APPLYING VALUE STREAM MAPPING IN MEASURING SOFTWARE TEAM PERFORMANCE THROUGH TASK MONITORING

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Abstrak

Memantau prestasi kumpulan adalah penting dalam kerja berkumpulan untuk memastikan kerjasama yang diberikan di antara ahli kumpulan adalah adil. Walau bagaimanapun , mengukur kecekapan kerja berpasukan dalam bidang pendidikan adalah sukar kerana teknik pengukuran yang sedia ada tidak mampu membuat ukuran dengan tepat. Objektif kajian ini adalah untukmengkaji bagaimana pendidik memantau dan mengukur prestasi kerja berpasukan dari segi kecekapan kumpulan dengan menggunakan teknik Value Stream Mapping (VSM). Teknik ini telah digunakan secara meluas terutamanya dalam industri kerana ia dapat mengukur kecekapan proses pembuatan dan menyediakan visual graf dengan tepat. Kajian ini terdiri daripada empat fasa. Fasa pertama memberi tumpuan kepada kajian isu-isu semasa dan teknik yang telah dikaji dalam kajian lepas . Fasa seterusnya memberi tumpuan kepada mereka bentuk Team Performance Task Monitoring (TPTM) dengan menggunakan teknik Value Stream Mapping (VSM). Fasa ini mengkaji dan menganalisis keperluan dan algoritma yang diperlukan untuk kajian fasa ini. Ia diikuti oleh satu kajian perintis yang menilai kesesuaian teknik yang dicadangkan dalam fasa ketiga. Akhir sekali, hasil kajian dan cadangan disediakan dalam fasa terakhir. Ia menyimpulkan bahawa teknik VSM adalah dapat membantu melihat kecekapan anggota pasukan dalam bidang pendidikan. Oleh itu, ia boleh membantu pelajar untuk meningkatkan prestasi mereka dalam tugasan yang akan datang. Ia juga dapat membantu pendidik untuk mengkaji semula tahap kesukaran dalam memberikan tugasan dan menyediakan pelan untuk memperbaiki kaedah pengajaran.

Keywords: Group Efficiency, Value Stream Mapping (VSM), Team Performance, Lean

Abstract

Monitoring team performance is crucial in group work to ensure equal contribution among team members. However, measuring the efficiency of the team members in educational field is difficult because the existing measurement techniques are difficult to be applied. Thus, a practical mechanism to monitor the group members' efficiency is highly needed. This study is intended to fill this gap by proposing a technique to measure the group efficiency using Value Stream Mapping (VSM).This technique was mainly used in industry because it is able to measure the efficiency of manufacturing process and visualize it. This study consists of four main phases, which are conceptual study, design Team Performance Task Monitoring (TPTM) Technique using Value Stream Mapping (VSM), evaluation of TPTM, and writing a report. A pilot study was carried out to assess the suitability of the applied technique. Finally, findings and recommendations for future research were discussed. It concluded that VSM technique is able to view the efficiency of team members in educational tasks. Thus, it can help students to improve their performance in their learning process. It also helps educators to review the level of difficulty in assigning assignment and prepare intervention plan to improve teaching methods.

Keywords: Group Efficiency, Value Stream Mapping (VSM), Team Performance, Lean

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CHAPTER ONE

INTRODUCTION

1.1 Overview of the Chapter

This chapter introduces the background of the study, research motivation, problem statement, research questions, and research objectives. The operational definition, research framework, research scope, significance of the research, and limitations of the research are also presented. The chapter ends with the outline of the thesis structure.

1.2 Background of the Study

Monitoring students' activity and performance are very important for educators to provide effective teaching and learning methods. This is to keep students involved in learning and to improve their understanding (Doctor & Iqbal, 2012). Currently, students are struggling with teamwork by using collaborative skills (Vivian, Falkner, & Falkner, 2013). One of the methods to minimize these issues is by monitoring students' task activity closely (Juan, Daradoumis, Faulin, & Xhafa, 2008). When the students' tasks can be monitored closely, educators can determine non-participating group members and balance distribution tasks and non-performing team members. In addition, it can help educators to identify the bottleneck area and thus improve team performance. The educators also face challenges in designing a course to meet current demand in software development. The course needs to provide guidelines for students, monitoring student processes for each task and the result, especially in large classes (Rong & Shao, 2012). Based on the above challenges, researchers are currently trying hard to find the method that solves the monitoring issues. This research utilizes the method already proven successful in the manufacturing process; based on past study, the success of Value Stream Mapping (VSM) implementation in the industry reinforces the researcher to deeply explore this method. The literature review in chapter two explains in detail the success of VSM in different domains.

Research on applying Value Stream Mapping (VSM) by Lasa, Laburu, and Vila (2008) discussed the VSM features that can improve the manufacturing process by monitoring the process flow. It is focused on transforming the current state mapping to the future state mapping. One of the processes in VSM is to transform the mapping to improve process efficiency. Based on the efficiency presented in the VSM technique, it seems like it is suitable to apply in education for monitoring the process. By calculating its efficiency, the educators can identify which tasks take the longest time to complete and can monitor the movement of the flow of the task from start until the end. The non-contributing members also can be determined by calculating the efficiency of the students respond to task assign by their lecturer. VSM presents a visual mapping graphic and educators can use this visual report as a proof to tackle the unfair grading issues.

Team Software Process (TSP) was designed by the Software Engineering Institute (SEI) to help engineers produce good software (Amaral & Faria, 2010). In this research, TSP was applied to help the participants and team to produce better result. The details of TSP are explained in chapter two. Based on current demand for complex software development, a qualified and experienced software engineer is needed. To meet this demand, university plays an important role in educating the future software engineer. The educators should provide clear techniques, tools, and knowledge to develop technical skill (Sussy, Calvo-Manzano, Gonzalo, & Tomás, 2008).

Based on the educator issues discussion in the previous paragraphs, this research attempted to design a team performance task monitoring method using the Value Stream Mapping (VSM) technique and evaluate the suitability of VSM as a technique to improve monitoring team performance, focusing on calculating the efficiency guided by the TSP discipline.

1.3 Research Motivation

Successful experience in implementing Value Stream Mapping (VSM) in the manufacturing industry has drawn attention to adopt the application of Value Stream Mapping (VSM) and apply it in the education domain.

1.4 Problem Statement

Measuring team performance in a fair and acceptable manner is a challenging task by most educators. This is because team dynamism factors are complex to uncover (Swigger, Serce, Alpaslan, Brazile, Dafoulas, & Lopez, 2009; Omar 2012). It is noted that problems such as non-participating group members and uneven distribution tasks among members are the common problems occurring in teamwork assignments and projects in the education field. These problems will force the groups to lose consistency and spend too much time and effort to rearrange and reschedule their tasks. As a consequence, conflict amongst team members will be expected to occur and lead to ineffective team members.

Referring to Nishimura, Kawasaki and Tominaga (2011), one of the effective methods to measure student team performance is by monitoring their task efficiency. This can be carried out by detecting the typical behavior of students in completing tasks in the given time. However, a few aspects need to be clearly considered to measure team performance by monitoring tasks performed by the members. The below sub chapter presented five studies in team performance with the limitation which is analyzing different factors and techniques that can contribute to the lack of current research.

Beja, Superior, Tecnologia and Barros (2010) established three techniques in their research. They are concrete alignment, stepwise alignment, and improvement of past grades. This research analyzed the indicators of realism, construction, preparation, comprehensiveness, cost-effectiveness, individualism, fraud safety, feedback, feasibility, engagement, fairness, and opportunity. While reviewing twelve indicators, this research has a limitation on workload and course difficulty. Next, Zhu, Chen and Lu (2010) used Group Analytical Hierarchy Process (GAHP) method. The focus indicators in this research are performance, behavior, and competence. Although these studies focus on performance as an indicator, it only covers the weight of the indicator.

The techniques of samples, procedures, project measures, and instruments were introduced in research by Swigger, Serce, Alpaslan, Brazile, Dafoulas, and Lopez

(2009) .The research indicators are culture, individual, and attitudes. However, this study still needs improvement in terms of distribution of the task. Next, Sudhakar, Farooq and Patnaik (2011) presented the secondary research by doing a literature review on past studies. This research focuses on environmental, technical, non-technical and organization indicators. They found conflict in team is the main factor that contributed to failure in group work.

J. Chen, Qiu, Yuan, Zhang, and Lu (2011) introduced the Novel Assessment Approach while researching cooperative learning; collaborative learning, team management, and learning style and not direct access to improve the teamwork skill.

From the above paper, the current mechanism in monitoring team performance has a limitation on monitoring workload and unbalance of the difficulties on task distribution. Current studies also focus on different indicators other than access to improve the teamwork skill. This gap gives significant insight that there is a need for a practical and reliable mechanism to measure team performance through task monitoring.

1.5 Research Questions

With a reference to the problems discussed in the previous section, this study attempts to answer the following research questions.

1) What is the requirement of Team Performance Task Monitoring (TPTM) method?

2) How to design a team performance task monitoring method using Value Stream Mapping (VSM) guided by Team Software Process (TSP) rules?

3) Is the proposed method suitable to be applied in the education field?

1.6 Research Objectives

There are three objectives in this study. They are:

1) To identify the requirement of Team Performance Task Monitoring (TPTM) method.

2) To develop a team performance task monitoring method using Value Stream Mapping (VSM) technique guided by Team Software Process (TSP) rules.

3) To evaluate the suitability of the proposed method in the education field.

1.7 Research Framework

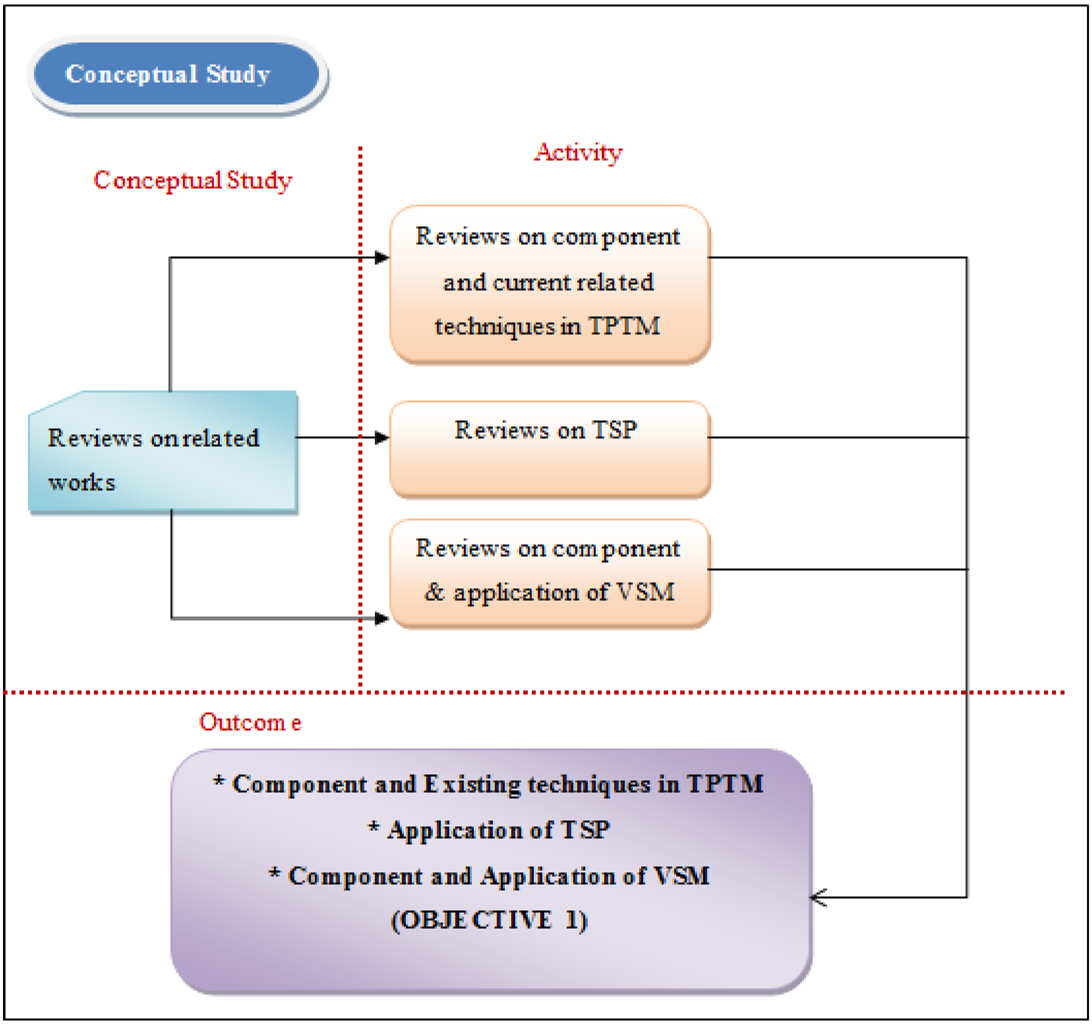

Figure 1.1. Research Framework (Conceptual Study).

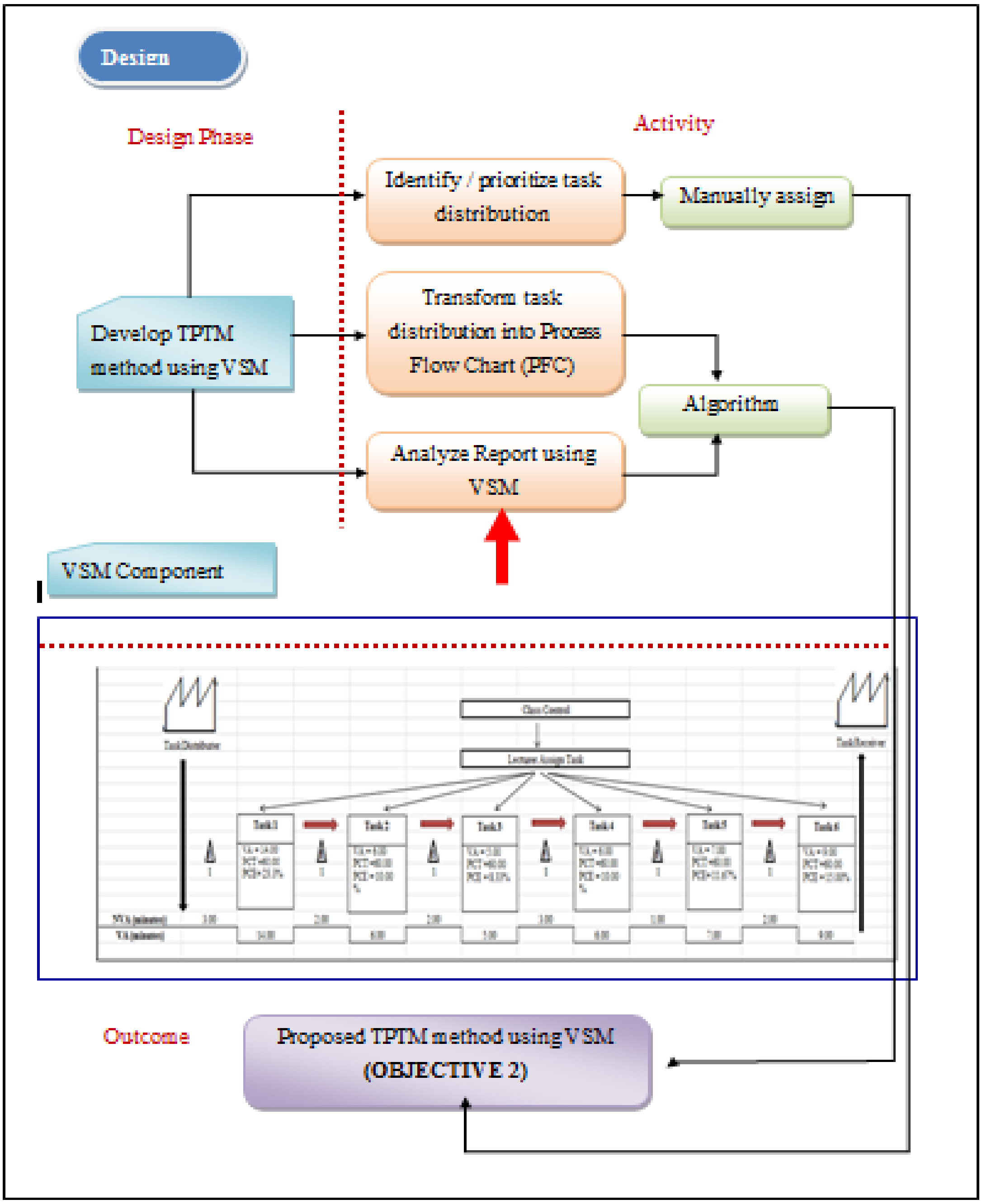

Figure 1.2. Research Framework (Design).

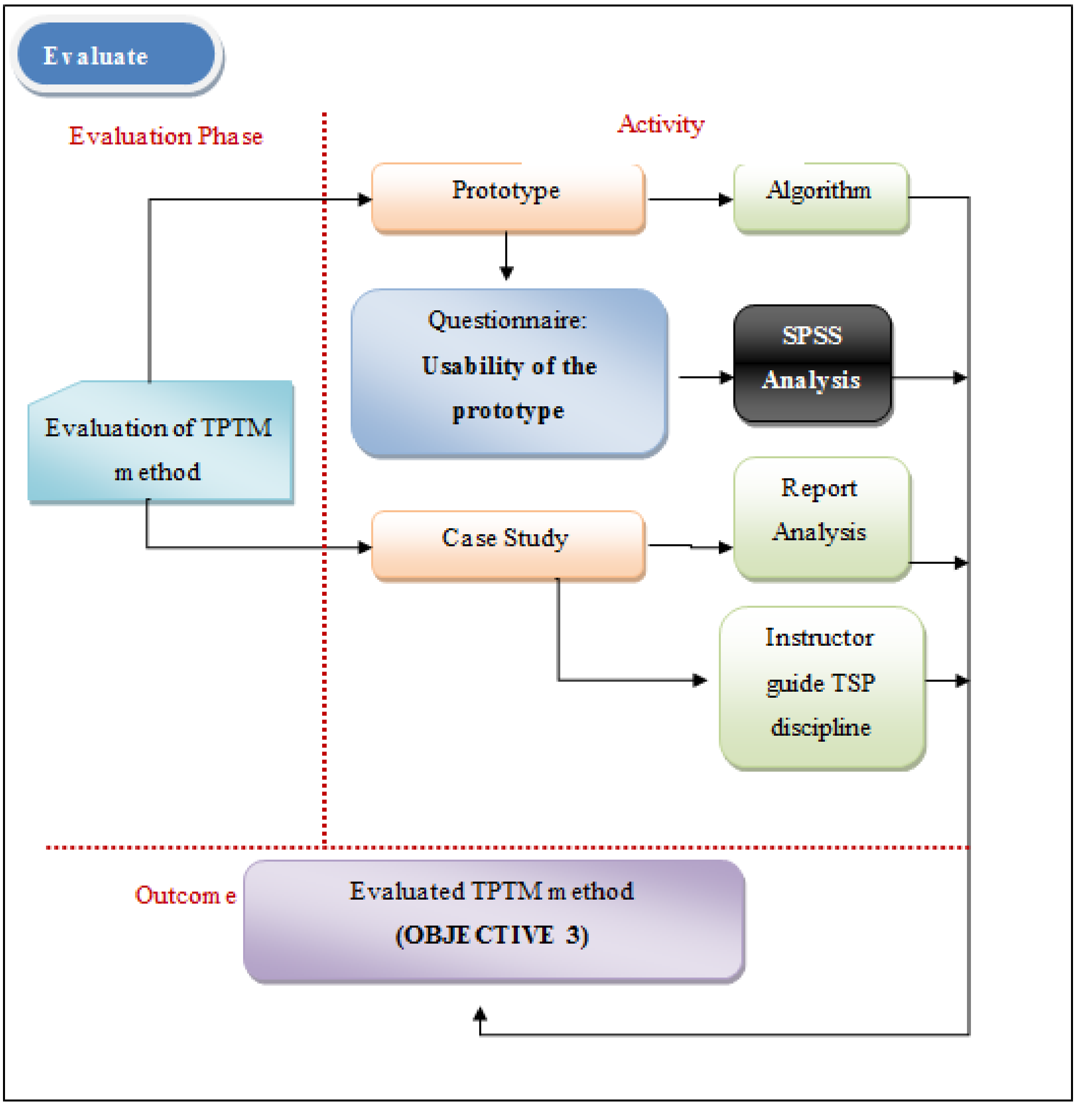

Figure 1.3. Research Framework (Evaluate).

This research is guided by the research framework as illustrated in Figure 1.1, Figure 1.2, and Figure 1.3. The research framework is divided into three sections that are based on the objectives of this study. The first section is a conceptual study that features reviews on related works in current techniques applied in team performance task monitoring as well as reviews on Team Software Process (TSP) and Value

Stream Mapping (VSM). The second section is a development of the proposed method. This section has three activities that contributed to the development section.

The first activity is identified and prioritized task distribution. In this activity, the lecturer manually identified the sequence of the task distribution. Continue with transforming task distribution into Process Flow Chart (PFC) and analyze report. These components and activities in VSM are applied with an algorithm representing the efficiency formula. The details of the VSM component are described in chapter three. The anticipated outcome of this section is to draft the proposed TPTM method using a VSM technique that meets the needs of objective 2.

The next section is an evaluation of the proposed method. In this section, the prototype and case study are evaluated. The usability of the prototype is evaluated by users with a questionnaire. The user's response in this questionnaire is analyzed using Statistical Package for Social Science (SPSS). In the prototype, the algorithm in the previous section is implemented to prove the method. The next case study involved two parties, a student and lecturer. In the case study, the instructor explained the Team Software Process (TSP) principle that needs to be applied as a guide in this case study. The result is presented in the VSM report and this report will be analyzed to measure the group performance. The questionnaire was distributed to students to collect their responses regarding the effectiveness of their group performance. This data was analyzed using SPSS

1.8 Operational Definitions

The operational definitions of the research are as below:-

1) Performance

Performance is a combination of behavior, results, and competence (Zhu, Chen & Lu, 2010). In this study, performance refers to the response of the participants to complete the project assigned by educator. The performance measured by an applied Value Stream Mapping (VSM) that focuses on efficiency.

2) Efficiency

Referring to Keskin (2012), efficiency is the extent to which time, effort, or cost used for the intended task. In this study, efficiency of team performance measured by applied Value Stream Mapping (VSM) which is focused on time.

1.9 Research Scope

In this study, team performance was measured based on tasks that can be completed by team members in a given time. It focused on the efficiency of the team members to complete the given tasks. This study emphasized VSM techniques under Lean Tools for the conformity in terms of computation time and visually sees the movement of each group member task activities. The study area selected at the course related to development system because it requires continues distribution of task with proper arrangement. This study chose the Students School of Computing (SOC) in the University Utara Malaysia as respondents because they were involved in a subject that related to the software development system.

1.10 Significance of the Research

The significant factors of this study are:

To provide a mechanism for monitoring team performance in the educational field by applying Value Stream Mapping (VSM) that focuses on process monitoring team performance and measuring the efficiency of each member of the group in completing the given tasks. This proposed technique may complement the current technique, which focused more on the quality of work. By using the proposed technique, it is hoped that the educators can easily identify and track non-efficient members in a team and difficult tasks that can occur delay time to complete the project. In addition, it is hoped that educators can prepare a suitable intervention plan, which is suited to students based on delayed tasks and inefficient team members identified. To familiarize the student with TSP's rules that can guide them to discipline themselves in the field of job in the future.

1.11 Limitation of the Research

The limitation of this research is the task assigned cannot be reversed. Once the student submits the first task and moves to the second task, they cannot redo the first task. This is because the time taken will not be valid for the efficiency's calculation formula.

1.12 Thesis Structure

This research has six chapters. The overviews of each chapter are as follow:-

The first chapter covered the introduction of the research. The introduction explained the background, problems that led to this study, objectives, and also the importance of this study.

Chapter 2 covers the related literature review including the current issues in Team Performance Task Monitoring (TPTM) and also the current applied technique in TPTM. This chapter also reviewed the proposed technique starting with an explanation on LEAN manufacturing with focus more on the technique. Discussion and comparison on the functionality of each technique under LEAN are also listed in this chapter. This is followed by reviews on Value Stream Mapping (VSM) that has been chosen as the best technique under LEAN for contribution to this research. Finally, this chapter reviewed Team Software Process (TSP) rules that were used in this research as guidelines for lecturers and students' interaction.

Chapter 3 presents the research methodology that was used in this research and details for the four phases involved in this research. It started with conceptual studies on problem definition in Team Performance Task Monitoring (TPTM), Value Stream Mapping (VSM) technique, and Team Software Process (TSP), followed by the second phase, which covered the design of TPTM using VSM and guided by TSP rules. In phase 3, the evaluation of the TPTM, which was presented by case study, was explained. Finally in phase 4, writing and publication activity were also described.

In chapter 4, the results and findings are presented. Starting with the explanation on the development of the prototype, which includes the details of software tools, programming language, and list of the functional and non-functional requirements, it was followed by software requirement specifications that were shown in a case diagram, sequence diagram, activity diagram, class diagram, state diagram, and interface. Besides that, an explanation on Team Performance Task Monitoring (TPTM) efficiency's algorithm was also provided. Finally, the implementation of TPTM was also described in chapter 4.

Chapter 5 presents the detailed evaluation of Team Performance (TPTM), which covered the explanation on a case study. It also covered a discussion on the findings of this study.

Finally, chapter 6 concludes this research by providing a general discussion of the research finding and also future work related to this field.

1.13 Summary of the Chapter

Based on this chapter, the research explained clearly the background of the study, research motivation, problem statement, research questions, research objectives, operational definition, research framework, research scope, significance of the research, limitations of the research and outline of the thesis structure to archive the goal of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of the Chapter

This chapter reviews on current Team Performance Task Monitoring (TPTM) techniques used to monitor students' team performance with pro and cons discussion on these techniques. The next section addresses the introduction of Lean and continues with detail explanation of tools under Lean. The selection of method that used in this research underlines the Value Stream Mapping (VSM) that is one of the Lean tools that have been present earlier. This chapter also underlines the Team Software Process (TSP) that have been chosen as a guideline support method to smoothly monitor the team work. Team efficiency, which is main research area presented at the end of this chapter. This chapter closed with a summary of the literature review that has been present earlier, which is contributes to this research.

2.2 Reviews on Team Performance Task Monitoring (TPTM)

Froyd (2002) categorized distribution of the tasks in team work into three categories. In-class exercises, routine homework, or extended projects. In this study, team work on in class exercise. Over the years, the issue and the best method to measure the performance of the group have not found an accurate solution yet (Swigger, Serce, Alpaslan, Brazile, Dafoulas & Lopez, 2009). However, this process is dependent on the assignments, attitudes, and types of project assigned. Each individual comes to any organization does not have all the required skills. Therefore, this issue can contribute to inequality in the completion of tasks and they should be fairly monitored.

Currently, the popular method used to monitor team performance is by using a survey Froyd (2002). In the survey, members of the group asked to self-monitor for operations and team performance. However, if done outside the classroom observation, the monitoring becomes more difficult. By using a survey, this evaluation team may not indicate the effectiveness because of the work may or may not be done in cooperative manner. Therefore currently monitoring takes many forms likes self-assessment survey, evaluating progress reports, grading occasional assignments and reading journal entries.

A previous study also showed that self-monitoring is the technique that was used in measuring the performance. However, this technique is more effective in application to the respondent that guides by the organization (Bryant, Mitcham, Araiza, & Leung, 2011). Therefore, this technique is not effective for individuals as much depends on the attitude of the individual. Student must develop the ability to monitor and improve their progress, because team members will need self-monitoring skills. Since self-monitoring is important for effective team operation, students should have some experience in this task. To provide experience, they will need training and opportunities to develop these skills. An intelligent system with applied Linguistic Summarization (LS) technique has also been used as a framework for monitoring individual or group performance during activity and problem based learning tasks. This framework will evaluate new teaching approaches, methodology, identify weakness and personalized feedback (Doctor & Iqbal, 2012). However, this technique didn’t focus on the efficiency of the group to complete the tasks that contributing to one of the successful factors in monitoring the group performances.

2.3 Lean

In 1450s, Henry Ford introduced the idea of process thinking that totally covered the production process in manufacturing. In 1913, he implements standard work process and moving conveyance to create a production flow. He set up production lines with special purposed machines and go no go gauges that suited to the process.

Through this assemble line, the components going to vehicle takes a few minutes and perfectly delivered. It was a revolutionary break from American System practice that introduced shop practices. Shop practice was consisted of proposed machines grouped by process and the components need to go through multiple assembly. The issue with Ford's idea is a variation of the order. This idea only can support to one color and the standard specification of the models. If have special color or specification models, this idea need a few days to restructure the flow and adjust the specification of the machines. Kiichiro Toyoda and Taiich Ohno from Toyota, looked at this situation and planned to improved Henry Ford's idea in process flow which is can meet variations of orders. They introduced Toyota Production System. In Toyota Production System, three type of waste has been identified. They are Muda (7 waste), Mura (unevenness) and Muri(overburden).

In this study, research focus more on Muda, which refer to any activity or process that does not add value.

2.3.1 LEAN Thinking

In production definitions, Lean is a creating value to customers. The main idea of Lean is to minimize the waste. To meet this idea requirement, lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through the entire value streams that flow horizontally across technologies, assets, and departments to customers. Decrease the waste along value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services with less costs and with minimum defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate. Based on systematic Lean literature, the growth of four decades was identified. Lean principles started to deploy in 1991- 1996 after crisis spurs interest in Japanese Method in 1970-1990. In continues years, Lean thinking was elevated to strategic implementation and the methods expand the use beyond manufacturing to other sectors. The development of Lean was growing rapidly with new focus on measuring performance that started around the year 2006 (Stone, 2012).

2.3.2 Lean Tools

According to http://www.leanproduction.com , LEAN has introduced tools to support the effectiveness of LEAN Thinking. In this website they selected 25 tops tools with different functions. Among the 25 selected tools, the most popular was Kanban, Just In Time (JIT), 5S, Value Stream Mapping and Poka- Yoke.

1) Kanban

Kanban is a tool used to minimize the waste from inventory and overproduction. According to Zhang (2013), production system can operate in pull or push the process in monitoring inventory by implementing Kanban. Kanban applied performance metric that covered customer service level, average of inventory level and control raw part release.

2) Just in Time (JIT)

Chen and Tan (2011) used Just In Time (JIT) tool in their research paper to investigate the impact of implementation of JIT in operations performance. In JIT parts was pulled in production lines based on customer demand, instead of project demand. However, from this study, found that the impact was depending on types of industry and the scale of industry. Therefore, any types of industry were suitable to implement JIT to improve operational performance.

3) 5S

In Zhang and Tan (2011) study on 5S, explained the combination of Japanese words Seiri (Organization), Seiton (Neatness), Seiso (Cleaning), Seiketsu (Standardization) and Shitsuke (Discipline). 5S was used for improvement in working area which is impacting the quality, cost and productivity. This research concluded, 5S is a simple practice, but it is very hard to implement because it’s discovered a long time.

4) Poka – Yoke

Liang, Guo and Yu (2008) developed a logistic strategy control for an assembly process. This research applied Poka Yoke to improve the assembly quality by design the error detection and prevention to achieve zero defects. Finding from this research is the Poka Yoke is effective to avoid the wrong assembly process.

5) Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a tool to map the production flow by visual by shows the current and future state process. According to Lasa, Laburu and Vila (2008), based on their research finding, VSM is a valuable tool for redesigning process flow and shows the opportunities for improvement.

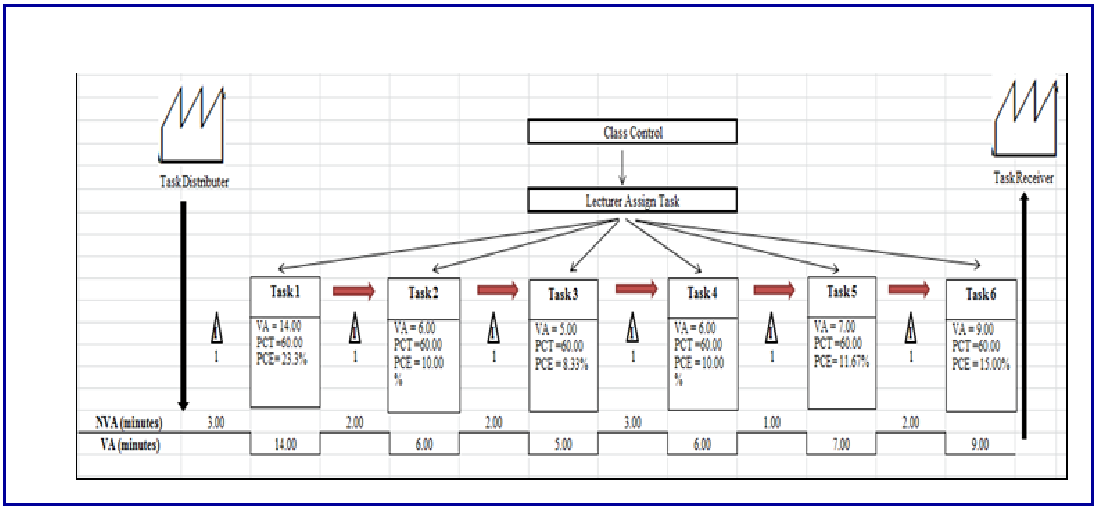

Figure 2.1. Value Stream Mapping graph.

In Cox and Llc (2004) study, they identifield the main element in VSM. They are Value Added (VA), Process Cycle Time (PCT) and Process Cycle Efficiency (PCE). VA refer to the amount of time that have a value applied in the process. PCT refer to the time taken from start process until end of the process. PCE is the efficiency calculation of the process, depend on the time of VA versus the total amount spend time in the process.

Table 2.1

Lean Tools.

No	Author (s)	Lean Tools	Description
1	Zhang (2013)	Kanban	Reduce lead times and stabilize in-time manufacturing
2	Chen & Tan (2011)	Just In Time (JIT)	Improve performance by controlling the production size lots and work in progress
3	Zhang & Tan (2011)	5S	Useful to establish and maintain work environment and processes, increase productivity and reduce errors
4	Liang, Guo, & Yu (2008)	Poka-Yoke	An Error Proofing control that can help assembly line to minimize the error
5	Lasa, Laburu, & Vila (2008)	Value Stream Mapping (VSM)	Visualize current flow and prepared for future state mapping that can impact positive outcome

Based on above review, Value Stream Mapping (VSM) is more suitable to implement in this research because VSM can provide a sketch for the identification of the problems faced by students, identify the contribution of students in group work and assist educators in preparing intervention plans in their future teaching sessions.

2.4 Application of Value Stream Mapping (VSM)

Value Steam Mapping (VSM) provides a tool for system decision making. It is a technique to visualize entire process and represent information and material flow to improve the process by identifying the waste and its sources and also transferring the information into “map”. VSM also successful in identifying the non-value added process and problem (Xie & Peng, 2012) . From the literature review, more researchers have gained interest in focusing Lean tools, especially Value Stream Mapping (VSM) with applied in different domain. Among this study are depicted in the next paragraph.

For further explained the functions of the VSM, review on past study in different domains and approach presented. Started with research from Taylor (2005) applied the VSM for food product farm to customer. VSM approach used to classify the issues and transform to physical flows. Continuous research by Keskin (2012) in the energy domain. VSM approach applied to the research for reducing the energy utilization. In this study, VSM applied to detect the level of energy used in each step in production or facility support.

Xie and Peng (2012) applied the VSM to represent operating room process and patient flow to identify problems. The purpose of this research is to improve the operating room flow and reduce patient waiting time. This research was covered for the medical domain. VSM also tested in Ford Motor Industry. Wee and Wu (2009) presented VSM to demonstrate the measurable indices for cost reduction, quality enhancement and lead time reduction. The purposed of this study is to address “how Toyota can continuously and consistently achieve its success through continuous waste elimination and the objective of long term philosophy”.

The VSM method in simulation introduced in research by Gurumurthy and Kodali (2011). The purposed of this research is to present an application of VSM with simulation during the design of lean manufacturing systems (LMS) in the manufacturing domain. Next research is from Balagopal (2008) and the purposed of this study is to organize the process at large food distribution center. In this research, VSM used to identify the Value Added for the product moving and Non Value Added for product sitting. The domain in this research is food distribution center.

Seth, Seth and Goel (2008) introduced VSM in their research to identify and remove Non Value Added. The goal of this study is to address the waste in the supply chain which is covered in the oil industry. Continues implementing of VSM is in Vinodh, Arvind and Somanaathan (2010) research. They used VSM to visualize the wastes occurring in the organization and the future possibility of reducing or eliminating them in an Indian camshaft manufacturing organization.

Others research implemented VSM as research base is by Arlbjørn, Freytag and Haas (2011). The purposed of this study is to investigate lean practices in the municipal sector in a service supply chain management (SCM). This research used two sets of questionnaire surveys from 2008 to 2009. The result for this surveys shows that the implementation of VSM helps the respondents to improve and monitor their works. For final exploration on application on VSM in various domain, research from Piercy and Rich (2009) selected. This study applied VSM tool in the pure service context. This study aims to assess the suitability of lean production methodologies in the pure service context. The conclusion in this study is positive and proven that, Lean tools helps in work improvement.

Table 2.2

Summary of VSM Application in Various Domains.

No	**Author (s)**	**Purpose of Research**	**VSM Approach**	**Domain Applied**
1	Xie & Peng (2012)	Improve the operating room flow and reduce patient waiting time.	VSM was applied to represent operating room process and patient flow to identify problems.	Medical
2	Taylor (2005)	To apply systematic technique for a food product from farm to consumer.	Used VSM to classify issues into physical flows and information flows.	Food
3	Keskin (2012)	To reduce energy utilization.	VSM was applied to detect Level of energy use at each step in production or in facility support.	Energy
4	Balagopal (2008)	To organize smooth process at a large food distribution center.	VSM applied to identified the VA for the time where the product is moving through	Food distribution center

			and the NVA time is the time when the product is sitting.	
5	Seth, Seth, & Goel (2008)	To identify and address wastes in the supply chain of the edible cottonseed oil industry	Used VSM to identify and remove non-value-adding (NVA) activities.	Oil
6	Vinodh, Arvind, & Somanaathan (2010)	enabling leanness in an Indian camshaft manufacturing organization	Used VSM to visualize the wastes occurring in the organization and the future possibility of reducing/eliminating them	Indian camshaft (case study)
7	Wee & Wu (2009)	to address "how Toyota can continuously and consistently achieve its success through continuous waste elimination and the objective of long term philosophy"	Used VSM to demonstrate the measurable indices for cost reduction, quality enhancement and lead time reduction.	Ford Motor
8	Arlbjørn,	to investigate	Analyses lean	municipal

	Freytag, & Haas (2011)	lean practices in the municipal sector in a service supply chain management (SCM)	implementation in Danish municipalities through the use of two sets of questionnaire surveys from 2008 to 2009	sector
9	Gurumurthy & Kodali (2011)	To present an application of VSM with simulation during the design of lean manufacturing systems (LMS)	Used VSM method in simulation.	Simulation in Lean Manufacturing System.
10	Piercy & Rich (2009),	to assess the suitability of lean production methodologies in the pure service context	Apply lean tools in the pure service context	Call service center

From the above review, the conclusion for the purposed technique of research is similar to each other. This technique used to visualize the current flow, identify Value Added and Non Value Added, and tackle bottle neck area with plan for future map. With the listed function of the techniques, identify the problem area and do improvement are the main key of the suitability of VSM implementation in the education domain to align with education issues which is discussed in previous chapter.

2.5 Team Software Process (TSP)

To produce better research results in case study, Team Software Process (TSP) discipline selected, to assist respondents in carrying out experiments in this study. Team Software Process (TSP) was developed for helping engineers do a quality work consistently. The objective of the TSP is related with the effort in the development process by simplifying processes, reduce process size and provide guides and support needed to ensure the process more efficient and useful. TSP will help engineers in planning their working schedule, dealing with management and manage their work to meet the date line schedule with produce quality outcome and also achieve their best performance in team. In implementation TSP, three concept need to follow. They are managing self-directed teams, process and measure in engineering works and quality management Over (2010).

1) Managing self-directed teams

In this section, the leaders will guide and motivate the team members and clearly understand the important issues. The team members need to participate in planning, managing and tracking their own work.

2) Process and measure in engineering works

There are four direct measurement apply in this section. The will divide to schedule, effort, size and quality. In this study, measurement can be accurately measure by applied Value Steam Mapping (VSM) that can help to visualize the time taken to monitor schedule, effort, size and quality.

3) Quality Management

TSP provides a guide for quality management. Started from planning, measure and tracking, defect removal filter, capture/recapture and defect prevention. The developers will track and record if any defect or error found and fixed. This quality tracking will be monitor and review by quality person and team. For every error or defect found, this team will analyze for prevention plan in future.

TSP produces good results with helps by support tools that applied together in this procedure. Below table describes the tools used, function and weakness (Fahmi & Choi, 2008).

Table 2.3

TSP support tools.

No	**TSP Support Tools**	**Function**	**Limitation / Weakness**
1	Team Dashboard	Open source tool that provide function like data analysis, hierarchy planning, simultaneous top-down and bottom up planning, real-time multi-project coordination, dependency tracking, customization form and report	-Difficulties in accessing this tool for non-expertise in TSP due to unfriendly user interface. - Only expertise can

		and custom process workflow.	interpret the data / result.
2	tVista	Open source application that provide functions like inspection report, issue tracking log, defect summary and quality plan.	- Still in development stage (supposed to finish in 2005)
3	Point	Providing features like central management for multi project and real time for consolidated data.	-Lack of proper data visualization
4	TSPi Workbook	The programmed that analyzing using excel file.	-User interface not attractive and lack of proper data visualization

The conclusion from above table is a function provided in current TSP support tools are not enough. The lacks identified are support tools are not user friendly and not handle the data visualization. In this research, the proposed technique adopt some of the disciplined in TSP to tackle the issues and can be trial run in academic fields before the student facing real working life. In this study, by implementing proposed technique, TSP will help to guide student in monitoring their work.

2.6 Summary of the Chapter

Based on literature, it demonstrates that the VSM technique has been successfully and widely used in various domains. However, extant literature fails to incorporate the application of VSM with software development team performance, especially in task monitoring especially in education domain. Therefore, based on above arguments, this research attempts to design a monitoring task performance by using VSM and gather with TSP idea to contribute new monitoring method in education domain.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview of the Chapter

This chapter is to present the methodology that applied in the study. First, the explanation of conceptual study that has been done in previous chapter is described. Next, the explanation of design Team Performance Task Monitoring (TPTM) includes the requirement analysis, software tools, programming language and algorithm. This chapter ends with described on the evaluation TPTM which covered the case study and usability test. The overview of the research as per figure 3.1 which is explain activities for each phase in this research and the output was visualized clearly.

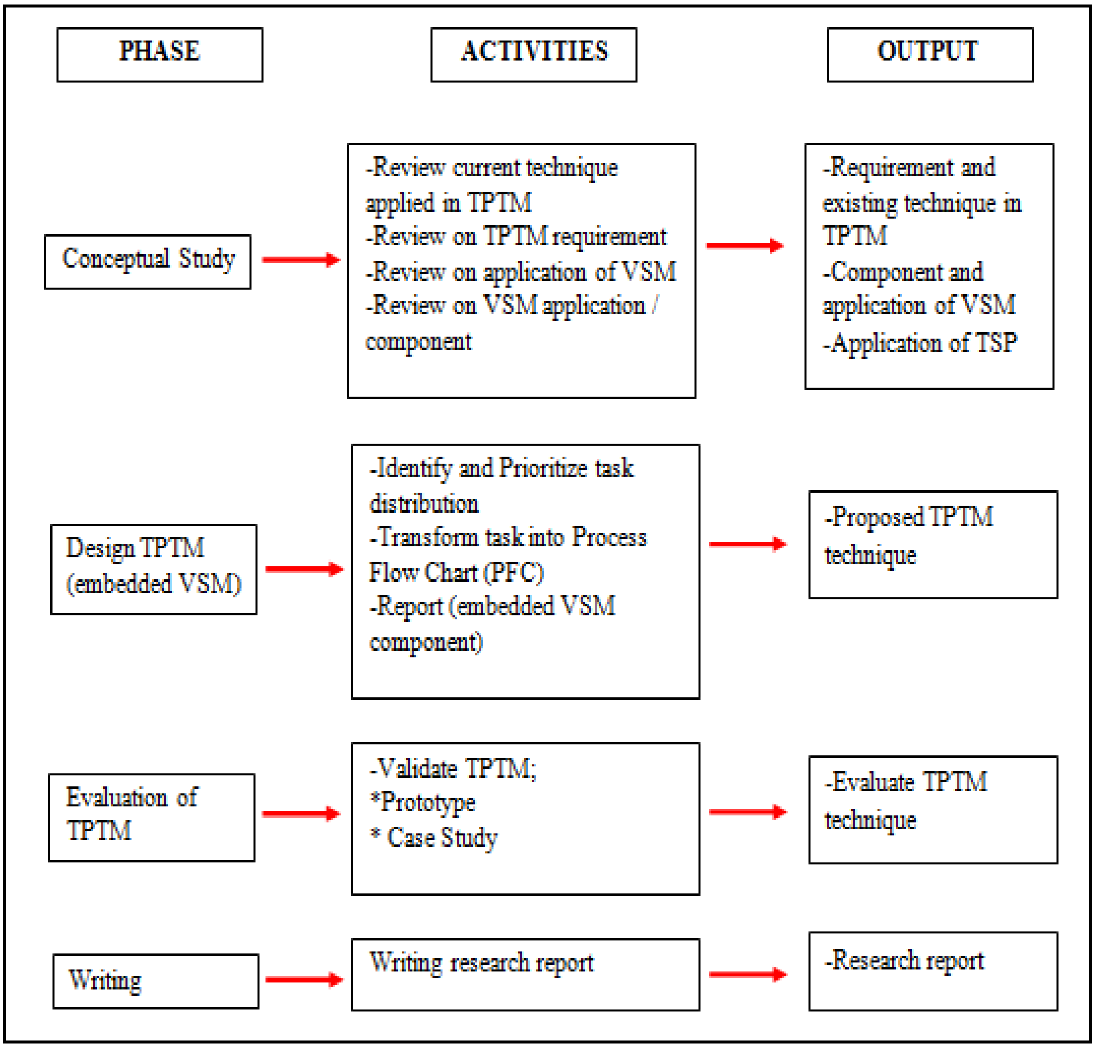

Figure 3.1. Overview of Research Methodology.

3.2 Conceptual Study

In this phase, initial study was carried out to define the problem of team performance monitoring technique, deeply understand the current issues and conceptual study reviews on the current technique that applied on Team Performance Task Monitoring. This study also highlights the survey of self-monitoring and Linguistic Summarization technique. The weakness of the listed techniques is discussed in detail in Literature Review chapter. The research is intended to enhance and resolve current issues. In order to tackle above gap, Value Stream Mapping (VSM) under Lean tools was used in the study. This is because it is successfully applied in manufacturing environment to monitor processes. In education field, Lean is not popular compared with manufacturing field. Conceptual study covered this issue with introducing Lean by explaining in general the historical of Lean and the principle of Lean. Next are described on the most popular tools under Lean. Also presented the past research finding for selected tools and followed by a description of the VSM and ended by presenting the previous studies on VSM applied in different domains. Team Software Process (TSP) discipline selected to assist respondents in carrying out the experiment. This review covered the objective and disciplines applied in TSP.

3.3 Design of Team Performance Task Monitoring (TPTM) Technique using Value Stream Mapping (VSM) guided by Team Software Process (TSP).

This phase is a critical phase and focuses more on prototype development with applied algorithm. The activities are to identify and prioritize task distribution, transform task distribution into Process Flow Chart (PFC) and analyze report using VSM explained in algorithm section. There are several activities carried out in order to achieve the objective. These activities are:

3.4 Team Performance Task Monitoring (TPTM) Requirement.

The requirements in TPTM are identified as requirement analysis, identified and prioritize task distribution and algorithm. Algorithm was divided into two part, transform task distribution in Process Flow Chart (PFC) and embedded VSM in reporting. The detail explanation for each requirements are as per below;

3.4.1 Requirement Analysis

This phase started with identifying the requirement analysis. Requirement analysis covered the requirement description. For this research, there are seven main requirements.

The identified requirements are visualized by Use Case diagram. In the diagram, it illustrates types of user and interaction between users and module clearly. Sequence diagram is to show the interaction arranged in time sequence. Activity diagram to presents the work flow of TPTM. Class diagram to illustrate the interaction between source code among the classes. This phase also explained the software tools and programming language that have been used in prototype development.

3.4.2 Identify and Prioritize Tasks Distribution

Before starting task distribution, educators identified the division of tasks with clear rules. The educators systematically organized tasks to be divided, based on its importance, the degree of difficulty or some relevant factors to be considered.

3.4.3 Algorithm

Algorithm used to automate and to calculate the process efficiency in prototype. They are divided into two types of algorithm;

3.4.3.1 Transform Tasks into Process Flow Chart (TPC)

Lecturer registers the task in the system before a student can proceed to download the task. Lecturer selects assignment registration page, then registers the detail of the assignment such as assignment title, bill of student, due date and remarks. After successfully registering, the system links to screen sub assignment. If there were more than one sub-task, the tasks will be transformed into a process flow chart (PFC). Pseudo code is control by first come first serve. Details explained in chapter four in algorithm section.

3.4.3.2 Analyze Report using VSM

In this study, the lecturer distributed tasks according to the provision stipulated time control. The time spent for each assignment will be recorded individually in the table and subsequently transferred to the diagram Value Stream Mapping (VSM).In order to monitor performance of each team members, the following formula applied (Cox & Llc, 2004).

PCE = VA/PCT

Note:

1) **Value Added (VA):** The amount of time that value actually applied to assignment while it is in process.
2) **Process Cycle Time (PCT):** The time taken to process a task from beginning until task complete. **Process Cycle Efficiency (PCE)**: The efficiency of the process is based on the time in which value added versus the total amount time spend in the process.

Table 3.1

Group value added and summary process cycle time.

Group 71 : Value Added

Matric No.	73	74	75
S813661	43.2500	7.1333	1.8167
S815600	74.7167	0.4000	3.2500
S815605	28.3167	8.5333	8.7333
S815062	27.6000	7.1833	7.2667
Average	43.47085	5.812475	5.266675

Group 71 : Summary Process Cycle Time(%)

Matric No.	73	74	75
S813661	74.97832996	12.36636810	3.14937879
S815600	71.23788336	0.38137613	3.09868107
S815605	59.76081604	18.00914527	18.43123461
S815062	58.82770870	15.31083481	15.48845471
Average	66.201184515	11.5169310775	10.041937295

Table 3.2

Individual Summary.

Matric No	Sub Assignment Id	VA	NVA	PCT	PCE(%)
S813661	73	43.2500	5.3833	57.6833	74.97832996
S813661	74	7.1333	0.1000	57.6833	12.36636810
S813661	75	1.8167	0.0000	57.6833	3.14937879
Total		52.2	5.4833	57.6833	90.49407685
Average		17.4	1.82776666667	57.6833	30.1646922833

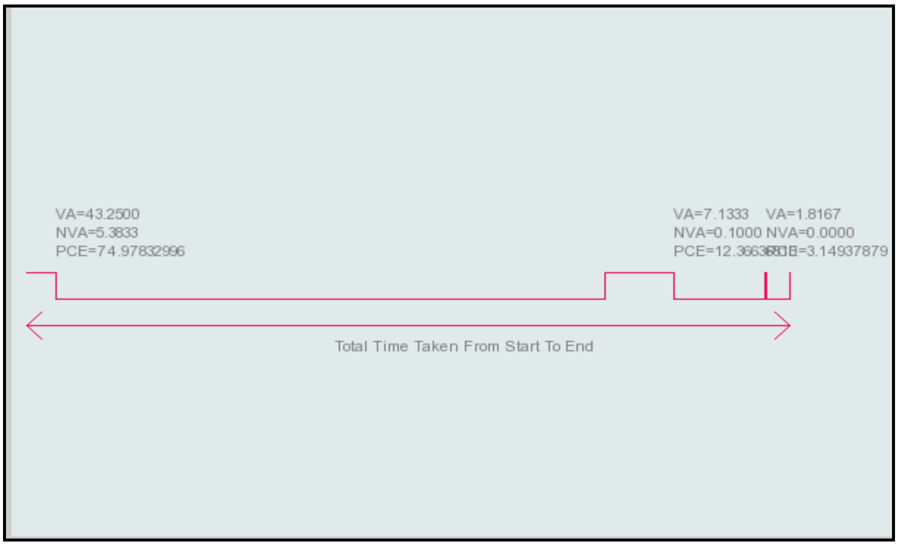

Figure 3.2. Individual Value Stream Mapping (VSM).

Table 3.1 shows the value added and summary process time of a group in the class. For individual details, referred to table 3.2 the individual summary. This efficiency's data were calculated by using above formula. This formula was applied by pseudo code which explained in detail in chapter four. This data also converted to VSM for clearly visualize the performance. The sample of VSM as per figure 3.2.

3.5 Evaluation of the TPTM

Case study and usability test conducted to determine the suitability of the proposed technique for application in the field of education. Participants of the study are students from School of Computing (SOC) University Utara Malaysia.

3.5.1 Case Study

They are 8 procedures in the case study that followed by instructors and participants. In general, this procedure includes briefing of the activity that carried out in this case study, monitoring participant's activity and group discussion that applied the Team Software Process (TSP) discipline. The details of the case study explained in chapter 5.

3.5.2 Usability Test

To access the usefulness of the prototype, 84 participants were selected to do usability test. Computer System Usability Questionnaire from http://hcibib.org/perlman/question.cgi is used to determine the level of user satisfaction. There are 19 questions in the questionnaire with 5 scales score. The details of usability test explained in chapter 5.

3.6 Summary of the Chapter

Based on this chapter, the overview of the research methodology presented clearly. The activity of this research described in details for each phase.

CHAPTER FOUR

DESIGN OF TEAM PERFORMANCE TASK MONITORING

4.1 Overview of the Chapter

In this chapter, the development of the prototype presented. In order to provide clear explanation, this chapter divided into five sub chapters. First sub chapter is the introduction. Second sub chapter that covered the development of the prototype which included the details of software tools and programming language, functional requirement, non-functional requirement and usability requirement. This chapter also includes the software requirement specifications that represent by use case diagram, sequence diagram, activity diagram and interface. Third sub chapter focuses on Value Stream Mapping (VSM) efficiency's algorithm that embedded in Team Performance Task Monitoring (TPTM). It explains how efficiency's algorithm works in details and the three main pseudo codes used. They are assigning team, assign task and download until upload the task. In sub chapter four, limitation and future work for this prototype also explained in detail for future references. This chapter ends with summary that conclude the challenge that facing in development phase.

4.2 Team Performance Task Monitoring (TPTM) Requirement Analysis

Requirement analysis is the important phase in development system. Requirement analysis includes identification of requirements for new system development or changes needed in current system. In order to ensure the software development process are well organized and efficient, all the requirements need to be documented to facilitate the experiment later and for features and function of the system reference, to fulfill the system purpose. In development Team Performance Task Monitoring (TPTM) requirement analysis, includes the requirement of the user's need which is focus for students and lecturer, prototype development, functional, non-functional and usability requirement also considered.

4.2.1 Functional Requirements

In functional requirement, it explains what system must do. This part includes the requirement description of the main module and Use Case Diagrams that represented the structure of the system and its behavior of how's the system process input and output and error handling.

4.2.1.1.Prototype Requirement Description

The development Team Performance Task Monitoring (TPTM) is divided into seven modules. They are login, user registration, assignment registration, assignment download, assignment upload and view report. Table 4.1 presented the requirement description for TPTM.

Table 4.1

TPTM Requirement Description.

No.	Requirement ID	Requirement Description	Priority
TPTM_01		**LOGIN**	
1	TPTM_01_001	Users login into the system.	H
2	TPTM_01_002	The system will display successful login message if the userID & password are valid.	H

3	TPTM_01_003	An error message will be displayed if the user entered invalid userID and password	H
TPTM_02		**USER REGISTRATION**	
1	TPTM_02_001	Users register their details.	H
2	TPTM_02_002	If compulsory fields not completed, an error message will be displayed.	H
TPTM_03		**ASSIGNMENT REGISTRATION**	
1	TPTM_03_001	Authorized user (Lecturer) register Assignment and sub assignment details	H
2	TPTM_03_002	User view registered assignment	H
3	TPTM_03_003	User update registered assignment	H
4	TPTM_03_002	If compulsory fields not completed, an error message will be displayed.	H
TPTM_04		**ASSIGNMENT DOWNLOAD**	
1	TPTM_04_001	User (Student) view Assignment and sub assignment details	H
2	TPTM_04_002	User (Student) download sub assignment	H
TPTM_05		**ASSIGNMENT UPLOAD**	
1	TPTM_05_001	User (Student) upload sub assignment	H
2	TPTM_05_002	If compulsory fields not completed, an error message will be displayed.	H
TPTM_06		**GROUP ASSIGNMENT UPLOAD**	
1	TPTM_06_001	User (Student-Group Leader) upload group assignment	H
2	TPTM_06_002	If compulsory fields not completed, an error message will be displayed.	H
TPTM_07		**VIEW REPORT**	
1	TPTM_07_001	Authorized user (Students and Lecturers) generate selected report.	H

2	TPTM_07_002	If no report selection, an error message will be displayed.	H

4.2.1.2 Use Case Diagram

Use Case diagram is used to describe user interaction with the system. Use Case diagram also illustrates the type of user and visualizes the interaction between user and modules that can be accessed Razali, Najafi, Mirisaee and Teknologi (2010).

Figure 4.1 shows the Use Case diagram of the interaction between student, lecturer and modules. In this Use Case diagram, it is clearly shown that, the student can access the login, download, upload, preview report and upload group discussion module. While lecturers can access the module of login, registration project, update registration project, registration sub project assignment and view report.

Refer to **Appendix 4-C** for prototype screen align with Use Case Diagram.

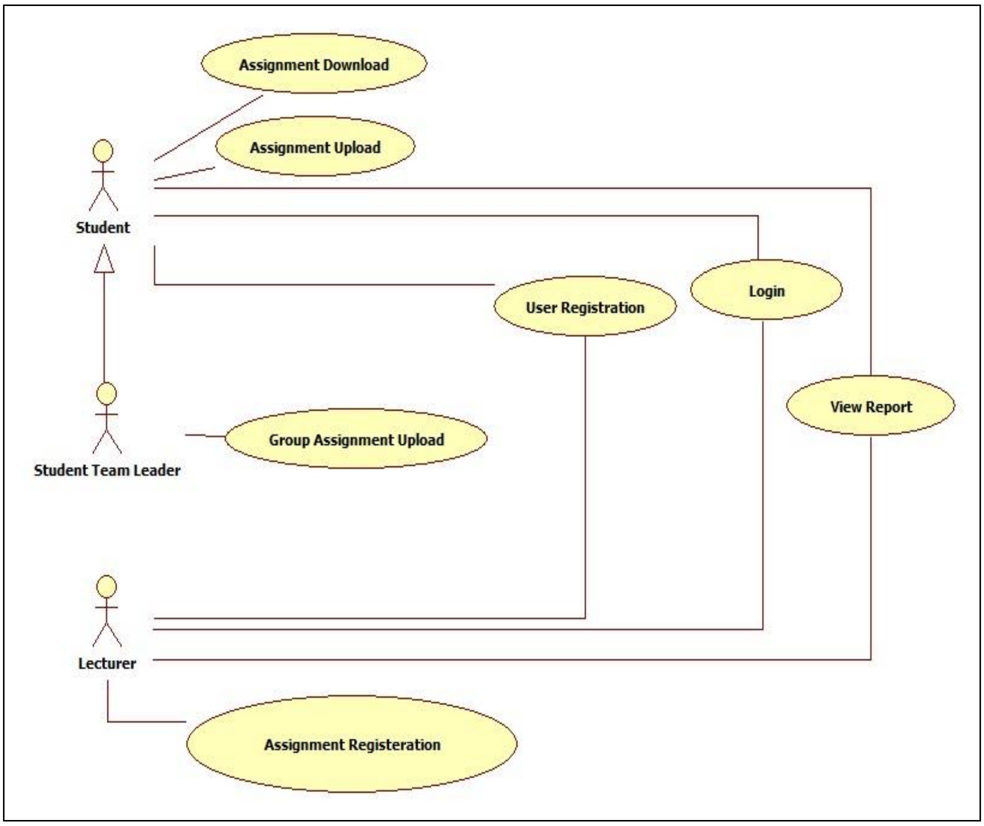

Figure 4.1. Team Performance Task Monitoring Use Case Diagram.

4.2.1.3 Sequence Diagram

Sequence diagram is an interaction diagram to show the process message transferred among object (Xiang & Zhi-qing, 2009). This diagram shows the interactions arranged in a time sequence.

Refer to **Appendix 4-A** for Team Performance Task Monitoring (TPTM) sequence diagrams.

4.2.1.4 Activity Diagram

Referring to Yang, Yu, Sun and Qian (2012), activity diagram explained the system dynamic behavior. In this study, activity diagrams presented business operational workflow of the Team Performance Task Monitoring (TPTM) prototype.

Refer to **Appendix 4-B** for TPTM activity diagrams.

4.2.2 Software Tools and Programming Language

The development of this prototype is using Windows 7 [Microsoft Corporation] as operating system. To facilitate the development of a prototype in design phase, Star UML is chosen as a modeling tool. For documentation purposed, Microsoft Word is used. Adobe Dreamweaver (PHP) is used as Interface design tools and MySQL MyPHPAdmin for database storage. The development is using a web application and rented web hosting from Ezabyte.com through student plan.

Table 4.2

Development Tools.

No.	Item and Vendor	Version	Description/Purpose
1.	Windows 7 [Microsoft Corporation]	Window 7	Operating System
2.	Star UML	5.0	UML Modeling tool
3.	Microsoft Word	2010	Documentation tool
4.	Adobe Dreamweaver (php)	Cs6	User Interface Design Tool
5.	MySQL MyPHPAdmin	-	DBMS

4.3 Value Stream Mapping (VSM) Efficiency's Algorithm

Algorithm is a step by step procedure for calculation, data processing and automated reasoning. Through the algorithm clear instructions can be implemented for carrying out a function. Algorithm started with an initial input followed by processing each command to produce output. Value Stream Mapping (VSM) algorithms calculate the student efficiency base on their response to online question posted by the lecturer. To support efficiency's algorithm, lecturer and student will be going through three main pseudo codes that can contribute to the efficiency calculation. They are assigning team, assign task and download and upload task. As discussed in chapter 3, among the important element in VSM are Value Added (VA), Process Cycle Time (PCT) and Process Cycle Efficiency (PCE).Value Added (VA) is the amount of time that value actually applied to assignment while it is in process. Process Cycle Time (PCT) is the time from when someone enters the process until the tasks completes. Process Cycle Efficiency (PCE) is the efficiency of the process is based on the time in which value added versus the total amount time spend in the process. This algorithm is embedded in Team Performance Task Monitoring (TPTM) method.

4.3.1 Pseudo Codes for Assign Team

TPTM prototype form the team among the students in the class based on first come first serves basis. This prototype will check the registration matric number for the task that chosen by student. If there is no record, system will assign the group Id to the new student automatically and system also checks the total of the student. If the student is the first member that registers to a group, system will assign the student as team leader automatically. The next student register will assign as a member until the counter exceed the maximum number of group member. If registration record found, system will proceed to download pages.

```
Select User_Reg_Detail
Set order to user_reg_id
Seek (MatricNo)
If found ()
      Total_sub_assignment = x
      Start_sub_assignment = x - 1
      Do while Start_sub_assignment <= x
                If button "Download".click = .T. then
                              Download Sub Assignment
                                Return
                      Else
                             If  button  "Submit".click  =  .T.
then
                                   Upload Sub Assignment
                                     Return
                            EndIf
                      EndIf
           Start_sub_assignment = Start_sub_assignment + 1
           Enddo
Else
Select Group_Reg_Detail
Append blank
Replace Group_Reg_Detail_id with xy (auto increments)
Replace Group_Reg_Id with group_id
Replace User_Id with MatricNo
Replace designation with L/M
Replace transaction_date with datetime ()
      Start_sub_assignment = 1
                If button "Download".click = .T. then
                              Download Sub Assignment
                                Return
                      Else
                             If  button  "Submit".click  =  .T.
then
                                   Upload Sub Assignment
                                     Return
                            EndIf
                      EndIf
EndIf
```

Figure 4.1. Pseudo Code Assigning Team.

4.3.2 Pseudo Codes for Lecturer Assign Task

Lecturer must register the task before student can proceed to download the task. Lecturer will select assignment registration page, then register the detail of the assignment such as assignment title, bill of student, due date and remarks. After successfully register, the system will link to screen sub assignment. If there is more than one sub task, lecturer has to click button "Next Sub Assignment" until sub task finish and end by clicking button "Submit".

```
      If Assignment Registeration.Click = T then
               If button "Submit".click = .T. then
                      Select Task Assign
                      Append blank
                      Replace  task_title  with  assignment
title
                      Replace  bil_student_group  with  bill
student
                      Replace due_date with select date
                      Replace remarks with remark

                      Register Sub Assignment

                      Repeat

      If Assignment "Next Sub Assignment".Click = T then
           Register Sub Assignment + 1
      End If

                      Until Submit = .T.
               EndIf
      End If
```

Figure 4.2. Pseudo Code Lecturer Assign Task.

4.3.3 Pseudo Codes for Student Download and Upload task

Student will select the Assignment Download menu. System will run the pseudo codes 4.3.1. After click the "Download" button, system will start to count the time taken until student press "Submit" button. If sub task more than one, system will link to download sub assignment page. These processes will repeat until all sub assignments is downloaded.

```
     If "Assignment Download".Click = .T. then
          Select Assignment Title
          Sub Assignment Start = 1
          Total Sub Assignment = x
          Do While Sub Assignment Start < Total Sub
Assignmet
               If button "Download".Click = .T. then
                    Start record time
                    Select Assignment Upload
                    Reply the answer
                    Submit
                    End record time
               EndIf
          Sub Assignment Start = Sub Assignment Start + 1
          End Do
     EndIf
```

Figure 4.3. Pseudo Codes student download until upload task.

```
VA sub assignment = X
PCT assignment = Y
Bill of assignment = Z
TotalPCE = 0

Do while bill of sub assignment <= Z
     PCE = ((X/Y) * 100)
     TotalPCE = TotalPCE + PCE
Bill of sub assignment = Bil of sub assignment + 1
End Do
```

Figure 4.4. VSM efficiency's algorithm.

4.4 Limitation

This prototype has a few limitations. Such as, students were unable to preview their answer after they click submit, students were not allow to redo their assignment, this system could not manage the time recorded for efficiency calculation, administrator must back up the data of each session and export to excel and all data must be cleared before proceed to next session due to critical space issue.

4.5 Summary of the Chapter

In this chapter, a prototype named TPTM successfully implemented. List of requirement, UML design which consists of use case diagram, activity diagram, sequence diagram and class diagram has been presented. The embedded of VSM efficiency's algorithm in TPTM method, also explained in details.

CHAPTER FIVE

EVALUATION OF TEAM PERFORMANCE TASK MONITORING

5.1 Overview of the Chapter

In this chapter, the evaluation results of the implementation of a Team Performance Task Monitoring (TPTM) was discussed and presented. This chapter was divided into six sub-chapters. The sub-chapters are introduction and explanation of the contents, case studies description and handling, the result of applying Value Stream Mapping, the result of a usability test and discussion on respondents' feedback. This chapter was end by the discussion of the evaluation result and summary of the result.

5.2 Case Study

The case study is to test the effectiveness of applying Value Stream Mapping (VSM) technique in Task Performance Monitoring Team (TPTM). Referring to Garg and Varma (2007), the result of the case study shows that the approach is more effective and interesting in learning Software Engineering (SE).

Table 5.1

Characteristics of Case Study.

Characteristics	Case Study 1	Case Study 2	Case Study 3
Date	05 Dec 2013	08 Dec 2013	29 March 2014
Number of Participant	24	35	25

Duration	2 hours	3 hours	2 hours
Subject	Advanced System Analysis And Design	System Analysis And Design	Advanced System Analysis And Design
Group Academic Level	Post Graduate	Under Graduate	Post Graduate
Method	Case study		
Procedure	1 – Instructor brief respondent regarding the research 2 – Instructor brief respondent regarding the activity in case study 3 – Instructor release the question 4 – Participant download the question (Individual) 5 – Participant answer the question (Individual) 6 – Participant submit the answer (Individual) Repeat steps 4 / 5 / 6 if question more than 1 7 – Participant discuss in group (applied TSP guidelines) 8 – Group Leader submits group answers.		
Instruments	www.tptaskmonitoring.com		

5.2.1 Experiment Procedures

In order to ensure that the experiment to be carried out smoothly, several procedures had been carried out before the experiment started. The procedures are the required materials such as portal's access, presentation slides and evaluation form were prepared in advance, brief participants on tasks detail description. During the experiment, participants are allowed to ask questions. Upon completion of the experiment, the collected data was exported for analysis data purposed and evaluation forms were transferred to SPSS for usability data analysis.

5.2.2 Case Study 1

The first case study was conducted on 5 Dec 2013 and 24 postgraduate students were involved. The subject chosen is Advanced Design System Analysis which under the supervision of Dr. Mazni Omar. This experiment took about 1 hour 30 minutes to complete. Before the experiment started, the procedures listed in the table 5.1 were explained to the students. The problem encountered during the experiment was the prototype does not have file upload functional. Therefore, students were only able to answer questions in written form. The satisfaction level of usability test for using this prototype was described in the sub-chapter 5.4.

5.2.3 Case Study 2

The second case study session held on 8 Dec 2013. For this session, a total of 35 undergraduate students' under Dr. Mazida Ahmad supervision were selected. This session took about two hours to complete. The procedures of the experiment that listed in the table 5.1 were explained to all students at the beginning of the session. Several problems were encountered in this session. Such as, having difficulties in accessing the internet due to network failure and students repeated the experiment for several times. This situation caused dissatisfaction of prototype; the rating of dissatisfaction level of usability test results is stated in sub-chapter 5.4.

5.2.4 Case Study 3

The last session was conducted on 29 March 2014. In this session, 25 postgraduate students from Advanced System Analyst and Design class which under the supervision of Dr. Mazni Omar was selected. The usability test result for this session was considered the most successful. This is because of the problems encountered in previous experiments were resolved and some improvements been made. The usability test results will be further discussed in the next sub-chapter.

5.3 Result of Applying Value Stream Mapping (VSM)

The result of applying VSM was divided into two sections. They are team analysis and class analysis.

5.3.1 Team Analysis

Lecturer assigned tasks to student. For example, lecturer assigned 3 tasks with estimate complete time for each task. The prototype will auto assigned the tasks to the groups and view individual performance of the group. Sample of the data collection and visualization of value stream mapping (VSM) are shown in table 5.2, table 5.3 and figure 5.1.

Table 5.2

Group 71 Value Added.

Matric No	**73**	**74**	**75**
S813661	43.25	7.13	1.81
S815600	74.71	0.40	3.25
S815605	28.31	8.53	8.73
S815062	26.60	7.18	7.26
Average	43.47	5.81	5.26

Table 5.3

Group 71 Summary Process Cycle Time (%).

Matric No	73	74	75
S813661	74.97	12.36	3.14
S815600	71.23	0.38	3.09
S815605	59.76	18.00	18.43
S815062	58.82	15.31	15.48
Average	66.20	11.51	10.04

Table 5.2 and 5.3 is referring to Value Added and Summary Process Cycle Time for group 71 which consists of 4 team members. The task id is presented as 73, 74 and 75. The time taken for each task by each individual in group was shown in the table. Student can used this data to compare their performance with the team members.

Table 5.4

Individual Summary.

<table>
<tr><th>Matric No</th><th>Sub Assignment ID</th><th>VA</th><th>NVA</th><th>PCT</th><th>PCE (%)</th></tr>
<tr><td>S813661</td><td>73</td><td>43.25</td><td>5.38</td><td rowspan="5">57.68</td><td>74.97</td></tr>
<tr><td>S813661</td><td>74</td><td>7.13</td><td>0.10</td><td>12.36</td></tr>
<tr><td>S813661</td><td>75</td><td>1.81</td><td>0.00</td><td>3.14</td></tr>
<tr><td colspan="2">Total</td><td>52.2</td><td>5.48</td><td>90.49</td></tr>
<tr><td colspan="2">Average</td><td>17.4</td><td>1.82</td><td>30.16</td></tr>
</table>

Table 5.4 shows the individual summary. For student whose matric no is S813661 was given 3 tasks. The average Value Added (VA) is 17.4 and Non Value Added (NVA) is 1.82. Total of process cycle time for this assignment is 57.68 and efficiencies of this student is 30.16 %.

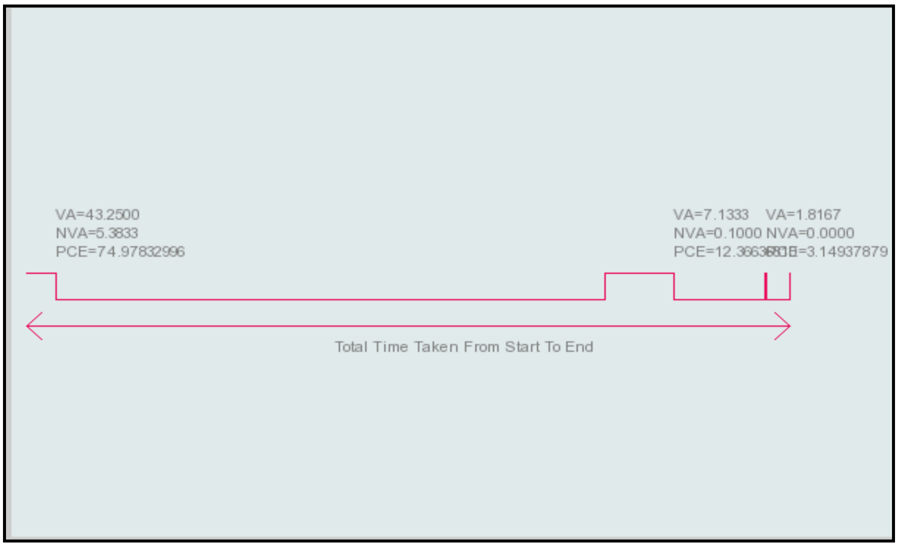

Figure 5.1. Individual Value Stream Mapping (VSM).

In Figure 5.1, Individual student's Value Stream Mapping (VSM) graph shows the time taken from the start until end of the assignment. All task time taken with analysis data was showed in this figure. The Value Stream Mapping (VSM) graph describes each question response time of the student with matric no S813661. The response time for the first question around 43.25 minutes and spare time to question two is 5.38 minutes. For the second question, students may take about 7:38 minutes. Through this graph can also be seen, the student only takes 1.81 minutes to complete the third question. From the Value Stream Mapping (VSM) graph, it is clear that question id 73 has the longest time to complete compared with question two and question three. From this graph, lecturers can analyze the difficulties of the questions and students' understanding of the questions based on the result. On the other hand, lecturers able to analyze the difficulties of other question. Such as, does the question meet the difficulty level, compared the results to identify the non-efficient teams and students.

5.3.2 Class Analysis

Table 5.5 shows the results of first case study data collection. In this experiment, the average of Process Cycle Time (PCT) is 52.76 which is the time required to complete a task. The first task took the longest time - 30.23 to complete, where second task took only 4.19 which are the shortest. From this data, the lecturer can identify the tasks difficulty and class efficiency.

Table 5.5

Summary of Case Study 1.

Case Study 1	**Assignment Id (VA)**			***NVA***	***PCT***	***PCE***
	73	**74**	**75**			
Average	30.23	12.23	4.19	6.10	52.76	87.04

Table 5.6

Summary of Case Study 2

Case Study 2	**Assignment Id (VA)**			***NVA***	***PCT***	***PCE***
	77	**78**	**79**			
Average	15.84	7.47	6.66	3.69	33.66	89.29

Table 5.6 shows the results of data collection for second case study. In this experiment, the average of Process Cycle Time (PCT) is 33.66 which is the time required to complete a task. The first task took the longest time- 15.84, where third task took only 6.66 which is the shortest. The average efficiency for this class is 89.29%.

Table 5.7

Summary of Case Study 3.

Case Study 3	**Assignment Id (VA)**			***NVA***	***PCT***	***PCE***
	92	**93**	**94**			
Average	9.56	6.73	9.60	6.12	32.02	81.35

Table 5.7 shows the results of data collection for third case study. In this experiment the average of Process Cycle Time (PCT) is 32.02 which is the time required to complete a task. The third task took the longest time - 9.60 and second task - 6.73 is the shortest time. The average efficiency for this class is 81.35%.

From the data collection of the case study, the average value can be used as a benchmark for monitoring the student performance. The longest time taken also can be used to analyze and identify the factors that contribute to time taken.

5.4 Usability Result and Discussion

To access the usefulness of the prototype, a usability test was conducted to 84 respondents. For this test, Computer System Usability Questionnaire from http://hcibib.org/perlman/question.cgi is used to determine user satisfaction level. There are 19 questions in the questionnaire and each question is measured by a 5 rate scale as per table 5.8.

Table 5.8

Computer System Usability Questionnaire Scale.

Description of Scale	Scale Rate
Strongly Disagree	1
Disagree	2
Do not agree neither disagree	3
Agree	4
Strongly Agree	5

However, data collection for undergraduate students gives the lowest scale rate in this study due to some problems encountered when undertaking the data collection. Students found it difficult to access to the portal and it took long time to download and upload activities. The students were frustrated and requested to restart the activity. The students repeated the same activity for a few time and caused the time taken invalid. With Statistical Package for the Social Sciences (SPSS), data collection was analyzed and the detail explanation was presented in next paragraph.

Question	N	Mean	Std. Deviation
Q1	24	3.125	0.99181
Q2	24	3.25	1.03209
Q3	24	3.42	1.018
Q4	24	3.13	1.035
Q5	24	3.125	0.99181
Q6	24	3.5	0.78019
Q7	24	3.6667	0.86811
Q8	24	3.25	0.89685
Q9	24	3.0833	1.1389
Q10	24	2.9583	0.99909
Q11	24	3.1667	1.0495
Q12	24	2.9583	0.80645
Q13	24	3.3333	0.86811
Q14	24	3.625	0.82423
Q15	24	3.5417	0.77903
Q16	24	3.5	0.9325
Q17	24	3.4167	1.05981
Q18	24	3.0833	0.88055
Q19	24	3.2917	1.08264
Total Mean / Std.Deviation		62.425	18.03467
Average Mean / Std.Deviation		3.285526316	0.949193158

Figure 5.2. Usability Test Result – Case Study 1.

Table 5.9

Characteristic Analysis – Case Study 1.

Case Study	**Characteristic Analysis**	
Case Study 1	**Min Scale Score (Median) :** 2.9583	**Std. Deviation :** 0.99909
	Q10 : Whenever I make a mistake using the system, I recover easily and quickly	
	Max Scale Score (Median) : 3.6667	**Std. Deviation :** 0.86811
	Q7 : It was easy to learn to use this system	

Usability Test Result for Case Study 1 can be seen in Figure 5.2 and summary can be seen in Table 5.9. From the summary table, Q10 has the lowest scale score, that is 2.9583. This factor is influenced by user's understanding due to first time used.This group concluded that this system easy to learn and use. The max scale score is 3.6667.

Question	N	Mean	Std. Deviation
Q1	35	2.4857	0.91944
Q2	35	2.5714	0.94824
Q3	35	2.69	0.9
Q4	35	2.69	0.832
Q5	35	2.6571	0.83817
Q6	35	2.5429	0.81684
Q7	35	2.9143	0.85307
Q8	35	2.8	0.79705
Q9	35	2.8	0.93305
Q10	35	2.7714	0.91026
Q11	35	2.8	0.90098
Q12	35	2.7429	0.78
Q13	35	2.7429	0.95001
Q14	35	2.6286	0.87735
Q15	35	2.8571	0.80961
Q16	35	3	1
Q17	35	2.6571	1.02736
Q18	35	2.5429	0.95001
Q19	35	2.4571	0.95001
Total Mean / Std. Deviation		51.3514	16.99345
Average Mean / Std. Deviation		2.702705263	0.894392105

Figure 5.3. Usability Test Result – Case Study 2.

Table 5.10

Characteristic Analysis – Case Study 2.

Case Study	**Characteristic Analysis**	
Case Study 2	**Min Scale Score (Median) :** 2.4571	**Std. Deviation :** 0.95001
	Q19 : Overall, I am satisfied with this system	
	Max Scale Score (Median) : 3	**Std. Deviation :** 1
	Q16 : The interface of this system is pleasant	

Figure 5.3 shows the results of a usability test for data collection of second session. The summary result is as shown in table 5.10. As mentioned in previous chapter, respondents encountered some problems which affected their emotions and satisfction using this prototype. The highest scale score given to the interface of the prototype is 3 scale score.

Question	N	Mean	Std.Deviation
Q1	25	4.0800	.81240
Q2	25	4.1200	.72572
Q3	25	4.0800	.81240
Q4	25	3.8800	.97125
Q5	25	4.0800	.75939
Q6	25	3.9600	.93452
Q7	25	4.2000	.81650
Q8	25	3.9600	.73485
Q9	25	3.4800	.82260
Q10	25	3.9200	.81240
Q11	25	4.1600	.85049
Q12	25	4.0800	.81240
Q13	25	4.2400	.72342
Q14	25	4.0000	.70711
Q15	25	4.2000	.86603
Q16	25	4.0400	.88882
Q17	25	4.1600	.85049
Q18	25	3.9600	.73485
Q19	25	4.2000	.76376
Total Mean / Std.Deviation		76.8000	15.39940
Average Mean / Std.Deviation		4.042105263	0.810494513

Figure 5.4. Usability Test Result – Case Study 3.

Table 5.11

Characteristic Analysis – Case Study 3.

<table>
<tr><th>Case Study</th><th colspan="2">Characteristic Analysis</th></tr>
<tr><td rowspan="4">Case Study 3</td><td>Min Scale Score (Median) : 3.4800</td><td>Std. Deviation : 0.82260</td></tr>
<tr><td colspan="2">Q9 : The system gives error messages that clearly</td></tr>
<tr><td>Max Scale Score (Median) : 4.2400</td><td>Std. Deviation : 0.7234</td></tr>
<tr><td colspan="2">Q13 : The information provided for the system is easy to understand</td></tr>
</table>

For the last case study, the students were not satisfied with the unclear defined error messages but they were satisfied with the information provided in the prototype which is easy to understand. The results are expressed in table 5.11.

5.5 Respondent Feedback

Respondent feedback is divided into two categories. They are instructor feedback and student feedback from School Of Computing, University Utara Malaysia.

1) Instructor Feedback

Some aspects have been identified by the lecturers to enhance the effectiveness in monitoring performance. They mentioned that the system should alert the student if the student exceeded the time. This is to avoid extra time taken in completing the tasks. Lecturers also mentioned that they should a admin module in the system to facilitate data analysis process. Overall, lecturers are satisfied with this research that displays numeric output.

2) Student Feedback

Most students responded that they require more initial information about the system so that they can learn and use the system before performing the tasks assigned lecturer. This step is to avoid unnecessary mistakes and obtain accurate calculation.

5.6 Summary of the Chapter

Generally, the data collection session had successfully demonstrated the expected output to meet the second objective by implementing Value Stream Mapping (VSM) technique in Team Performance Task Monitoring (TPTM). Respondent satisfaction is depends on the function of the system. This greatly influences the efficiency calculation.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview of the Chapter

This chapter describes the conclusion of the research which conducted to meet the objectives set at the beginning of the study, as below:-

Firstly, the research summary of the case study is to highlight the alignment and effectiveness of the proposed technique that described in methodology.

Secondly, the research contribution for conclude the findings in the research.

Finally, presents the limitation and recommendation for future improvement.

6.2 Summary of the Research

The purpose of this study is to examine and monitor team performance by using the existing techniques that had been proven to be effective in other fields. In this case study, the educator who is seldom explored to existing techniques in the education domain, was motivated to search for better solutions to improve the effectiveness of team performance monitoring techniques. The detail of the summary was further explained in next paragraph according to the objectives.

The first objective is to identify the requirements of Team Performance Task Monitoring (TPTM). A comprehensive reviewed on related works and TPTM requirements have been done to achieve this objective. The TPTM requirements list was created based on the information found in the review. The list of requirements are prioritize the distribution of task, transform the task distribution into Process Flow Chart (PFC) and analyze the report by embedded the Value Stream Mapping (VSM) components. The listed requirement discussed in chapter 3.

The second objective is to develop a team performance task monitoring method by using Value Stream Mapping (VSM) technique which was guided by Team Software Process (TSP) rules. Three case studies were conducted to support the study and to achieve this objective. The participants were lecturers, undergraduate and postgraduate students of School of Computing (SOC) in University Utara Malaysia. The methodology used, design details and results discussion of the experiment was explained in depth in chapter 3, chapter 4 and chapter 5.

Third objective is to evaluate the suitability of the proposed technique in education field. An evaluation form is distributed to each participants of the experiment to evaluate the appropriateness of the study. The preliminary result from Computer System Usability test shows that the satisfaction of Team Performance Task Monitoring (TPTM) is 3 out of 5.

By applying the Team Performance Task Monitoring (TPTM) method, the time taken to complete a task by the non-participating team members can be easily determined and compared with others team members. Subsequently, a lecturer can determine and track the non-performing team members. The complexity of the assignment which is represented by over of the limit time sets by lecturer can trigger the lecturer to reassess the complexity of the assignment given.

6.3 Contributions of the Research

The first contribution of this study is to monitor the team performance by applying VSM technique. The performance result is presented by numerical value, thus this data can be used to reduce student dissatisfaction within the team; as well as an evidence to align with this issue.

The second contribution of this study is to indicate the difficulty level of the assignment given by a lecturer. Hopefully with the longest time taken by the students will pose questions to the lecturer. Using this data, the lecturer hoped to expand the study of the assignment. Lecturers can also improve the teaching method to enhance students' understanding. From the average time taken to complete the tasks, lecturers can provide estimation time in future with more accurate.

6.4 Limitations of the Research

There are two limitations of this research, as below:-

First, this study is suitable for the assignment that distributes in the classroom. Students will have a discussion after completing individual tasks. Lecturer requires group answers in order for students to monitor the correctness of the answers which is not accounted in this study.

Second, this research is unable to monitor respondents' attitude. If the respondent copied the answers from other group members and submit the assignment in shortest time, this action will impact the accuracy of result. This result will lead the lecturer to wrong direction. Such as, the lecturer assumes the students performed well in the group and the complexity of the assignment might be under estimated.

6.5 Recommendations for Future Research

Although this study contributes to the academic domain, there are areas still needs to improve. This study only focused on the team efficiency, whereby the correctness of the answer was excluded. In the future research, other researcher would enhance the method by including correctness elements in the study to obtain accurate result.

Further studies might focus on instructor impact to the result. Based on this study, the instructor plays a big role to influence the outcome. The experience of teaching also contributes to the student understanding.

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