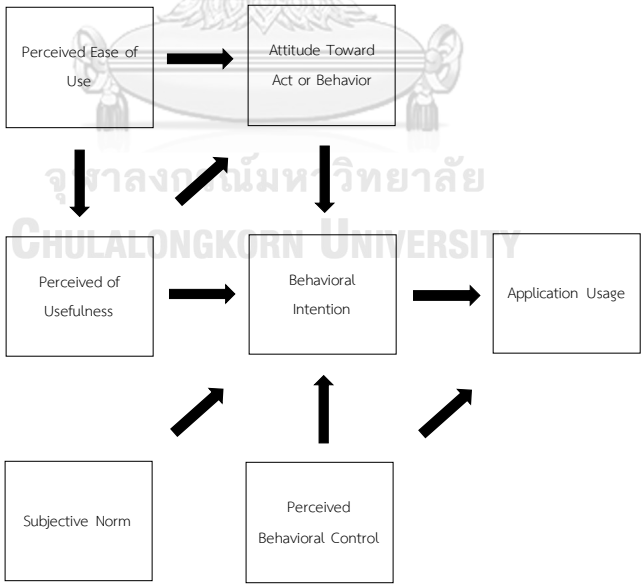


Figure 23 The combination of Technology Acceptance Model and Theory of Planned Behavior

Adapted from Miller (2010, p.3).

Table 6 Hypothesis Formulation

No.	Hypothesis
1	Attitude toward act or behavior is positively related to Behavioral Intention
2	Perceived Behavioral Control is positively related to Behavioral Intention
3	Perceived of Usefulness is positively related to Behavioral Intention
4	Subjective Norm is positively related to Behavioral Intention
5	Behavioral Intention is positively related to Application Usage
6	Perceived Behavioral Control is positively related to Application Usage
7	Perceived of Usefulness is positively related to Attitude toward act or behavior
8	Perceived Ease of Use is positively related to Attitude toward act or behavior
9	Perceived Ease of Use is positively related to Perceived of Usefulness
10	Behavioral Intention mediates the relationship between Attitude toward act or behavior and Application Usage
11	Behavioral Intention mediates the relationship between Perceived Behavioral Control and Application Usage
12	Behavioral Intention mediates the relationship between Perceived of Usefulness and Application Usage
14	Behavioral Intention mediates the relationship between Subjective Norm and Application Usage
15	Attitude toward act or behavior mediates the relationship between Perceived of Usefulness and Behavioral Intention
16	Attitude toward act or behavior mediates the relationship between Perceived Ease of Use and Behavioral Intention
17	Perceived of Usefulness mediates the relationship between Perceived Ease of Use and Attitude toward act or behavior
18	Perceived of Usefulness mediates the relationship between Perceived Ease of Use and Behavioral Intention

Note. Adopted from Sentosa (2012, p.5).

This questionnaire had questions that mention the perceiving of application benefits, perceiving ease of use, the intention to use the application, the subjective norm for the application, the attitude to use the application, perceiving the behavior control, and the behavior of application using. Those mentions are referred to as the combination of the Technology Acceptance Model and Theory of Planned Behavior as shown in Figure 23.

The population to answer the questionnaire are department of transport in Company L which is composed of 2 Senior Managers, 4 Managers, 2 Assistant Managers, and 30 involved users. Tables 6-12 show the items that were used to ask the users for the survey.

Table 7 Items Used for Measuring Theoretical Dimension

Short Name	Full Name	Description
PEU	Perceived Ease of Use	The application is easy to use.
PU	Perceived of Usefulness	It has many benefits of applications
SN	Subjective Norm	Many colleagues try to use this application
AT	Attitude of Usability	The users are confidence to use this system
BI	Behavioral Intention to Use	Users have intention to use the application
PBC	Perceived Behavior Control	Users believe to use the application

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Table 8 Perceived of Ease Useful

Construct	Measure Definition
Perceived Ease of Use (PEU)	**PEU 1** The system can input easily.
	PEU 2 The system can conduct the result easily.
	PEU 3 The system can display directly and clearly.
	PEU 4 The system can be evaluated quickly.
	PEU 5 The system is easy to learn and easy for first using person.
	PEU 6 The system is easy to export the data.

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Table 9 Perceived of Useful

Construct	Measure Definition
Perceived of Use (PU)	**PU 1** The system can show the information real time
	PU 2 The system has completely information and can use to analyze quickly
	PU 3 The system alert real time if the processing area have some problem
	PU 4 The system help to know the problem immediately
	PU 5 The system help to solve the problem in processing area immediately
	PU 6 The system has big data which can be useful in the future

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Table 10 Subjective Norm

Construct	Measure Definition
Subjective Norm (SN)	**SN 1** The system is back bone of factory.
	SN 2 Many department have to use this system
	SN 3 Have to use the information from this app
	SN 4 The most of information in factory is from this system.

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Table 11 Attitude of Usability

Construct	Measure Definition
Attitude of Usability (AT)	**AT 1** I think I would like to use this system always.
	AT 2 I think this system has many data.
	AT 3 I think I can know the problem immediately if I use this system.
	AT 4 I think this system can help me to solve the problem quickly
	AT 5 I think this system is easy to use and export the data

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Table 12 Behavioral Intention to Use

Construct	Measure Definition
Behavioral Intention to Use (BI)	**BI 1** I intend to know the product information.
	BI 2 I intend to know the problem and error in the process.
	BI 3 I intend to solve the problem in process quickly.

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Table 13 Perceived Behavior Control

Construct	Measure Definition
Perceived Behavior Control (PBC)	**PBC 1** This system is easy to use.
	PBC 2 This system helps to know the problem and error in process quickly.
	PBC 3 This system helps to solve the problem immediately.
	PBC 4 This system has the truly and precisely data.

Note. Adapted from Abu-Dalbouh (2013, p.5) and Gagnon (2012, P.1)

Chapter 4
Result

This study provided new insight of comparison between agile and waterfall methodology as prior studies compared only speed of developing product and users' satisfaction by interviewing. Whereas this study used Technology Acceptance Model to compare efficiency and shows magnitude of factors affecting users' decision in adopting dashboards.

This study was divided the result into three parts. The first part is the timeline length of developing dashboard by Waterfall and Agile methodologies. This part compares speed of developing dashboard. The faster developed dashboard would help Company L in solving logistic problem better. The second part is the semi-structured interviews about satisfaction of Waterfall dashboard and Agile dashboard to see if the new dashboard literally provides more satisfaction, and in what terms. The third part is the result of the questionnaires of Technology Acceptance Model and Theory of planned behavior. Respondents got 2 sets of identical questionnaires, one for Agile dashboard and another to waterfall dashboard. The questionnaires were distributed one weeks after agile dashboard was launched. The interviews were conducted in third and fourth week after users start using agile dashboard. The waterfall dashboard has been used about one month before the team develop the agile dashboard. In summary, at the time this study was conducted, Company L has been using waterfall dashboard for 3 months and using agile dashboard for one month.

The existed dashboard was dedicated truck type TMS mobile usage tracking status dashboard, which was developed with Waterfall model, shown in Figure 24. The problem of company L faced with the existed dashboard was that the dashboard delivery date was delayed from the plan because of some bug in the system testing phase and must redo the dashboard from the beginning. These problems can be prevented with Scrum method. To prove, this study compares 2

dashboards, the existed dedicated truck type TMS mobile usage tracking status dashboard and consolidated truck type TMS mobile usage tracking status dashboard, which was developed by Scrum model, shown in Figure 25.

As the consolidated dashboard was developed by Scrum method. The dashboard was periodically adjusted to fit users' requirement. The final dashboard contains critical figures, visualized problem and performance, and detail list. Users' satisfaction was measured by interview in section 4.2

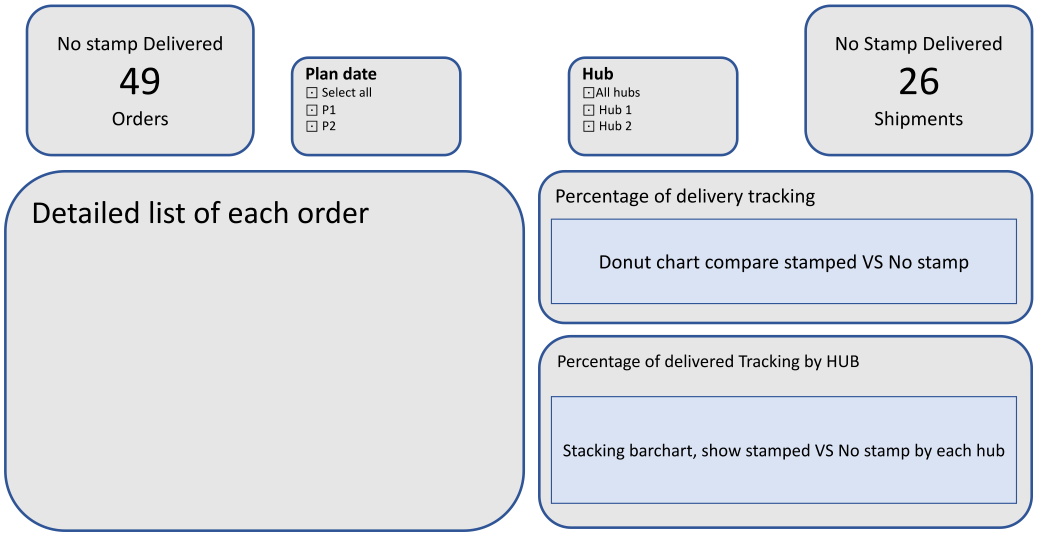


Figure 24 Dedicated truck type TMS mobile usage tracking status dashboard

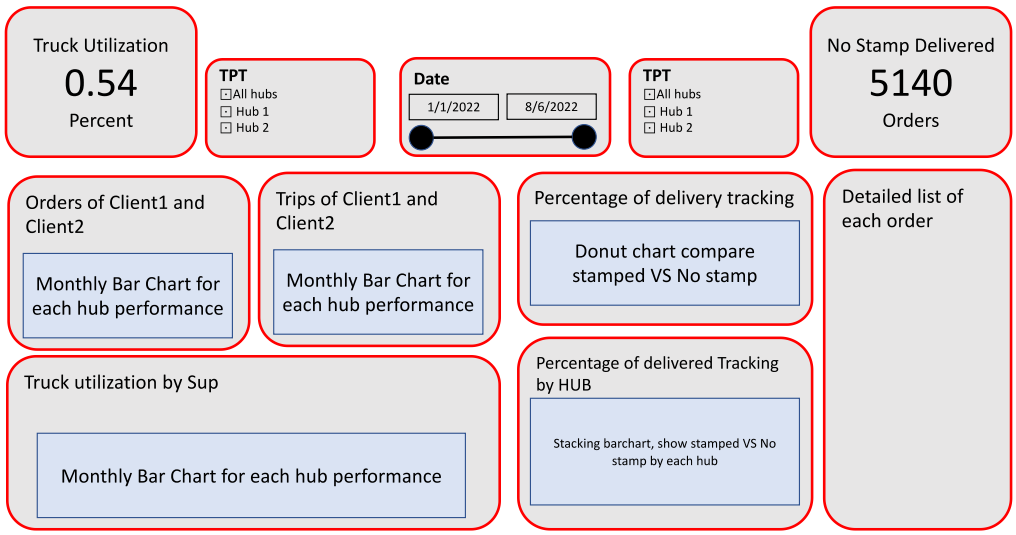


Figure 25 Consolidated truck type TMS mobile usage tracking status dashboard

4.1 Timeline of developing Dashboard

New dashboard system was developed by using Scrum model for project management. The scrum master planned the developing into 3 sprints. Users will be able to give feedback 3 times to prevent misaligned development.

Figure 26 shows Gantt chart comparing between Scrum stage and waterfall stage in developing dashboard for Company L. According to total time in Gantt chart, scrum developing method spent 8 weeks for delivering dashboard. Within 8 weeks in Gantt chart, there were 3 meetings between dashboard developer and end-users. Final meeting was dashboard presentation and implementation. On the other hand, waterfall software development method allows users only to give requirement and see final dashboard after 1 month. If end users would like to amend dashboard, the developers must spend another two or three weeks in amendment. As a result, waterfall development method spent 12 weeks in total time, or 50 percent more than Scrum method development.

Nevertheless, there was a challenge of developing the dashboard by agile method. Bottleneck happened in week 5 to week 7 as 3 sprints were executed simultaneously. In week 5, automation was being tested, data was being queried and imported, and dashboard was being designed. In week 6 to 7, While automation was under testing, and a team was designing dashboard, email notification sprint was started coding and testing. It was prepared bottlenecked by scrum master; hence, the bottleneck did not delay the delivery.

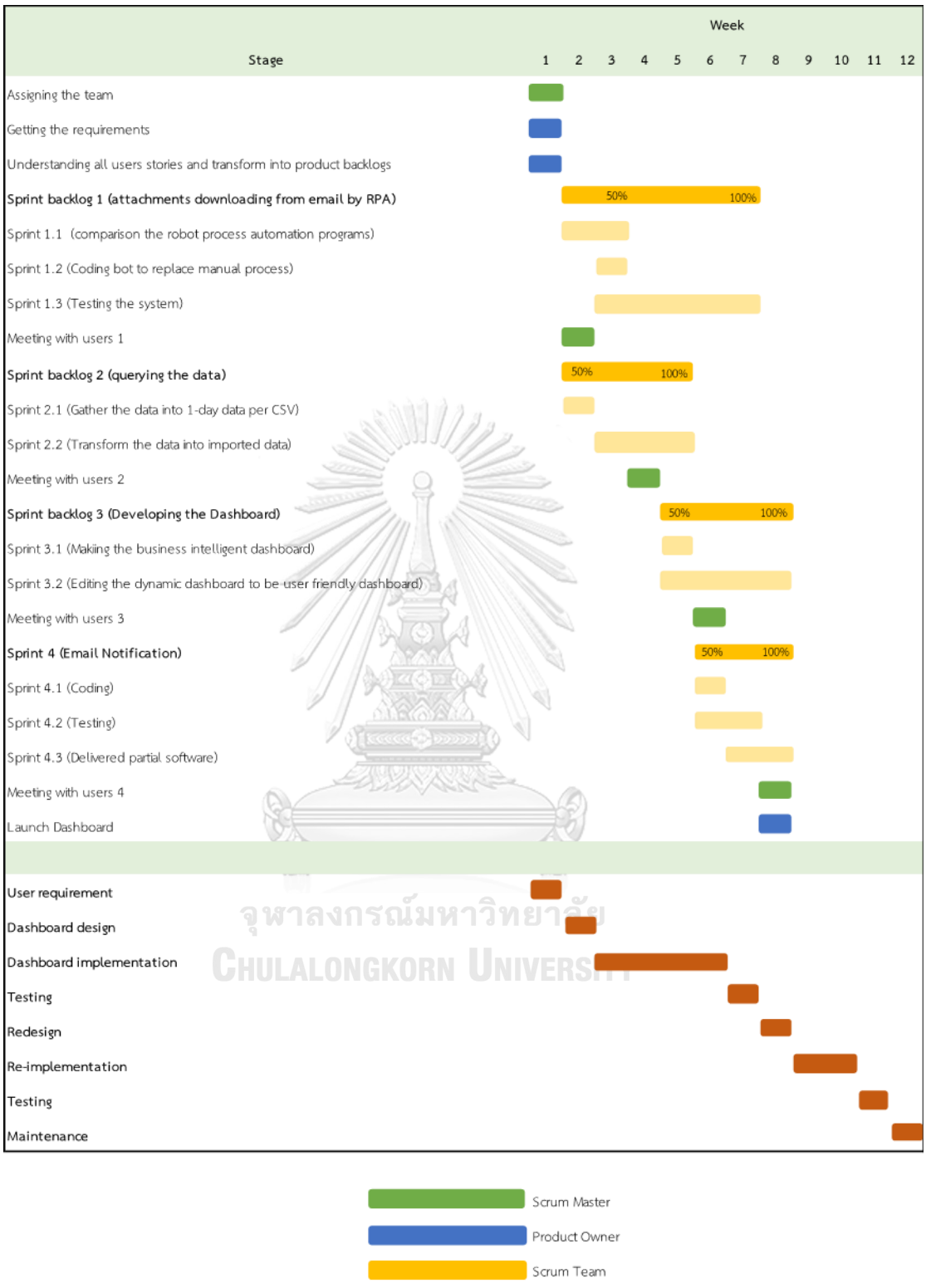


Figure 26 Timeline of developing dashboard by Waterfall and Agile

4.2 Semi-Structure interview

The interview was conducted with 2 managers and 5 involved users. Those people are end users that have experience with dedicated dashboard, developed by Waterfall method, and consolidated dashboard, developed by Scrum method.

Interviewees were asked 13 questions, 10 of them were asked to give numerical score. Raw answer for numerical question was shown in Table 14. Data in Table 14 was used to test hypothesis that numerical scores of agile dashboard are higher than waterfall dashboard. (H_0: μ > waterfall's score, where μ is agile's score). Mean and standard deviation were calculated from agile score.

Table 15 illustrated result of hypothesis testing. 8 Dimensions of agile dashboard are significantly higher than agile dashboard. 2 Dimensions that are not significantly higher are whether agile dashboard make users feel uncomfortable or pressure and whether agile dashboard create conflict or misunderstanding between team. According to the raw data, these 2 dimensions were given almost same score. In interview details, users do not feel different in terms of pressure and conflict as two dashboards convey same massages across team. To summary, agile dashboard significantly provides more users' satisfaction, but not relieves or creates pressure and conflict, compared to existed dashboard.

Table 14 Quantitative score from semi-structure interview

Agile	P1	P2	P3	P4	P5	P6	P7	*Average*
Advantage of dashboard	10	10	10	10	10	10	10	***10***
Increase corporation between teams	8	6	7	6	8	8	6	***7***
Reduce the time in tracking logistic	8	9	7	8	7	9	8	***8***
Speed up the problem tracking and solving	8	9	7	8	7	9	8	***8***
Flexibility for users' requirement	10	10	10	10	10	10	10	***10***
Friendly user interface	9	9	8	10	8	9	10	***9***
Uncomfortable or pressure	4	6	5	5	4	6	5	***5***
Conflict or misunderstandings between team	4	6	5	5	4	6	5	***5***
Workloads	7	5	6	7	5	6	6	***6***
Decrease problem solving late	9	9	9	10	8	10	8	***9***
Waterfall	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	*Average*
Advantage of dashboard	6	5	6	5	7	7	6	***6***
Increase corporation between teams	5	6	4	6	4	5	5	***5***
Reduce the time in tracking logistic	5	5	5	5	5	6	4	***5***
Speed up the problem tracking and solving	5	5	5	5	6	4	5	***5***
Flexibility for users' requirement	3	5	3	5	4	4	4	***4***
Friendly user interface	4	4	4	4	4	3	5	***4***
Uncomfortable or pressure	5	5	5	5	7	3	5	***5***
Conflict or misunderstandings between team	5	3	7	4	6	5	5	***5***
Workloads	3	5	3	5	4	4	4	***4***
Decrease problem solving late	5	5	4	6	5	3	7	***5***

Table 15 Semi-constructed interview hypothesis test

Hypothesis	*μ*	Waterfall	Mean	*S.D.*	T	P-value	Hypothesis
Advantage of dashboard	*10*	6	10	0.00			Accept
Increase corporation between teams	*7*	5	7	1.00	5.29	0.001	Accept
Reduce the time in tracking logistic	*8*	5	8	0.82	9.72	0.000	Accept
Speed up the problem tracking and solving	*8*	5	8	0.82	9.72	0.000	Accept
Flexibility for users' requirement	*10*	4	10	0.00			Accept
Friendly user interface	*9*	4	9	0.82	16.20	0.000	Accept
Uncomfortable or pressure	*5*	5	5	0.82	0	0.5	Reject
Conflict or misunderstandings between team	*5*	5	5	0.82	0	0.5	Reject
Workloads	*6*	4	6	0.82	6.48	0.000	Accept
Decrease problem solving late	*9*	5	9	0.82	12.96	0.000	Accept

4.2.1 Interviewees' profile and demographic

7 end users were interviewed. Their ages were distributed between 36 - 50 years. Work positions of the interviewee varies in level from involved users to senior manager. All of the interviewees' educational background are at least Bachelor's degree.

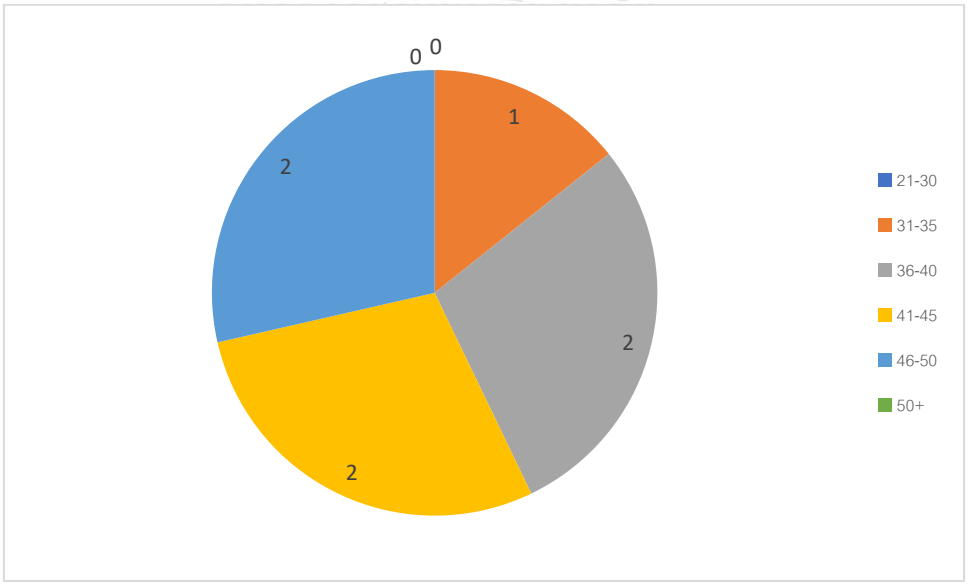


Figure 27 Age distribution of interviewees

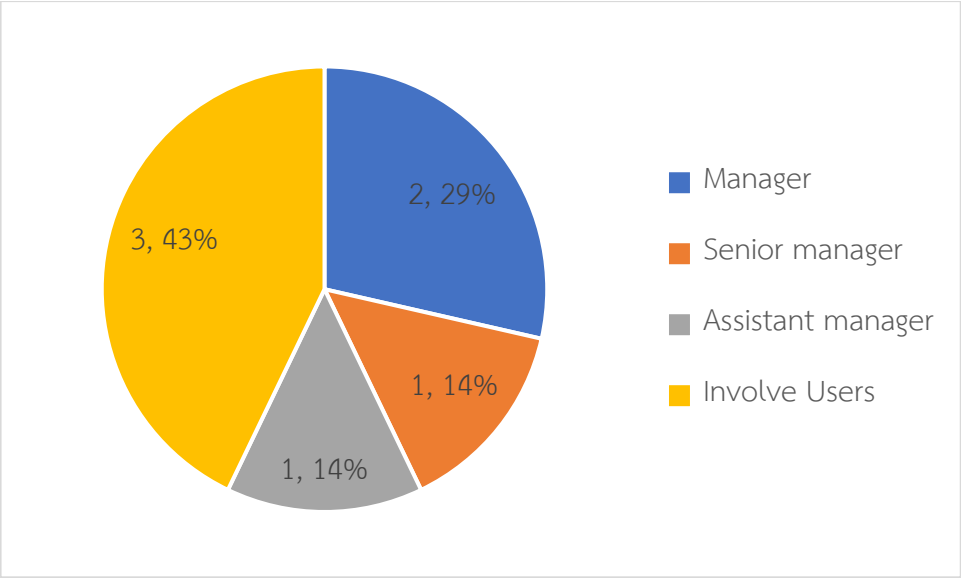


Figure 28 Interviewees' work position proportion

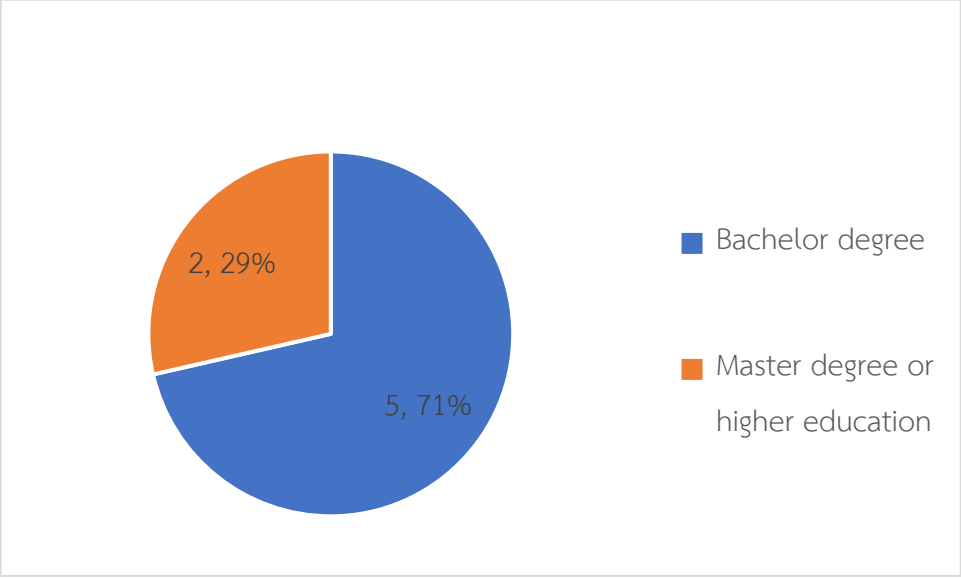


Figure 29 Interviewees' educational background

4.2.2 Advantage of dashboard (Waterfall vs Agile)

All the interviewee agreed that advantage of Agile Dashboard is to visualize performance. This allows stakeholders to track efficiency of the delivery. For the existed dashboard, although the performance was shown, it was not visualized. The visualized performance results in recognition of problems and on-time action.

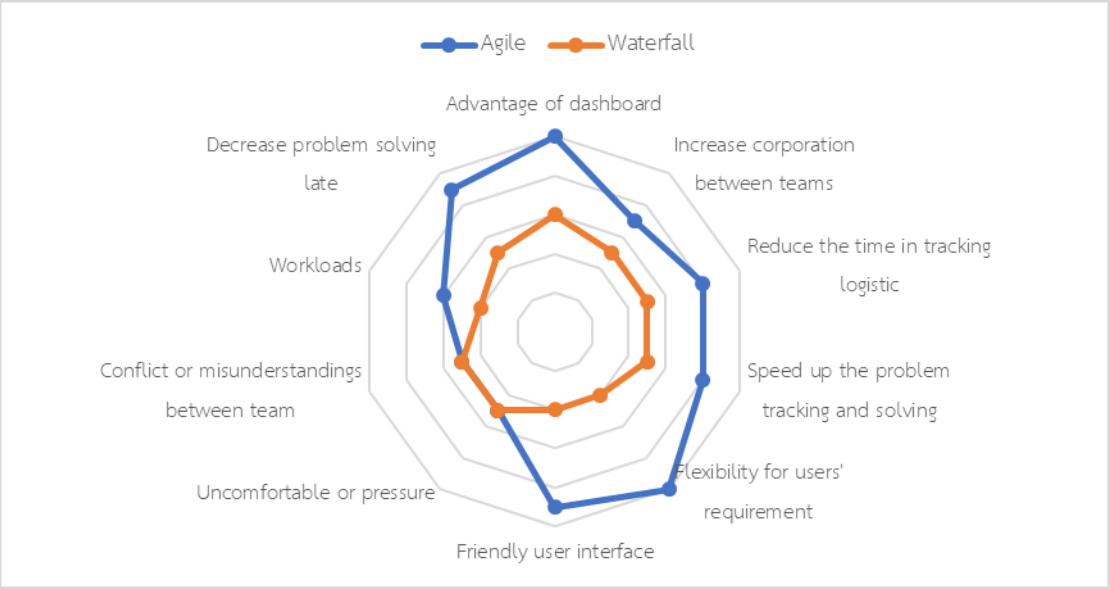


Figure 30 Overall satisfaction by dimension

Another advantage that Agile dashboard offers beyond Waterfall dashboard is that measurable information. As shown in Figure 25, consolidated dashboard illustrates performance by hub. The management team can react immediately if any hub performs worse than standard.

Finally, Agile dashboard updates information and email notification real-time by RPA. The involved users will get notified real-time and immediately take actions.

4.2.3 Which method increase corporation between team and another department more, Why?

In terms of corporation, there was no major change when apply new dashboard. Nevertheless, interviewees stated that new dashboard increase communication among departments as related departments will get same email notifications at the same time. Hence, the departments must discuss whenever notified.

4.4.4 Which method more reduce the time in tracking logistic? How?

Logistic was tracked by number of stamped orders, which was shown in both dashboards. Nevertheless, interviewees agreed that consolidated dashboard enormously reduce time in tracking logistic as the dashboard is updated almost real time by RPA.

4.2.5 Did Agile dashboard speed up the problem tracking and solving?

6 of 7 of the interviewees stated that agile dashboard speeds up the problem tracking and solving as agile dashboard is updated every 15 minutes by RPA. Furthermore, the new dashboard increases sense of urgency by notifying via email if the measurements are critical.

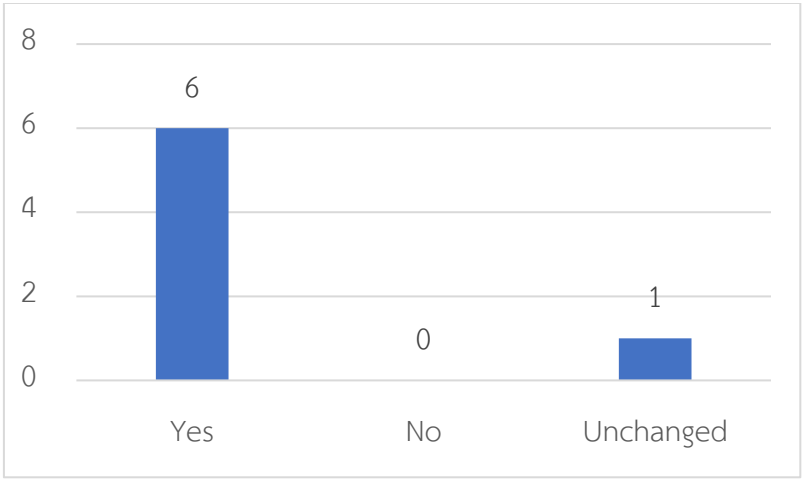


Figure 31 Did Agile dashboard speed up the problem tracking and solving?

4.2.6 Did agile more flexible than waterfall when users change the requirement of situation changes? How?

All seven interviewees agreed that developing dashboard by agile method is more flexible than waterfall method. For the waterfall method, users gave requirement and saw final dashboard. If the dashboard needs to be adjusted, developers must spend time and resources as the code was not designed to be re-coded. The developers also quoted cost of dashboard amendment. The agile developed dashboard was more flexible as users were allowed to give feedback in the three sprint meetings. The code in agile method was designed to be more flexible, easy to be adjusted.

4.2.7 Did agile dashboard make the user interface friendlier?

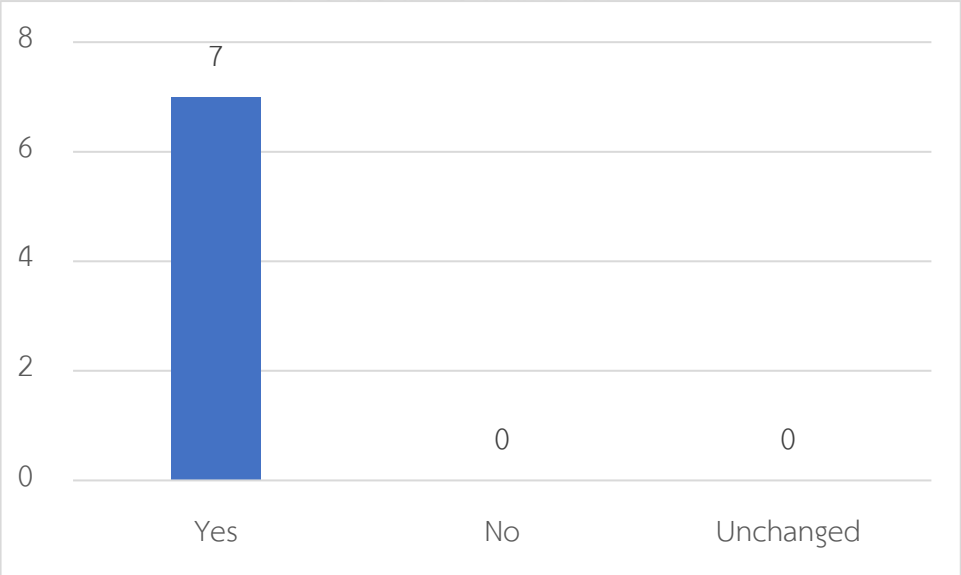


Figure 32 Did agile dashboard make the user interface friendlier?

Friendly user interface has been challenges in developer community as users' requirement is regularly unclear. End users are not user interface designer, yet they know if the interface were user friendly or hostile. Interviewees agree that agile development method favored them to see draft of a dashboard and gave them opportunity to give feedback. As a result, agile dashboard user interface is friendlier.

4.2.8 Did you feel any uncomfortable or more pressure than old style dashboard? How?

100 percent of interviewee felt no uncomfortable or pressure than old style dashboard. The main reason was the objective of the dashboard is unchanged. The new dashboard eases them in tracking and solving problems. The interviewees were asked to give quantitative score for uncomfortable or pressure arising from using each dashboard. The average score was same at 5 out of 10. The reason behind the equal score was assumed to be that the uncomfortableness or pressure only occurred during the introducing of a dashboard. However, users have been using old style dashboard and forgot the struggle of using waterfall dashboard. Whereas the agile dashboard caused no uncomfortableness or pressure even being used for the first time.

4.2.9 Did agile dashboard make more conflict or misunderstandings between team? How?

The answer to this question was consensus. Agile dashboard made no conflict and misunderstandings between team because every team get same information, same notification. The teams were asked to give opinion towards dashboard during sprint meetings; thus, the teams had mutual understandings in dashboard information. In terms of quantitative score, both dashboards scored 5 out of 10. Both dashboards provide same information for every team. Messages from the dashboards are cleared and unified. The agile dashboard is more user friendly and easier to understand; however, it does not improve the conflict or misunderstandings as there is none of the problem.

4.2.10 Did agile dashboard give you more workload? How?

5 of 7 interviewees agreed that the new dashboard give them more workload. They illustrated that the agile dashboard comes with email notification. The email

was sent whenever there is a problem. Sometimes they must attack problems off workhour. Whereas the old dashboard was updated during workhour.

4.2.11 Did agile dashboard make problem solving late? How?

In the contrast of the question, all interviewees answered that agile dashboard make problem solving faster than the old dashboard. The agile dashboard is updated by RPA every 15 minutes while the old dashboard was updated manually. To illustrate, at the end of the day, stakeholders will number of orders stamped by hub. If the numbers less than planned, they can get details immediately. Previously, they must wait until the next morning to see summary number of orders stamped in the day before.

4.3 Technology Acceptance Model (TAM) Questionnaires

Objective of the questionnaires is to prove the hypothesis that agile dashboard has more efficiency than waterfall dashboard. The expected result was that agile dashboard has higher coefficient in dashboard usage.

The questionnaire, shown in Appendix A, has 2 sections. The first section contains demographic question, gender, work, and educational background. The second question contains 28 factors from 6 dimensions in TAM. The 28 factors were shuffled to prevent bias. Respondents were asked to given Likert scale 1-5. 5 means strongly agree and 1 means strongly disagree.

4.3.1 Respondents' Profile

102 involved users from Company L were given 2 identical questionnaires, one towards agile dashboard and another towards waterfall dashboard. The 2 questionnaires with the complete answers were submitted in a total of 102 responses (100 percent response rate). There were 5 work positions among

respondents as shown in Figure 33. In terms of gender, 32 percent of them is female, another 69 percent were male as shown in Figure 34.

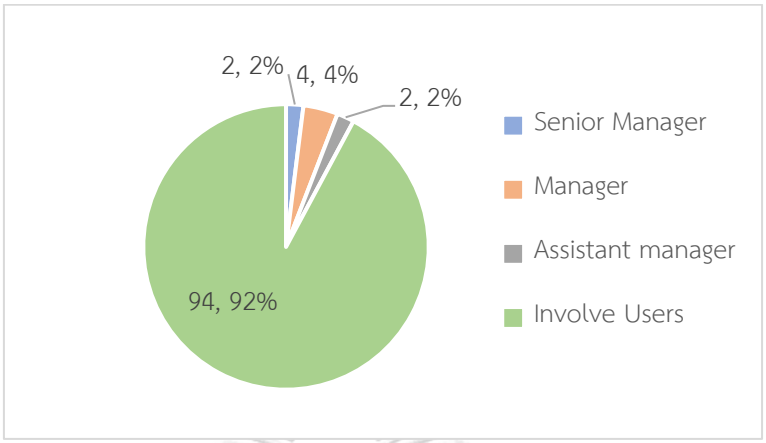


Figure 33 Respondents work position proportion

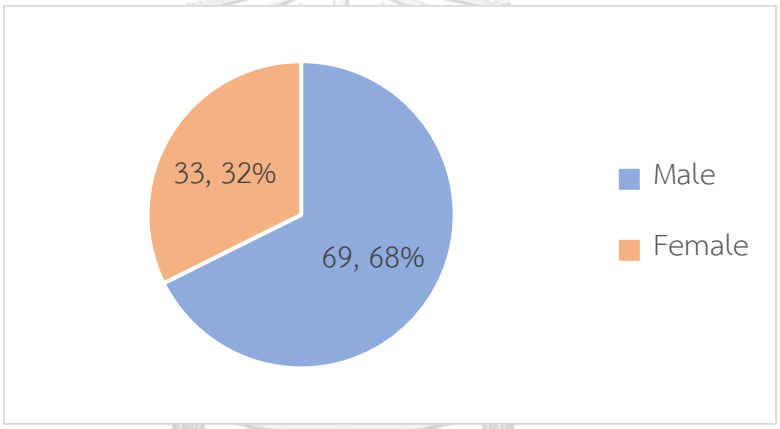


Figure 34 Respondents gender proportion.

4.3.2 Quality Assessments

To adjust the Technology Acceptance Model to the final model in questionnaires, all items must be assessed. Item that correlates with a factor will result in outer loadings higher than 0.7. Table 16 and Table 17 present results of outer loadings of each item within each factor from agile dashboard and waterfall dashboard questionnaire result. Factors' outer loading is the correlation coefficient for the factor and its items. If the outer loading is higher than 0.7, it means that the factor is valid, and fit with the model. The low outer loading means that the items cannot explain, or do not contribute to their factor.

Table 16 Outer loading for technology acceptance model of Agile dashboard

Construct	Item	Loadings
Perceived Ease of Use (PEU)	PEU 1 The dashboard can input easily.	0.79
	PEU 2 The dashboard can conduct the result easily.	0.75
	PEU 3 The dashboard can display directly and clearly.	0.80
	PEU 4 The dashboard can be evaluated quickly.	0.71
	PEU 5 The dashboard is easy to learn and easy for first using person.	0.69
	PEU 6 The dashboard is easy to export the data.	0.68
Perceived of Use (PU)	PU 1 The dashboard can show the information real time	0.89
	PU 2 The dashboard has completely information and can use to analyze quickly	0.85
	PU 3 The dashboard alert real time if the processing area have some problem	0.91
	PU 4 The dashboard help to know the problem immediately	0.90
	PU 5 The dashboard help to solve the problem in processing area immediately	0.91
	PU 6 The dashboard has big data which can be useful in the future	0.72
Subjective Norm (SN)	SN 1 The dashboard is back bone of factory.	0.64
	SN 2 Many departments have to use this dashboard	0.70
	SN 3 Have to use the information from this app	0.71
	SN 4 The most of information in factory is from this dashboard.	0.68
Attitude of Usability (AT)	AT 1 I think I would like to use this dashboard always.	0.73
	AT 2 I think this dashboard has many data.	0.69
	AT 3 I think I can know the problem immediately if I use this dashboard.	0.78
	AT 4 I think this dashboard can help me to solve the problem quickly	0.77
	AT 5 I think this dashboard is easy to use and export the data	0.70
Behavioral Intention to Use (BI)	BI 1 I intend to know the product information.	0.71
	BI 2 I intend to know the problem and error in the process.	0.79
	BI 3 I intend to solve the problem in process quickly.	0.80
Perceived Behavior Control (PBC)	PBC 1 This dashboard is easy to use.	0.78
	PBC 2 This dashboard helps to know the problem and error in process quickly.	0.88
	PBC 3 This dashboard helps to solve the problem immediately.	0.88
	PBC 4 This dashboard has the truly and precisely data.	0.72

Table 17 Outer loading for technology acceptance model of Waterfall dashboard

Construct	Item	Loadings
Perceived Ease of Use (PEU)	PEU 1 The dashboard can input easily.	0.72
	PEU 2 The dashboard can conduct the result easily.	0.71
	PEU 3 The dashboard can display directly and clearly.	0.86
	PEU 4 The dashboard can be evaluated quickly.	0.69
	PEU 5 The dashboard is easy to learn and easy for first using person.	0.68
	PEU 6 The dashboard is easy to export the data.	0.69
Perceived of Use (PU)	PU 1 The dashboard can show the information real time	0.85
	PU 2 The dashboard has completely information and can use to analyze quickly	0.81
	PU 3 The dashboard alert real time if the processing area have some problem	0.90
	PU 4 The dashboard help to know the problem immediately	0.89
	PU 5 The dashboard help to solve the problem in processing area immediately	0.80
	PU 6 The dashboard has big data which can be useful in the future	0.73
Subjective Norm (SN)	SN 1 The dashboard is back bone of factory.	0.72
	SN 2 Many departments have to use this dashboard	0.71
	SN 3 Have to use the information from this app	0.69
	SN 4 The most of information in factory is from this dashboard.	0.73
Attitude of Usability (AT)	AT 1 I think I would like to use this dashboard always.	0.72
	AT 2 I think this dashboard has many data.	0.75
	AT 3 I think I can know the problem immediately if I use this dashboard.	0.79
	AT 4 I think this dashboard can help me to solve the problem quickly	0.80
	AT 5 I think this dashboard is easy to use and export the data	0.71
Behavioral Intention to Use (BI)	BI 1 I intend to know the product information.	0.85
	BI 2 I intend to know the problem and error in the process.	0.89
	BI 3 I intend to solve the problem in process quickly.	0.82
Perceived Behavior Control (PBC)	PBC 1 This dashboard is easy to use.	0.82
	PBC 2 This dashboard helps to know the problem and error in process quickly.	0.85
	PBC 3 This dashboard helps to solve the problem immediately.	0.89
	PBC 4 This dashboard has the truly and precisely data.	0.90

Although there are some items that loadings are below 0.7, they are nearly to 0.7. Hence, all items in both models are correlated with their factor. The next criteria for model quality assessment is internal consistency, which is measured by Cronbach's alpha and Composite reliability. The values are expected to be higher than 0.7. The result was shown in Table 18 and Table 19.

Table 18 Internal consistency of Technology Acceptance Model of Agile dashboard

Construct	Cronbach's alpha	Composite reliability
Perceived Ease of Use (PEU)	0.89	0.89
Perceived of Use (PU)	0.81	0.81
Subjective Norm (SN)	0.71	0.71
Attitude of Usability (AT)	0.79	0.79
Behavioral Intention to Use (BI)	0.85	0.85
Perceived Behavior Control (PBC)	0.82	0.82

Table 19 Internal consistency of Technology Acceptance Model of Waterfall dashboard

Construct	Cronbach's alpha	Composite reliability
Perceived Ease of Use (PEU)	0.80	0.80
Perceived of Use (PU)	0.82	0.82
Subjective Norm (SN)	0.70	0.70
Attitude of Usability (AT)	0.75	0.75
Behavioral Intention to Use (BI)	0.79	0.79
Perceived Behavior Control (PBC)	0.79	0.79

Finally, the validity of technology acceptance model was tested by consistency validity and discriminant validity. Consistency validity is measured by Average Variance Extracted (AVE). If a model is consistency, AVE must higher than 0.5. For discriminant validity, it is measured by relationship within a factor and its items must be stronger than the item and other factor. The result in Table 20 and Table 21 showed that the models are valid as AVEs are higher than 0.5 and a factor does not relate with another factor.

Table 20 Validity of Technology Acceptance Model of Agile dashboard

Factors	AVE	PEU	PU	SN	AT	BI	PBC
PEU	0.78	0.83					
PU	0.86	0.22	0.79				
SN	0.58	0.03	0.00	0.58			
AT	0.84	0.43	0.03	0.00	0.92		
BI	0.90	0.35	0.20	0.01	0.49	0.89	
PBC	0.81	0.50	0.35	0.20	0.10	0.03	0.91

Table 21 Validity of Technology Acceptance Model of Waterfall dashboard

Factors	AVE	PEU	PU	SN	AT	BI	PBC
PEU	0.69	0.79					
PU	0.54	0.04	0.75				
SN	0.70	0.00	0.00	0.60			
AT	0.76	0.50	0.12	0.00	0.87		
BI	0.79	0.43	0.25	0.04	0.45	0.76	
PBC	0.82	0.53	0.30	0.05	0.23	0.47	0.89

In summary, both agile and waterfall model adopted from technology acceptance model and theory of planned behavior are valid. All items and all paths in the model are fitted.

4.3.3 Hypothesis testing

Coefficient of dashboard usage was derived from the combination of Technology Acceptance Model and Theory of Planned Behavior as shown in Figure 35. Before the coefficient was derived the hypothesis in Table must be tested.

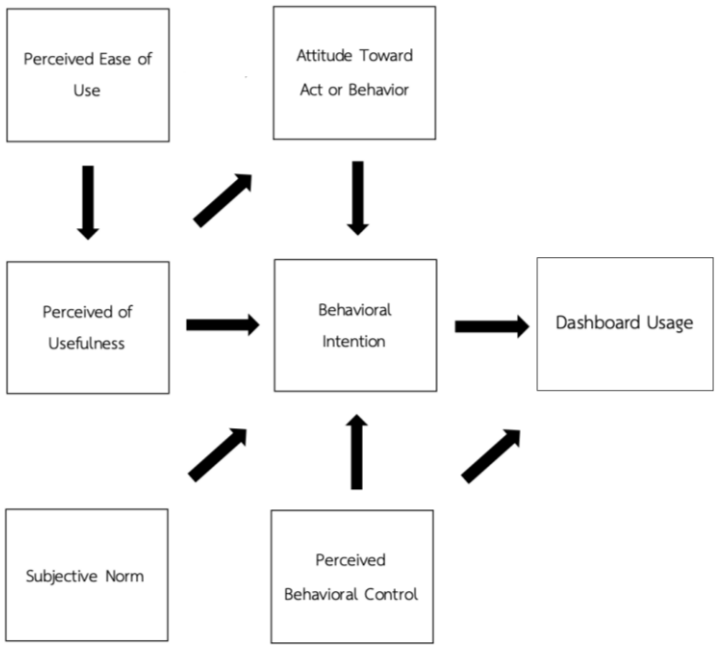


Figure 35 Technology Acceptance Model and Theory of Planned Behavior

Null hypothesis ($H_{0(n)}$) is that the factor has no positively relationship to another factor. Structural equation modeling was constructed in Smart PLS and the result was shown in Table 22. Of the 17 hypotheses, 11 were accepted at 95% confidence level. To summary, Subjective Norm has no contribution in Dashboard Usage. Perceived of Usefulness and Perceive Ease of Use have no contribution to Attitude Toward Act or Behavior. Behavioral Intention does not mediate the relationship between Perceived of Usefulness or Subjective Norm and Dashboard Usage. Attitude toward act or behavior does not mediate the relationship between Perceived of Usefulness and Behavioral Intention. The only relationship different between waterfall dashboard and agile dashboard is that Perceived Ease of Use is positively related to Attitude toward act or behavior. This relationship is rejected in waterfall dashboard but accepted in agile dashboard. The rest of relation are significantly positive.

The reason that subjective norm does not significantly influence behavioral intention in both dashboards was that users' decision in adopting dashboard is independent from college and other department. According to raw data in questionnaire, items within subject norm were scored different among respondents. Someone gave full score, yet someone gave 0 score. The fluctuation in raw data caused insignificant relationship for this factor.

Another 2 rejected relationships were perceived of usefulness and perceive ease of use to attitude toward act or behavior. This means easiness in using and useful appearance do not affect attitude towards the dashboards. The attitude towards act or behavior is whether users are confident to use the dashboard. The rejection might root from the fact that confidence of users is affected by other variables outside the model such as the development team, the executive who oversees the dashboard.

The rest rejected relationships were mediation. Behavioral Intention does not mediate the relationship between perceived of usefulness and dashboard usage. Although perceived of usefulness positively related to dashboard usage, they are not mediated by behavioral intention. As mentioned above that useful appearance does

not affect attitude, as well as intention. Hence, behavioral intention does not mediate the relationship.

Behavioral intention also does not mediate the relationship between subjective norm and dashboard usage because subjective norm was not a significant factor according to result.

That perceived ease of use is positively related to attitude toward act or behavior was rejected in waterfall dashboard but accepted in agile dashboard. The possible explanation is that although users perceived waterfall dashboard easy to use, the perceivingness does not influence attitude toward behavior. To illustrate, waterfall dash might be simple and easy to understand, but users have no attitude to use or action corresponding to waterfall dashboard. Whereas perceived ease of use is positively related to attitude toward act or behavior in agile dashboard.

Table 22 Hypothesis testing for waterfall dashboard and agile dashboard

Hypotheses	Waterfall dashboard			Agile dashboard		
	t-value	p-value	Hypothesis testing	t-value	p-value	Hypothesis testing
Attitude toward act or behavior is positively related to Behavioral Intention	3.502	0.000**	$H_{1(1)}$: Accepted	3.967	0.000***	$H_{1\,(1)}$: Accepted
Perceived Behavioral Control is positively related to Behavioral Intention	3.189	0.001**	$H_{1(2)}$: Accepted	4.237	0.000***	$H_{1\,(2)}$: Accepted
Perceived of Usefulness is positively related to Behavioral Intention	1.854	0.033	$H_{1(3)}$: Accepted	1.680	0.048	$H_{1\,(3)}$: Accepted
Subjective Norm is positively related to Behavioral Intention	1.004	0.159	$H_{1(4)}$: Rejected	0.987	0.163	$H_{1(4)}$: Rejected
Behavioral Intention is positively related to Dashboard Usage	6.598	0.000**	$H_{1(5)}$: Accepted	8.433	0.000**	$H_{1\,(5)}$: Accepted
Perceived Behavioral Control is positively related to Dashboard Usage	3.200	0.001**	$H_{1(6)}$: Accepted	5.674	0.000**	$H_{1\,(6)}$: Accepted
Perceived of Usefulness is positively related to Attitude toward act or behavior	1.102	0.136	$H_{1(7)}$: Rejected	1.389	0.084	$H_{1\,(7)}$: Rejected
Perceived Ease of Use is positively related to Attitude toward act or behavior	1.612	0.055	$H_{1(8)}$: Rejected	1.682	0.048	$H_{1(8)}$: Accepted
Perceived Ease of Use is positively related to Perceived of Usefulness	5.499	0.000**	$H_{1(9)}$: Accepted	5.969	0.000**	$H_{1(9)}$: Accepted
Behavioral Intention mediates the relationship between Attitude toward act or behavior and Dashboard Usage	3.201	0.001**	$H_{1(10)}$: Accepted	3.971	0.000**	$H_{1(10)}$: Accepted
Behavioral Intention mediates the relationship between Perceived Behavioral Control and Dashboard Usage	3.199	0.001**	$H_{1(11)}$: Accepted	3.430	0.000**	$H_{1(11)}$: Accepted
Behavioral Intention mediates the relationship between Perceived of Usefulness and Dashboard Usage	1.557	0.061	$H_{1(12)}$: Rejected	1.621	0.054	$H_{1(12)}$: Rejected
Behavioral Intention mediates the relationship between Subjective Norm and Dashboard Usage	0.753	0.227	$H_{1(13)}$: Rejected	0.870	0.193	$H_{1\,(13)}$: Rejected
Attitude toward act or behavior mediates the relationship between Perceived of Usefulness and Behavioral Intention	1.234	0.110	$H_{1(14)}$: Rejected	1.499	0.068	$H_{1\,(14)}$: Rejected
Attitude toward act or behavior mediates the relationship between Perceived Ease of Use and Behavioral Intention	2.105	0.019	$H_{1(15)}$: Accepted	2.758	0.003	$H_{1(15)}$: Accepted
Perceived of Usefulness mediates the relationship between Perceived Ease of Use and Attitude toward act or behavior	6.434	0.000**	$H_{1(16)}$: Accepted	7.187	0.000**	$H_{1(16)}$: Accepted
Perceived of Usefulness mediates the relationship between Perceived Ease of Use and Behavioral Intention	3.229	0.001**	$H_{1(17)}$: Accepted	3.967	0.000**	$H_{1(17)}$: Accepted

4.3.4 Technology Acceptance Model and Theory of Planned Behavior in using waterfall dashboard VS agile dashboard

From the Technology Acceptance Model and Theory of Planned Behavior, there were six factors influencing dashboard usage. There are measures within each factor, mentioned in chapter 3. Respondents were asked to give level of impact of the measures ranked from no impact (0) to absolute impact (1). The results are and regressed to get sensitivity of each measure.

Figure 36 and 37 were drawn from results from Smart PLS. Dotted line represent statistically insignificant relationship. The result was that 57.5 percent of waterfall dashboard usage and 85 percent of agile dashboard usage were explainable by technology acceptance model and theory of planned behavior. Inferably, users prefer to use agile dashboard to waterfall dashboard under the same factors. In details, Table 23 compares coefficients of the two Smart PLS results.

In terms of model fit, the path in the model was constructed based on Technology Acceptance Model and Theory of Planned Behavior which is well established and was tested by many studies. Hence, this study assumed the model is fitted. In addition, the sample size is 102 for 28 variables – big enough to create perfect fit model.

Table 23 Coefficients of TAM in using waterfall dashboard VS agile dashboard

Items affecting users in adoption dashboard	Waterfall dashboard	Agile dashboard
Perceived Ease of Use (PEU)		
PEU1	**0.745**	0.647
PEU2	0.654	**0.742**
PEU3	0.685	**0.753**
PEU4	0.620	**0.655**
PEU5	**0.690**	0.647
PEU6	**0.640**	0.632
Perceived of Usefulness (PU)		
PU1	0.487	**0.713**
PU2	0.643	**0.759**
PU3	0.590	**0.825**
PU4	0.658	**0.789**
PU5	0.654	**0.798**
PU6	0.521	**0.590**
Subjective Norm (SN)		
SN1	**0.782**	0.780
SN2	0.665	**0.659**
SN3	0.716	**0.720**
SN4	**0.721**	0.707
Attitude of Usability (AT)		
AT1	0.521	**0.639**
AT2	0.558	**0.678**
AT3	0.750	**0.759**
AT4	0.782	**0.894**
AT5	0.590	**0.601**
Behavioral Intention to Use (BI)		
BI1	0.685	**0.690**
BI2	0.890	**0.895**
BI3	0.814	**0.824**
Perceived Behavior Control (PBC)		
PBC1	**0.750**	0.725
PBC2	0.774	**0.890**
PBC3	0.698	**0.800**
PBC4	0.592	**0.625**
Dashboard Usage	0.575	**0.850**

The higher coefficient, the bigger magnitude influence users' behavioral in using dashboard. There are 28 items in 6 factors in the questionnaire. 22 items in Agile dashboard questionnaire resulted higher magnitude. This turned out in higher probability that users are willing to use agile dashboard.

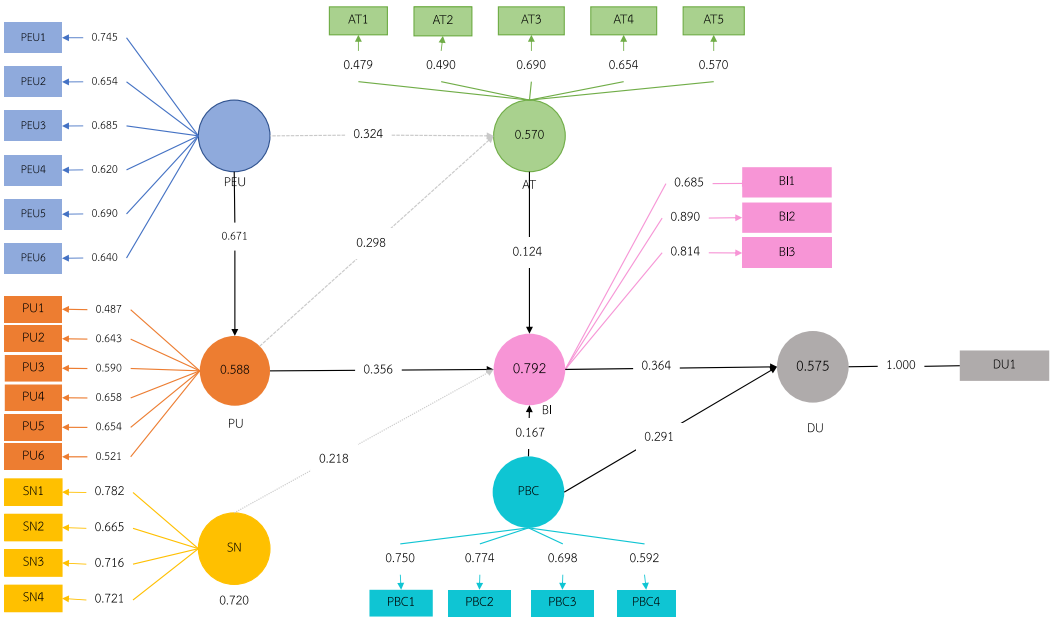


Figure 36 Waterfall dashboard technology acceptance model result

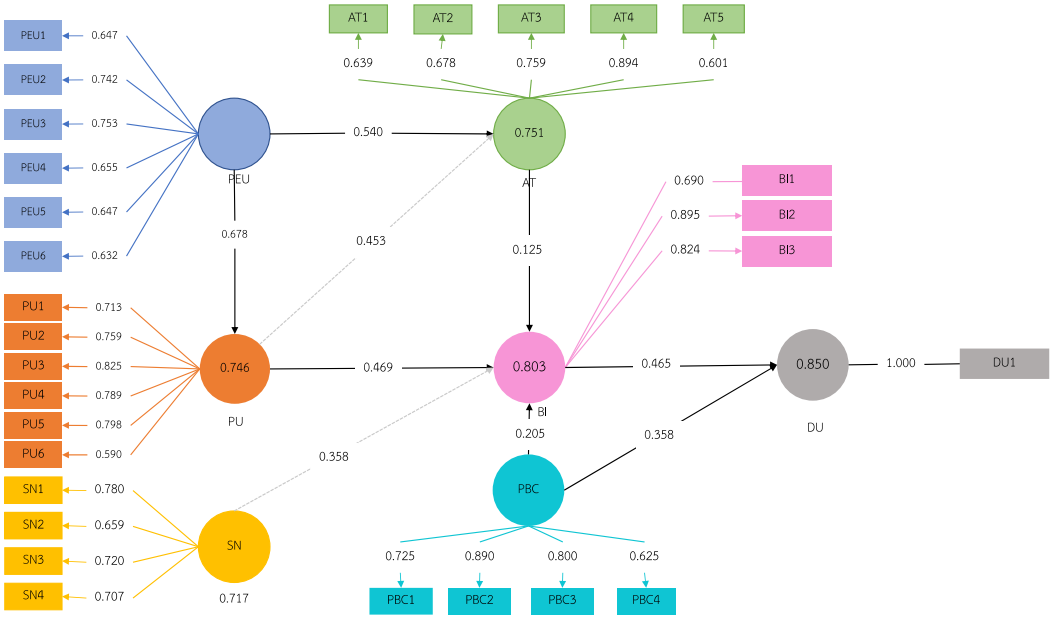


Figure 37 Agile dashboard technology acceptance model result

The factor which magnitude is highest according to its coefficient is behavioral intention, which explain 79.2 percent in waterfall dashboard usage and 80.3 in agile dashboard usage. Magnitude of behavioral intention to use indicates that users have intention to use the dashboard. Behavioral intention of users in both dashboards was most impacted by that users intend to know the problem. Second important item is

that users intend to solve the problem quickly, and the least important item in this factor is that users intend to know dashboard information.

Next factor is perceived behavior control, measuring belief of users in using dashboard. All items in perceived behavior control of agile dashboard were more impactful than in waterfall dashboard except that dashboard is easy to use.

For attitude of usability, it is measured by confidence of users to use the dashboard. All 5 items in this factor resulted higher magnitude in agile dashboard than waterfall dashboard. The most 2 vital items are that users think the dashboard can solve problems quickly and that users think they can know problems immediately by using this dashboard. The least impact in terms of attitude of usability according to waterfall dashboard questionnaire is that users think that they would like to use this dashboard always, and that users think this dashboard is easy to use and export the data in agile dashboard. The result can be interpreted that the usability of dashboard depends on speed of showing problem to allow users solving problems in time. The likability, amount of data and exportability of data are less vital.

Although Subject Norm possess high coefficient in both dashboards, they were not significant as shown in Table 23. Explicitly, peer pressure rarely influences users in adopting dashboards.

Perceived of usefulness is measured by the benefits of dashboard that users perceive. As same as attitude of usability, all measures in agile dashboard appeared higher magnitude than waterfall dashboard. For agile dashboard, the most important item is the real time alert. The second and third impactful items are the help in solving problem immediately and help to know the problem immediately. The least impactful item is that the dashboard has big data. According to the result, timing is the most critical item in the factor of usefulness.

The first factor of the TAM is perceived ease of use. It was assumed to be rooted of users' decision in adopting a technology. Perceived ease of use is measured by how easy the dashboard be used in users' vision. Comparatively, that that the dashboard can conduct the result easily, that the dashboard can display directly and clearly, and that the dashboard can be evaluated quickly were given

higher score which is resulted in higher coefficients for agile dashboard than waterfall dashboard.

Besides relationship according to hypothesis, the questionnaires implied that there were long-distance causal relations between perceive ease of use and dashboard usage. According to the technology acceptance model, the perceive ease of use contribute to dashboard usage in two paths. The first is through perceive of usefulness and behavioral intention to use. The second is through attitude of usability and behavioral intention to use. The result in this study showed that in company L, only the second path is significant causation. In sum, company L user decide to adopt agile dashboard because they perceived that it is easy to use, and they have attitude and behavioral intention to use.

Chapter 5
Conclusion

This study developed a dashboard for logistic company using Scrum methodology. After the dashboard was delivered, the team proved three aspects of the agile dashboard, compared to existed dashboard which was developed by waterfall methodology. The first aspect is speed of developing dashboard. It is measured by comparative timeline. The second aspect is users' satisfaction. It is measured by semi-structed interview. The final aspect is efficiency which is measured by the combination of the TAM and TPB using a questionnaire survey.

5.1 Discussion and Research Conclusion

Agile methodology is established to solve major problems in developing software. The methodology can be applied beyond software development. Comparatively, agile methodology and waterfall methodology are beneficial in different ways.

Agile methodology is flexible and can be delivered quickly, but the result is uncertain. The method is suitable for unclear users' product requirement. For waterfall methodology, the benefits are predictable results. The timeline is certain. However, it is not flexible and usually spends more time. The method is suitable for well-planned product by professionals.

This study applied the method to create a dashboard that is more user friendly, more applicable, and more useful. The goal of every product is to help users do their task better. This study has proved that agile method assists developer to offer a product help user to achieve their goal. In this study, agile dashboard outperforms existed dashboard all three aspects according to the result in chapter 4. Agile dashboard is better than waterfall dashboard because it was delivered faster, with higher users' satisfaction, and higher efficiency.

The reason that agile dashboard is better than waterfall because it divides task into sprints. Each sprint can be executed independently. While waterfall perform tasks chronologically, sprints can be performed simultaneously. This increases speed of development. In this study, developing the dashboard by agile method spent 8 weeks, while the traditional method spent 12 weeks.

Besides speed, agile dashboard results better in satisfaction. There were 4 meetings between product owner and users every one or two weeks. Users can comment and adjust the dashboard during the development process. This satisfied both users and scrum team. In waterfall dashboard, users will see the product in the final stage, where amendment is costly. Users are not expert in designing interface, but they can tell how to improve to be more friendly and useful. Sprint meetings offer opportunities to users for inserting vital or dropping unnecessary information in dashboard. This research showed that users' satisfaction for agile dashboard was given higher numerical score in 8 of 10 dimensions. The dimensions that agile dashboard performs equally to existed dashboard are whether the dashboard increase conflict or misunderstandings between teams, and whether the dashboard make users more uncomfortable or create more pressure.

In details, all users prefer agile dashboard to existed dashboard key points that users are more satisfied are friendlier user interface, real-time updates by RPA, and auto email notification. These 3 key points were not requested by users initially. They arose through discussion in sprint meetings. Without the multiple mini meetings, the dashboard would not be efficiently developed. Hence, agile methodology creates better dashboard and better users experience.

Finally, agile dashboard has higher efficiency according to TAM and TPB questionnaires. Objective of the questionnaires is to prove that users intend to use agile dashboard more than waterfall dashboard. The TAM and TPB discover magnitude of factors towards users' decision and behavioral in using dashboards.

Result from Smart PLS showed 5 and 6 insignificant connections of the TAM for agile dashboard and waterfall dashboard respectively. Statistically insignificant positive relationships in both dashboards are subjective norm to behavioral intention and perceived of usefulness to attitude toward act or behavior. The mediations that

is statically insignificant are that behavioral intention mediates the perceived of usefulness and dashboard usage, that behavioral intention mediates subjective norm and dashboard usage and that attitude toward act or behavior mediates perceived of usefulness and behavioral intention. The hypothesis that perceived ease of use is positively related to attitude toward act or behavior is valid for agile dashboard but rejected for waterfall dashboard. Inferably, user perceive ease of use for agile dashboard, which affects attitude toward act or behavior, resulted in decision to adopt agile dashboard. the rest of the model was statistically significant for both dashboards.

In terms of magnitude of relationship of paths in technology acceptance model, agile dashboard appears to have stronger relationship in every path. Table 24 illustrates coefficient of relationships and percent increase from traditional dashboard. The most increase coefficient is the model to dashboard usage. In waterfall dashboard, 57.5% of dashboard usage can be explained by the model. On the other hand, in agile dashboard, 85% of dashboard usage can be explained. This can be interpreted that agile dashboard is more efficient than waterfall dashboard because the users' behavior is more corresponding to technology acceptance model.

Table 24 *Coefficients derived by Smart PLS*

Relationships in Technology Acceptance Model and Theory of Planned Behavior	Waterfall dashboard	Agile dashboard	%increase in coefficient
Perceived Ease of Use to Perceived of Usefulness	0.671	0.678	1.04%
Perceived of Usefulness to Behavioral Intention to Use	0.356	0.469	31.74%
Attitude of Usability to Behavioral Intention to Use	0.124	0.125	0.80%
Perceived Ease of Use to Attitude of Usability	insignificant	0.540	
Behavioral Intention to Use to Dashboard Usage	0.364	0.465	27.75%
Perceived Behavior Control to Dashboard Usage	0.291	0.358	23.02%
Dashboard Usage to Dashboard Usage	0.575	0.850	47.83%

In summary, this study follows agile guideline in developing a dashboard. The result is as expected that agile dashboard outperforms traditional dashboard in terms of speed, users' satisfaction, and efficiency. Users from Company L can utilize agile dashboard efficiently because they joined developing process in sprint meetings.

Learned from this study, the team will continue to use scrum method in developing software, system, dashboard, or other deliverables. This study fortunately experienced no unexpected accident. Nevertheless, next time in planning sprints, the bottleneck or any delay sprint must be included.

5.2 Limitation and future research direction

The scope of this study is limited to develop a replaced dashboard for a logistic company. The possible bias was that the company has been unsatisfied by traditional dashboard for a period. The opinion towards existed dashboard might be overly negative. The future research might improve this limitation by develop dashboards with same requirement, one by waterfall methodology and one by agile methodology, to compare speed, satisfaction, and efficiency of the developing method.

5.3 Recommendation

As mentioned, limitation of this study was that only agile dashboard was newly developed. The status quo dashboard has been used for a while. To remove this limitation, the future study can develop two dashboards simultaneously by waterfall method and agile method. The bias of comparison will be removed.

Appendix A

Technology Acceptant Model Questionnaire

Gender: ☐Male ☐Female Age: .....

Position: .....Department: .....

Education background: ☐Junior High School ☐Senior High School ☐Vocational Certificate

☐High Vocational Certificate ☐Bachelor's Degrees ☐Master's Degrees or above

Faculty: .....

Question

No	Measure Definition	5 (Strongly Agree)	4 (Agree)	3 (Neutral)	2 (Disagree)	1 (Strongly Disagree)
1	The system can input easily.					
2	The system can show the information real time					
3	The system is back bone of factory.					
4	I think I would like to use this system always.					
5	I intend to know the product information.					
6	This system is easy to use.					
7	The system can conduct the result easily.					
8	The system has completely information and can use to analyze quickly					
9	Many department have to use this system					
10	I think this system has many data.					
11	I intend to know the problem and error in the process.					
12	This system help to know the problem and error in process quickly.					
13	The system can display directly and clearly.					
14	The system alert real time if the processing area have some problem					
15	Have to use the information from this app					
16	I think I can know the problem immediately if I use this system.					
17	I intend to solve the problem in process quickly.					
18	This system help to solve the problem immediately.					
19	The system can be evaluate quickly.					
20	The system help to know the problem immediately					
21	The most of information in factory is from this system.					
22	I think this system can help me to solve the problem quickly					
23	This system has the truly and precisely data.					
24	The system is easy to learn and easy for first using person.					
25	The system help to solve the problem in processing area immediately					
26	I think this system is easy to use and export the data					
27	The system is easy to export the data.					
28	The system has big data which can be useful in the future					

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VITA

NAME	Siribhop Yooyongchuen
DATE OF BIRTH	3 June 1995
PLACE OF BIRTH	Bangkok
INSTITUTIONS ATTENDED	KING MONGKUT'S UNIVERSITY OF TECHNOLOGY NORTH BANGKOK
HOME ADDRESS	1692/284 Moo.4 Theparak Muang Samutprakarn
PUBLICATION	IE NETWORK 2022
AWARD RECEIVED	Best Paper Award IE Network 2022