MONITORING TASK PERFORMANCE USING VALUE STREAM MAPPING (VSM) TECHNIQUE

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ABSTRACT. Monitoring task performance is crucial in team work in order to ensure equal participation of all team members. However, it may be difficult to implement due to team dynamism. One of the approaches that can be adopted when monitoring group work relies on measuring efficiency of each task performed by the team members. Thus, this paper aims to demonstrate application of Value Stream Mapping (VSM) technique in monitoring team performance in terms of group efficiency. VSM is a technique used to visualize process flow and improve process effectiveness. When applying VSM, the process commences with task prioritization, which is followed by transforming the tasks into a process flow chart, and culminates with analyzing the report using VSM. Empirical evidence indicates that, applied in this manner, the VSM technique provides a view of the team members' efficiency in educational tasks. Thus, the outcome yielded can help students improve their performance in the next assignment. It also helps educators evaluate the level of difficulty of individual assignments and prepare intervention plans to improve their teaching methods.

Keywords: team performance, task, efficiency, value stream mapping (VSM)

INTRODUCTION

Measuring team performance in a fair and acceptable manner can be challenging for most educators, because team dynamism factors are complex and difficult to uncover (Swigger, Serce, Alpaslan, Brazile, Dafoulas & Lopez, 2009; Mazni, Sharifah-Lailee, Naimah, 2012). The most common problems affecting successful completion of teamwork assignments and projects are non-participating group members and uneven task distribution among members (Oakley, Felder, Brent, & Elhajj, 2004; Varol, 2013). In such cases, groups typically loose consistency, and tend to spend too much time and effort on rearranging and rescheduling their tasks, which reduces their chances of successful completion. Consequently, conflict amongst team members tends to occur, which making the team members ineffective and the overall team performance becomes suboptimal (Lewis & Smith, 2008; Qureshi, Alshamat, & Sabir, 2014).

Student team performance can be effectively measured by monitoring their task efficiency (Nishimura, Kawasaki & Tominaga; 2011; Pieterse, van Knippenberg, & van Ginkel, 2011). This can be accomplished by detecting the typical behaviours associated with completing tasks in the given time. When students' tasks can be monitored closely, educators can identify non-participating and non-performing group members, as well as detect unbalanced distribution of tasks, more easily. In addition, it can help educators recognize areas that cause suboptimal performance and thus make the necessary changes to mitigate these issues (Tafliovich, Petersen, & Campbel, 2015). Due to these challenges, researchers are currently trying to develop a method that can solve the main monitoring issues (Froyd, 2002; Zhang, Shi, & Diaz, 2015).

In practice, the use of VSM can improve manufacturing process, as it allows monitoring the process flow, which focuses on transforming the current state mapping to the future state mapping (Lasa, Laburu, & Vila, 2008). By providing correct mapping, process efficiency can be substantially enhanced. As it clearly addresses efficiency issues, applying the VSM technique for monitoring processes in education seems suitable. By calculating their students' efficiency, educators can identify tasks that require the longest time to complete and can also monitor the task flow from start until completion (Lasa, Laburu, & Vila, 2008). The non-contributing members can also be easily identified by calculating the efficiency with which the students respond to the tasks assigned by their lecturer. Finally, as VSM provides a visual map, educators can use this graphic report as evidence when addressing unfair grading issues, as well as identify tasks that require additional focus. Thus, this paper intends to demonstrate the application of VSM in monitoring task performance among students.

RELATED WORKS

Froyd (2002) categorized task distribution in teamwork into three categories, namely in-class exercises, routine homework, and extended projects. In this study, the focus is on teamwork that takes place during an in-class exercise. Thus far, despite evident need to measure the performance of the group, a suitable solution has not been found (Swigger et al., 2009). However, it is recognized that team performance is dependent on the assignments, attitudes, and types of project assigned. In addition, when an individual is assigned to a team, it is unlikely that he/she would have all the required skills. Therefore, this issue can contribute to inequality in task completion, which should be monitored fairly. Presently, when monitoring team performance, survey seems to be the most utilized approach (Froyd, 2002). This is a convenient technique, as it allows all group members to self-monitor operations as well as provide input on team performance. However, if done outside the classroom observation, monitoring can be difficult and yield inaccurate results.

While self-monitoring can be used in measuring performance, this technique is more effective when the respondent provides input pertaining to the organization, rather than individuals (Bryant, Mitcham, Araiza, & Leung, 2011). In other words, as this technique is reliant on the attitude of the individual, it is not suited for measuring individual performance. If surveys are completed by students, they must develop 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, which can be gained through training and opportunities that promote development of these skills.

VSM provides a tool for system decision-making. It is a technique that allows visualizing the entire process. It represents information and material flows, allowing the process to be improved by identifying waste and its sources, while providing a "map" of information. VSM is also successful in identifying problems and processes that add no value and can thus be eliminated (Xie & Peng, 2012). According to the literature reviewed as a part of this work, researchers are increasingly focusing on the use of VSM, applied in different domains. In particular, thus far, VSM has found applications in medical (Xie & Peng, 2012), food (Folinas, Aidonis, Triantafillou, & Malindretos, 2013) and energy industry (Keskin, 2012).

THE APPLICATION OF VISUAL STREAM MAPPING (VSM)

When designing a task monitoring process using VSM, it is essential to first identify and prioritize task distribution, before transforming the task distribution into Process Flow Chart (PFC) and finally analyzing the report using VSM. When VSM is applied in educational context, this implies that educators first need to identify the division of tasks in their group assignments or tasks before distributing them to students. Thus, educators should systematically organize tasks to be divided, based on their importance and the degree of difficulty.

After all group tasks have been identified and prioritized, educators can expand information on each task, by providing details, such as assignment title, students in charge of the task, due date and remarks. If a task is divided into sub-tasks, it should be transformed into a PFC. The lecturer distributed tasks according to the provision stipulated time control. The time spent on completion of each assignment was recorded individually in the table and subsequently transferred to the diagram VSM as depicted in Figure 1. In order to monitor performance of each team member, the following formula was 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.
3) 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.

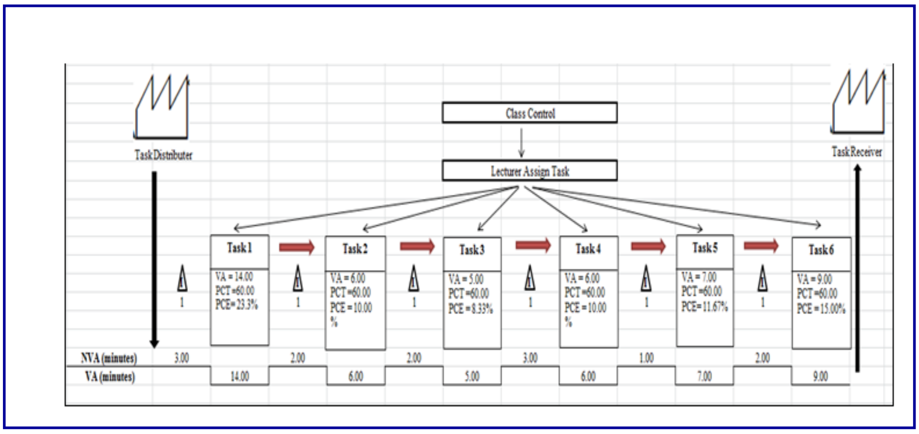

Figure 1. Value Stream Mapping Graph

VSM Algorithm

VSM algorithm calculates the student efficiency based on their response to the group tasks given by their lecturer, as depicted in Figure 2. As discussed before, the important elements in VSM are Value Added (VA), Process Cycle Time (PCT) and Process Cycle Efficiency (PCE). VA is the amount of time that value actually applied to assignment while it is in process. PCT is the time from when someone enters the process until the tasks completes, while 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.

```
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
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Figure 2. VSM Efficiency's Algorithm

Sample of Data Collection

In order to demonstrate the application of VSM in monitoring the task performance, a prototype was developed to evaluate the application of VSM in monitoring the students' task. Data were collected from three classes of Advanced Systems Analysis and Design course. The course was chosen as a case study because it focuses on the development of software application that requires students to work in a team. With regards to this, the students need to complete several stages or tasks to achieve the course objectives. For example, a lecturer will assign three (3) tasks – the task ID number is 73, 74 and 75, with the estimate time to complete for each task. Table 1 shows one group, which consist of four team members' VA, which refers to the time taken to complete each task given. The average of VA for Task 73 is 43.22 minutes, Task 74 is 5.81 minutes, and Task 75 is 5.26 minutes. Then, the PCT can be calculated as depicted in Table 2.

Table 1. Group Value Added (VA)

Matric No	Task ID		
	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	**43.22**	**5.81**	**5.26**

Table 2. Group Summary Process Cycle Time (%) (PCT)

Matric No	Task ID		
	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**

Besides, the group performance, individual data can also be calculated, as depicted in Table 3. For student whose matric no is S813661, was given 3 tasks. The average Value Added (VA) is 17.4 minutes and Non Value Added (NVA) is 1.82 minutes. Total of process cycle time for this assignment is 57.68 minutes and efficiencies of this student is 30.16 %. By having this, student can used this data to compare their performance with the other team members. From the data calculation, individual VSM graph can be generated as depicted in Figure 3.

Table 3. Individual Summary

Matric No	Sub Assignment ID	VA	NVA	PCT	PCE (%)
	73	43.25	5.38		74.97
S813661	**74**	7.13	0.10		12.36
	75	1.81	0.00	57.68	3.14
Total		52.2	5.48		90.49
Average		17.4	1.82		30.16

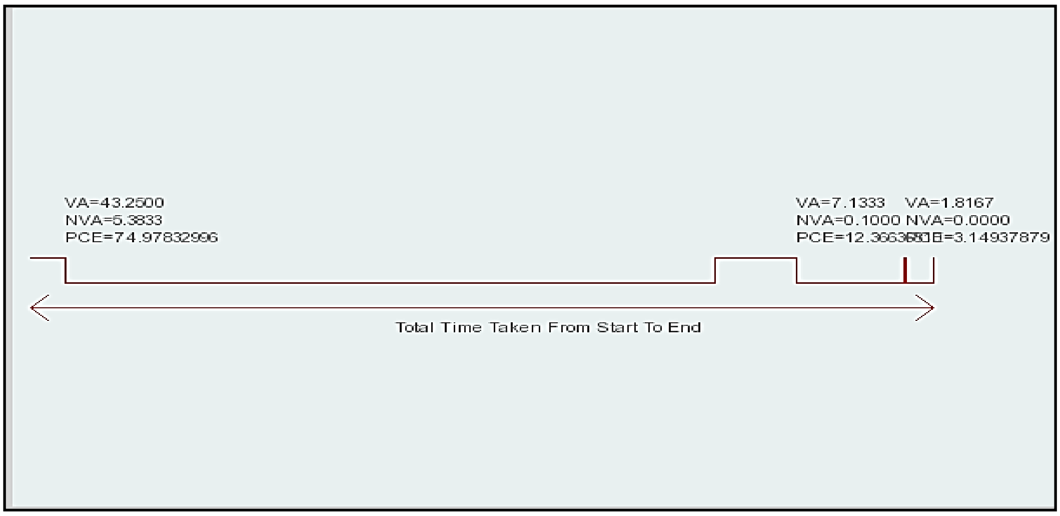

Figure 3. Individual's VSM

Based on Figure 3, the individual's VSM shows the time taken from the start until end of the assignment. The VSM graph demonstrate each task response time of the student with matric no S813661. The response time (VA) for the first task (task id 73) around 43.25 minutes and spare time (NVA) to task number two is 5.38 minutes. For the second task (task id 74), students may take about 7.13 minutes. Through this graph can also be seen, the student only takes 1.81 minutes to complete the third task (task id 75). From the VSM, it is clear that the first task (task id 73) has the longest time to complete compared with the other tasks. 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 are able to analyze the difficulties of other questions. Such as, does the question meet the difficulty level, compared the results and thus can identify the non-efficient teams and students.

CONCLUSION AND RECOMMENDATIONS

This study proposed an approach for monitoring team performance in the educational field by applying VSM technique that focuses on process monitoring in the context of team performance and measuring the efficiency of each member of the group in completing the given tasks. This approach can be adopted as a complement to the current technique, which primarily focuses on work quality. By using the proposed VSM technique, it is hoped that educators can easily identify and track non-efficient team members and recognize difficult tasks that can cause delays in project completion. In addition, by adopting this technique, it is hoped that educators can prepare a suitable intervention plan, allowing students to address delayed tasks more efficiently, while motivating inefficient team members to perform in accordance with expectations. Future works will focus on the development and evaluation of team performance task monitoring prototype.

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