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Research Article

Lean Procurement Strategy in the Service Industry: Its Impact on Customer Satisfaction

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ABSTRACT

The problem of long lead time in the fulfilment of quality goods and services in the education sector has a significant effect on customer satisfaction. This study aims to identify the factors causing lead time in the procurement of goods and services in educational institutions and propose strategies to reduce it using Define, Measure, Analyse, Improve, Control (DMAIC) steps, Value Stream Mapping (VSM), and the Dynamic Powersim System. Data was obtained from the recapitulation of procurement of goods and services for Academic Year 21-22 to Academic Year 23-24. The results of the study showed that the average lead time in Academic Year 23-24 reached 52 days, far exceeding the target of 10 days, particularly during the submission, approval, and realization stages. With the implementation of Lean Procurement through DMAIC steps, VSM, and with Powersim Dynamic System modelling, it was found that before the improvement, the total lead time ranged from 27.98 to 39.57 days, while after the improvement the lead time decreased to around 16.85 to 21.07 days, so it is expected to increase customer satisfaction. These findings are expected to contribute practically to procurement efficiency in the education sector and academically to the development of Lean Procurement in the service industry.

Keywords: Customer Satisfaction, DMAIC, Lean Procurement, Lead Time, Service Industry

INTRODUCTION

In the context of today's modern economic development, the service industry, based on Setiawan, (2021) writing, which includes various sectors such as Finance, Health, Transportation, Public Services, and other services such as Education, is increasingly playing an important role in supporting economic growth in various countries.. In the writing of Kierzkowski et al., (2023) in a broad sense procurement is any form of purchasing process, whether in the form of purchasing, renting or obtaining supplies, services or construction from external suppliers. Furthermore, Prihantini, (2021) highlights that procurement in the service industry, particularly in the education sector, involves activities aimed at providing all types of educational facilities and infrastructure based on needs analysis and planning to achieve predetermined educational goals.

In the service industry, the timeliness of procuring goods and services is among the factors influencing customer satisfaction. For example, in the education sector, delays in procuring learning facilities and infrastructure can disrupt the learning process. In the healthcare sector, delays in procuring medicines and medical equipment can directly impact patient care. Similarly, in the transportation sector, delays in sourcing spare parts can interfere with operations and lead to schedule disruptions. Consequently, lean procurement strategies are needed to ensure that services are delivered on time and meet quality standards, thereby improving customer satisfaction.

Several studies have examined lead time issues in the service industry. For instance, Radhila Gwen et al., (2023) found that in the healthcare sector, stockouts of medicines led to urgent and unexpected purchases, resulting in patients not receiving the necessary medication, with an observed lead time of 9 days, 23 hours, and 25 minutes. Pangastuti, (2020) identified lead time issues in the property sector, where the procurement of goods and services

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exceeded the 45-day target, with a cycle time of 90.1 hours. In the hospitality sector, Phuangjan & Ruangchoengchum, (2024) reported alarming delays in material procurement processes.

These studies underline the critical importance of ensuring the timely availability of goods and services in the service industry. Lead time issues in procurement are a primary concern requiring effective strategies to achieve lean lead times. However, research on lean procurement predominantly focuses on the manufacturing sector, whereas the service sector presents unique challenges and dynamics. Therefore, it is crucial to conduct in depth studies on the application of lean procurement in the service industry, particularly in reducing lead times for goods and services procurement.

As mentioned earlier, the service industry consists of various sectors. To narrow the scope of this study, the focus is placed on the education sector, where the procurement of learning facilities and infrastructure for students and teachers remains a fundamental issue recurring annually, with seemingly no quick and effective solutions for stakeholders, including teachers, students, parents, and management.

Over a three-month period from July to September 2024, coordination meetings between school principals and management recorded 42 complaints related to lead times, as documented in meeting minutes. The number of complaints regarding procurement from each education unit, from kindergarten as many as 9 complaints, Elementary School as many as 6 complaints, Junior High School as many as 8 complaints and Senior High School as many as 19 complaints.

Complaints about lead times were not only raised by school principals but also by representatives of parents, who directly conveyed their concerns to school management. These complaints included issues such as unfulfilled learning facilities, school uniforms, and other necessities. The following is the author presenting procurement lead time data from Academic Year 21-22 to Academic Year 23-24 based on procurement data recapitulation, namely in Academic Year 21-22 it was 33 days, Academic Year 22-23 it was 41 days and Academic Year 23-24 it was 52 days. This data shows that, in the last 3 years, the problem of lead time in the procurement of goods and services has not been resolved.
This institution has set a target of completing procurement within a maximum of 10 days. However, the realization of procurement completion always exceeds the target, with a lead time reaching 52 days in the 23-24 academic year. Based on the above, at the beginning of 2024, a study was conducted to reduce lead time in the Procurement Division by identifying and improving inefficient processes.

Based on previous studies addressing lead time issues, various strategies have been implemented. For instance, Radhila Gwen et al., (2023) conducted research in the healthcare sector using the Lean Six Sigma method with Define, Measure, Analyze, Improve, and Control (DMAIC) steps and a Participatory Action Research approach. This method successfully reduced lead time in the medicine procurement process from 9 days, 23 hours, and 25 minutes to 4 days, 7 hours, and 50 minutes. Similarly, Chin et al., (2024) applied a Lean Service approach using the DMAIC method in the healthcare sector, achieving a significant reduction in lead time from 216 days to 110 days, or a 45% decrease.

Pangastuti, (2020) utilized the Value Stream Mapping (VSM) method to address procurement issues in the property or housing sector, reducing the cycle time from 90.1 hours to 39.38 hours. Additionally, Phuangjan & Ruangchoengchum, (2024) used the ECRS (Eliminate, Combine, Rearrange, and Simplify) method to identify factors causing inefficiencies and delays in the material procurement process, reducing an ineffective procurement process duration from 1.85 days to a more efficient 1.17 days.

Based on these findings, the research problem is formulated as follows, which processes contribute to lead time issues, What strategic solutions can be implemented to eliminate or reduce lead time, Based on the proposed solutions what percentage reduction in lead time can be targeted compared to the current process, How can the implementation of these new processes be effectively applied in the education sector?

The author aims to focus this research on the education sector, contributing both practical and academic insights to the service industry, particularly in education. By improving procurement performance through the elimination or reduction of lead time using Lean Procurement with DMAIC steps, the reduced lead time is expected to positively

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impact customer satisfaction, (Yang & Zhu, 2006) wrote that customer satisfaction is defined as a comprehensive evaluation based on all experiences related to a particular product or service.

LITERATURE REVIEW

The following presents previous studies related to and connected with the thesis title, along with various methods employed to reduce the lead time in the procurement of goods and services.

In the writing of Phuangjan & Ruangchoengchum, (2024) investigated the factors that cause waste due to errors and delays in the procurement process of goods in the hotel sector using a mixed method of Linear Regression Techniques and Tree Diagrams Together with the ECRS Method (Eliminate, Combine, Rearrange, Simplify) which can overcome delays from 1.85 days to 1.17 days. Abdul Rahman Damanik et al., (2017) provided suggestions for improvements in reducing waste in the furniture business sector by using the VSM (Value Stream Mapping) method which maps the value of each activity in each process, the results obtained for Non-Value Added (NVA) activities decreased from 5700 seconds (49%) to 1845 seconds (25%) and Value Added (VA) activities increased from 5532 seconds (51%) to 5542 seconds (75%). (Nurhadyan & Suryani, 2022)identified waste and activities that caused waste in the procurement process using the VSM (Value Stream Mapping) method and the results obtained were that Value Added increased from 11,360 minutes to 11,695 minutes and Non Value Added decreased from 28,940 minutes to 5,940 minutes. Sely Apriliana & Rahmaniyah Dwi Astuti, (2018) conducted a study to identify waste as an effort to reduce procurement delays in the oil and gas business sector using the VSM (Value Stream Mapping) method, the results showed a decrease in the Current State VSM time of 39,425 minutes with the Future State VSM of 23,085 minutes, resulting in a decrease in time of 16,340 minutes. (Kurnia et al., 2023) studied waste in the procurement of medical devices, using the VSM method combined with Kaizen, resulting in a reduction in procurement from 51 days to 38 days or 34.2%. (P. Chuensunk, 2018) conducted research on a Power Generation Company that experienced problems in procuring spare parts, using the VSM method, the results showed that processing time was reduced from 50.5 days to 6.1 days. Damayanti et al., (2019) who conducted a study to improve the procurement process for new goods and projects, using the Lean Consumption method applied with the help of DMAIC and Lean Consumption Map (LCM) found that the total time required was reduced from 2,374 minutes to 1680 minutes, an increase of 29.23%. Chin et al., (2024) conducted a study to eliminate waste in the medical device procurement process in the health service sector through the Lean Service approach with the DMAIC (Define, Measure, Analyze, Improve and Control) method, resulting in a reduction in waiting time from 216 days to 110 days or a decrease of 45%. Radhila Gwen et al., (2023) studied the drug procurement process in a pharmaceutical installation using the Lean Six Sigma method, the waiting time from 9 days 23 hours 25 minutes decreased to 4 days 7 hours 50 minutes. Maryadi & Prasetya Ichtiarto, (2021) conducted a study to reduce process lead time in the entire internal supply chain in the automotive industry using the six sigma DMAIC method, the process lead time decreased from 14 days 404 minutes to 10 days 196.3 minutes. Kochov & Argilovski, (2021) conducted a study in the manufacturing industry using the Lean Six Sigma DMAIC method to increase raw material purchases and has succeeded in reducing the overall process length from 166 working hours to 92 working hours. Prakoso & Singgih, (2023) conducted a study by adopting the DMAIC framework, to analyze the procurement process and identify critical areas of waste, for root cause analysis using the 5 Why method, Failure Mode and Effect Analysis will help prioritize high-risk waste areas for improvement, using Quality Function Deployment to align optimal solutions with customer expectations and technical requirements, and waste is identified in 3 prominent types of waste, namely Waiting for the next step (Waiting), Excessive processing (Processing) and Document Transportation (Transportation). Based on the findings of (Noto & Cosenz, 2020) VSM adopts a static and non-systemic perspective in the representation of organizational processes. This can result in the implementation of Lean projects being inconsistent with the organization's overall long-term strategy, resulting in dysfunctional performance, to overcome this limitation by combining VSM with System Dynamics (SD) modeling - DVSM to encourage a strategic perspective in lean thinking applications. Based on research by Díaz-Ruiz & Trujillo-Gallego, (2021), it was found that six sigma through the application of the DMAIC cycle, with the integration of System Dynamics, is a powerful tool for simulating improvement projects before implementation, likewise, the model can guide management in determining the best scenario for investing in the process, and thus obtain results that benefit the company, both in terms of profit and product quality.

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Based on the previous studies above, the methods used include Eliminate, Combine, Rearrange, Simplify (ECRS), Value Stream Mapping (VSM) and Lean Six Sigma Define, Measure, Analyze, Improve and Control (LSS DMAIC) to find waste that arises in terms of delays (waiting time) in the procurement process of goods and services.

The author sees that there are still not many studies that examine the application of Lean procurement of goods and services, especially in the Education Sector Service Industry, especially how efficiency/timeliness of procurement can directly or indirectly affect customer satisfaction, besides that in terms of research methods that not many have conducted research by combining DMAIC steps with VSM and using dynamic system modelling Powersim to simulate the total lead time for procurement of goods and services, finally it was found that research on Lean is more in the manufacturing industry, compared to the service industry which has its own challenges and dynamics.

METHOD

In general, the flow of this research stages can be described as follows :

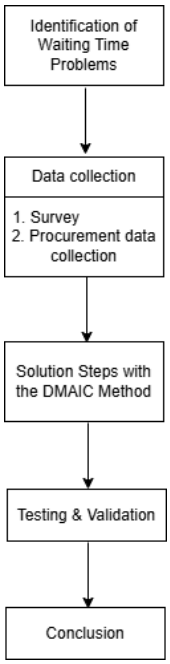

FIGURE 1. RESEARCH PROCESS FLOW

At the Identification of Lead Time Problems stage, initial identification and formulation of problems in the procurement process were carried out. Based on field studies and literature reviews, as well as analysis of procurement data recapitulation for the 23-24 academic year, it was found that the main problem faced by the service industry in the education sector was the lead time for procurement of goods and services which was too long, reaching 52 days. This far exceeds the company's target, which sets a maximum procurement realization time of 10 days. This study employs a quantitative approach, focusing on analyzing the impact of implementing Lean Procurement using the DMAIC methodology to reduce procurement lead time. Additionally, it examines how this implementation affects customer satisfaction in the service industry, particularly in the education sector.

At the stage of Procurement Data Collection, the author collected data on procurement of goods and services for the period of academic year 21-23 to academic year 23-24 from one of the educational institutions under the auspices of the Yayasan Pendidikan Islam Ibuku located in South Tangerang City, Banten Province, the data can be accessed at the following link https://doi.org/10.5281/zenodo.15012332. The data collection technique used was to conduct direct research on the subject matter, namely conducting surveys and interviews with stakeholders in the procurement process and recapitulating procurement data for the academic year 21-22 to academic year 23-24.

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For the Data Processing stage, after collecting the results of interviews with stakeholders in the procurement process and summarizing procurement data, the data is then processed to design improvement steps with the DMAIC methodology to overcome the problem of lead time for procurement of goods and services, which consists of Define, namely identifying and defining the problems that occur, the tools used in this first step are SIPOC and Voice of Customer (VoC); Measure is the second stage that focuses on measuring inefficiencies in the procurement process, the tools used in this stage are VSM Current State Map, Procurement Recap and VoC results; Analyze, namely identifying the main problems and providing solutions, the tools used are 5 Whys and Fishbone Diagram; Improve focuses on eliminating waste and non-value added activity, the tools used are VSM Future State Map and Powersim Dynamic System Modeling; and finally the Control stage which aims to ensure that the improvements made in the improve stage can be maintained sustainably, the tools used are the creation of new SOPs and periodic evaluations/audits..

Testing and Validation, based on the DMAIC steps above, improvement scenarios are carried out assisted by Powersim Dynamic System Modeling to measure the impact of process changes and carry out validation by comparing the waiting time before and after the improvement.

RESULT AND DISCUSSION

Based on the DMAIC methodology above, the following explains the steps in its implementation as follows:

1. Define

The Define step involves identifying and defining the problem. In this study, the issue is the long lead time for the procurement of goods and services, which reached 52 days in the 23-24 academic year, exceeding the company's target of a maximum procurement realization of 10 days. To map the internal supply chain business process from start to finish, simplify, and separate business process variables, this Define phase utilizes a SIPOC Table, which consists of five key components: Suppliers, Input, Process, Output, and Customer.

Below in Figure 2 is the SIPOC Table for the current procurement process. The author obtained this data through discussions with procurement process stakeholders and also based on their professional experience working at this institution. From the SIPOC Table below, inefficiencies in the procurement process were identified through discussions, interviews, and observations.

SIPOC FOR PROCUREMENT PROCESS

S Suppliers	I Input	P Process	O Output	C Customer
Permanent Partner	Application Form	**Procurement Request**	Procurement Request	Employee
e-Commerce		**Verification of Request :**	Draft Procurement List	Parents
	Inventory List	a. check inventory list		Students
		b. check budget		
	Procurement Request List	c. submit procurement to finance		
		Finance Departement Approval :	Approved Procurement List	
	Procurement Budget List	a. according to budget	Approved Procurement Budget List	
		b. if outside the budget		
	Application Form, Specifications	**Procurement Process :**	Goods or Services	
	Contractor List, MOU	a. Selection of Contractor	Selected Contractor	
		b. Negotiation		
	Invoice	**Payment**	Receipt	
		Goods Received :		
	Specifications	a. Checking	Goods or Services	
	Receipt	b. Inventory Record	Inventory List	
	Handover Form	c. Handover	Signed Handover Form	

FIGURE 2. SIPOC TABLE

(SOURCE : PROJECTMANAGER, N.D.)

Based on this analysis, the process suspected to be a major contributor to the long lead time is the Procurement Request Verification stage. This issue arises due to the limited number of procurement personnel, who are responsible for verification, checklist review, budget availability checks, and procurement request processing. Additionally, the financial approval and payment process also contributes to the prolonged waiting time.

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SIPOC FOR PROCUREMENT PROCESS					
S	**I**	**P**	**P**	**O**	**C**
Suppliers	**Input**	**Process**	**Define**	**Output**	**Customer**
		Procurement Request			
		Verification of Request	Limited number of procurement staff		
		Approval of Draft Procurement List			
		Budget Plan Created			
		Procurement Process			
		Selection of Contractor			
		Submission of Procurement Request to Finance Department	inspection and approval process		
		Payment			
		Goods Received			
		Inventory Record			
		Handover			

FIGURE 3. DEFINE LEAD TIME

(SOURCE : PROJECTMANAGER, N.D.)

To complete the process of identifying the causes of lead time, a survey was conducted at the beginning of the 24-25 academic year to obtain VoC (Voice of Customers) and the following VoC recap was obtained:

	No	VoC (Voice of Customers)
Challenges	1	Lengthy procurement process
	2	Procurement takes a long time until realization
	3	The procedure is lengthy and involves many divisions
	4	Enhance communication regarding the stage of the process
	5	The procedure is quite complicated
	6	Some procurement requests have not been followed up
	7	Procurement does not match the actual needs
	8	The quality of the desired goods does not meet expectations
Suggestions	9	The process should not go through too many parties
	10	Streamline the procurement process
	11	Improve communication on procurement progress
	12	Enhance communication regarding the stage of the process
	13	Speed up the purchasing process
	14	Ensure timeliness/efficiency in procurement
	15	Set clear completion targets
	16	Vendors should follow customer/user preferences
	17	Involve users in product selection
	18	Establish an effective procurement team and utilize technology-based systems

FIGURE 4. VOICE OF CUSTOMERS

(**Source** : Survey 24-25 Academic Year)

From the VoC list above, it can be concluded that there are several major problems in the procurement process, as illustrated in this list:

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Issue Category	Detailed Issues	Frequency
Lengthy and inefficient Process	- Lengthy procurement process (No. 1) - Takes too long until realization (No. 2) - Lengthy procedure involving many divisions (No. 3) - Complex and complicated procedures (No. 5)	4
Lack of Communication & Follow up	- Poor Communication regarding process progress (No. 4) - Some procurement request are not followed up (No. 6)	2
Mismatch between procurement and needs	- Procurement does not match actual needs (No. 7) - Quality of goods does not meet expectations (No. 8)	2

FIGURE 5. VOC CATEGORY

(**Source** : Survey 24-25 Academic Year)

VoC analysis shows that the main problems in procurement of goods and services are long and complex processes, lack of communication, and the inconsistency of goods with user needs.

The Define phase in the DMAIC methodology is a foundational step that establishes a clear understanding of the problem to be addressed. In the context of procurement, "Define" refers to the structured identification and articulation of inefficiencies, bottlenecks, or quality gaps within existing processes. This phase helps create alignment among stakeholders by outlining the scope, goals, and expected outcomes. A critical output of this step is the SIPOC (Suppliers, Inputs, Process, Outputs, Customers) diagram, which maps the high-level process and provides clarity on who is involved and what is required. Proper definition sets the stage for targeted, effective improvements.

2. Measurement

The measurement phase is the second phase of DMAIC, where at this stage is measuring waste that occurs in the procurement process of goods and services. This is done by collecting procurement lead time data for the 23-24 academic year obtained from the Procurement Department, then calculating the lead time using Microsoft Excel for ease and efficiency, by analyzing key columns such as Submission Date, Response Date, Target Date, Realization Date, and Lead Time, and using Value Stream Mapping (VSM) to analyze the procurement process lead time and identify Value-Added (VA) activities.

Based on this data, Lead Time is calculated as the difference between the Realization Date and the Target Date, using the following formula:

$$Lead\ Time = Realization\ date - target\ date$$

No	Submission Date	Response (Date)	Target Completed	Name of Goods/Services	Realization / Execution Date	Lead Time
	TA 23-24					
1	03-Jul-23	03-Jul-23	13-Jul-23	Science Lab Tables and Chairs	01-Aug-23	19
2	27-Jun-23	01-Jul-23	07-Jul-23	Fluorescent lamps	01-Sep-23	56
3	03-Jul-23	03-Jul-23	13-Jul-23	Printer	01-Aug-23	19
4	03-Jul-23	03-Jul-23	13-Jul-23	Printer	12-Jul-23	
5	03-Jul-23	03-Jul-23	13-Jul-23	Mic Wireless	11-Sep-23	60
6	03-Jul-23	03-Jul-23	13-Jul-23	Laptop	11-Sep-23	60
7	03-Jul-23	03-Jul-23	13-Jul-23	Bracket Infocus	12-Sep-23	61
8	03-Jul-23	03-Jul-23	13-Jul-23	Infocus	12-Sep-23	61
9	03-Jul-23	03-Jul-23	13-Jul-23	Infocus	01-Sep-23	50
10	03-Jul-23	03-Jul-23	13-Jul-23	Infocus Screen	01-Sep-23	50

FIGURE 6. EXAMPLE PROCUREMENT DATA

(SOURCE : PROCUREMENT SUMMARY DATA 23-24 ACADEMIC YEAR)

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Based on the procurement summary data for the 23-24 academic year, it was found that the average lead time was 52 days with a very long lead time percentage of 86%.

To complete the lead time measurement process, based on the data obtained from the survey results on the procurement of goods and services process, the following data was obtained:

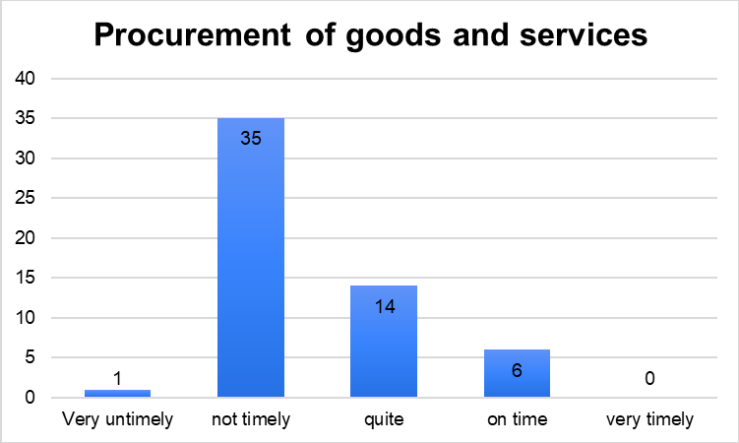

FIGURE 7. PROCUREMENT OF GOODS AND SERVICES

(Source : Survey 24-25 Academic Year)

Based on the graph above, we can see that the Mode (the value that always appears) is not on time as many as 35 respondents or 62.5%, only a small portion stated that procurement had been carried out on time, namely 6 respondents or 10.7%, thus indicating that the majority of respondents considered that procurement of goods and services was not on time and was still a challenge.

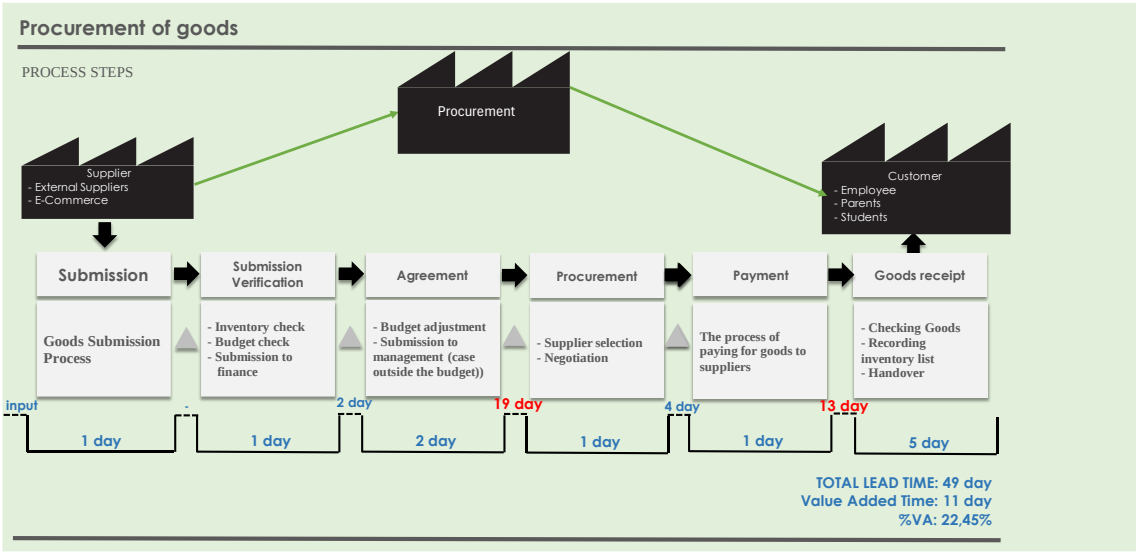

FIGURE 8. VSM CURRENT STATE MAP

(Source : Sely Apriliana & Rahmaniyah Dwi Astuti, 2018)

This Value Stream Mapping (VSM) as in Figure 8 Current State Map shows the process flow from supplier to customer with Total Lead Time 49 days much greater than Value Added Time 11 days, which shows that there is a lot of Non Value Added time 38 days or 77.55% in this process. Based on this VSM analysis, the identification of waste procurement time takes 19 days, caused by the supplier selection process and negotiation and approval of the leadership and when receiving goods caused by the inspection process and updating inventory.

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The Measure phase in the DMAIC methodology is critical to measuring the performance of the current procurement process. This phase focuses on collecting accurate and relevant data to identify lead times in the procurement process. Key performance indicators (KPIs) such as lead time, process cycle time, and frequency of late procurements are measured using tools such as Value Stream Mapping (VSM) and Excel analysis. By examining the gaps between actual and targets performance, this phase provides a factual basis for identifying problems. Accurate measurement ensures that subsequent improvements are based on real data and helps establish a benchmarks for evaluating future performance.

3. Analyze

This phase identifies the root causes of the long procurement lead time using the 5 Whys Analysis, a structured yet simple method to uncover fundamental issues and guide effective solutions.

Based on the 5 Whys analysis below, it appears that the long lead time in procurement of goods and services is caused by delays in the verification and financial approval process, which is basically due to the limited number of personnel and the system is still manual, the more fundamental cause of this problem is the lack of digitalization in the procurement process, which still relies on human resources in verification and approval and further causal factors, this occurs because there has been no initiative from management to implement a digitalization system that can speed up the process. Therefore, the main solution to overcome this problem is to develop and implement a digitalization system in the procurement process, so that it can increase workforce efficiency and speed up the approval flow and financial verification, which will ultimately reduce the lead time for procurement of goods and services significantly.

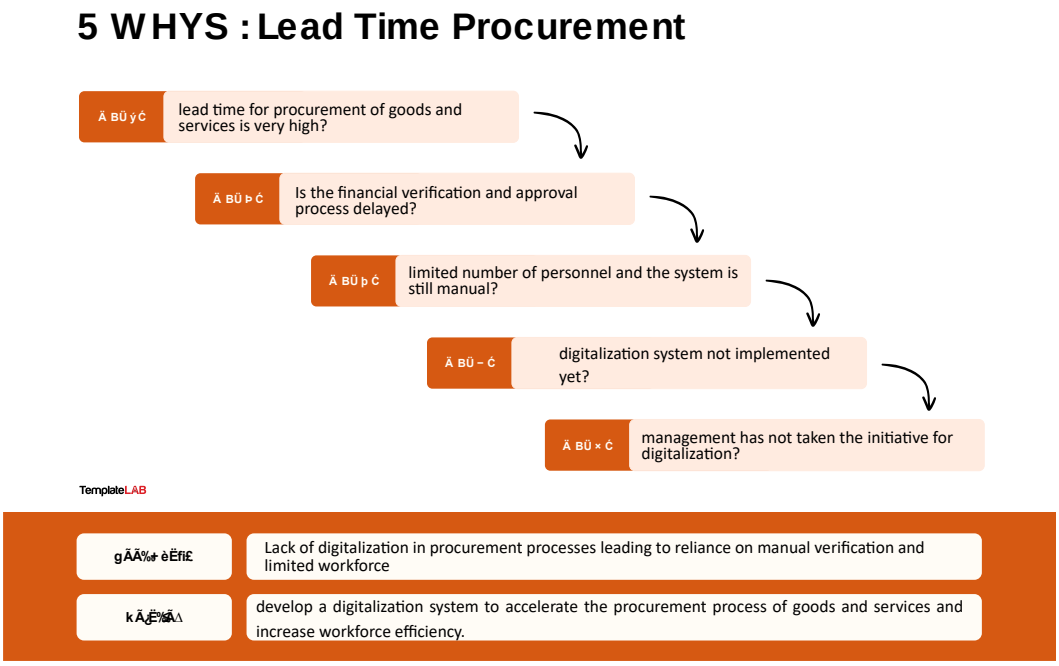

FIGURE 9. 5 WHYS

(SUMBER : TEMPLATELAB.COM, N.D.)

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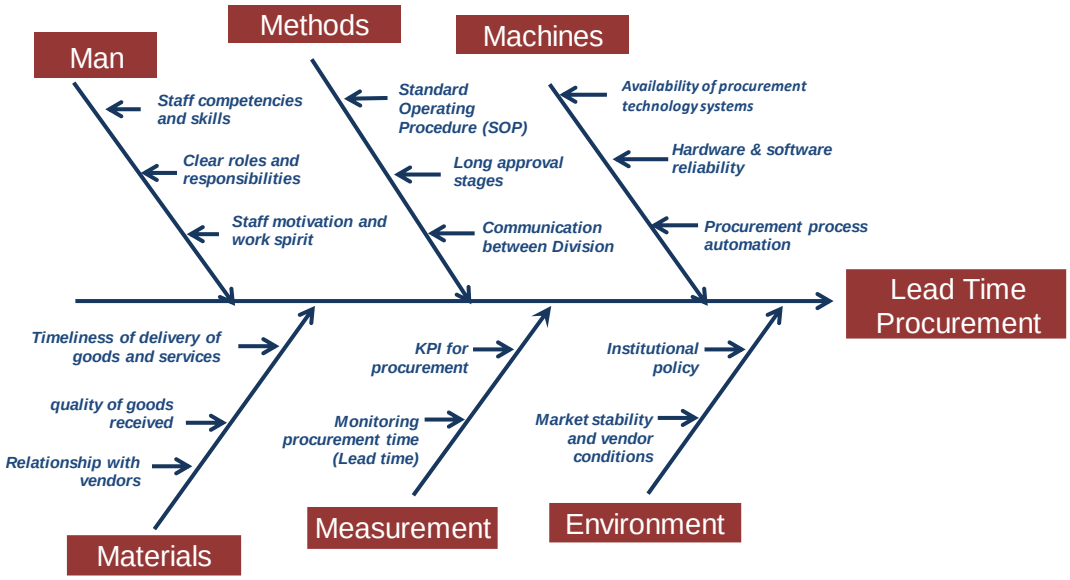

FIGURE 10. FISHBONE DIAGRAM

(Source : Sely Apriliana & Rahmaniyah Dwi Astuti, 2018)

Based on the analysis of the fishbone diagram above, procurement lead time is influenced by six main factors, namely Man, Methods, Machines, Materials, Measurement, and Environment. Man factors include staff competence, role clarity, and work motivation that can accelerate or hinder the procurement process, in terms of methods, namely complex procedures and ineffective communication between divisions can extend the approval time, as well as the use of technology that is not optimal and the lack of automation in the procurement process are also obstacles. In addition, late delivery of goods from vendors, poor quality goods, and poor relationships with suppliers also have a negative impact. Measurement factors, such as the absence of clear KPIs and ineffective lead time monitoring, can cause inefficiency. Meanwhile, the external environment, such as institutional policies and unstable market conditions, can be external factors that extend the procurement process. To reduce procurement lead time, it is necessary to improve staff skills, simplify procedures, implement automation systems, and monitor and evaluate performance periodically to ensure efficiency and effectiveness in the procurement of goods and services.

The Analyze phase in the DMAIC methodology aims to uncover the root causes of inefficiencies identified during the Measure phase. Through structured problem-solving tools such as the 5 Whys, Fishbone Diagram, this phase dissects data and stakeholder insights to identify patterns and bottlenecks. In the procurement context, this often reveals issues like manual processes, lack of automation, poor communication, or unclear responsibilities. By distinguishing between symptoms and underlying causes, the analysis phase ensures that improvement efforts are not merely reactive but strategic. A thorough analysis allows organizations to prioritize solutions that target the most impactful problems for lasting change.

4. Improve

The Improve phase focuses on eliminating waste and non-value-added activities to enhance the procurement process. In this study, the improvement efforts aim to reduce lead time in procurement by implementing Dynamic Powersim Simulation to model and optimize the procurement workflow.

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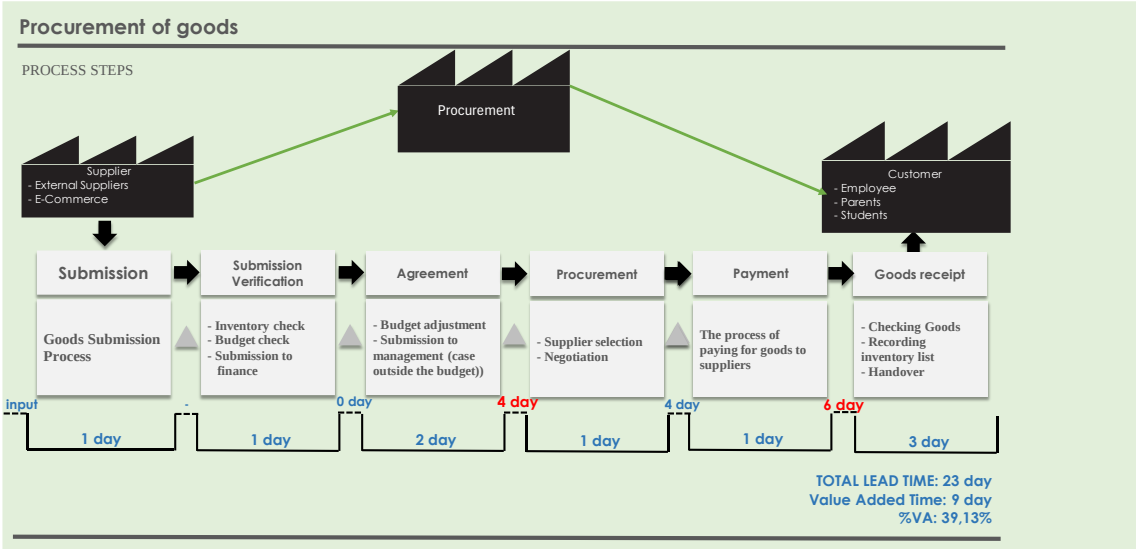

FIGURE 11. VSM FUTURE STATE MAP

(Source : Sely Apriliana & Rahmaniyah Dwi Astuti, 2018)

In Figure 11 Future State Map, improvements were made to the procurement process resulting in increased efficiency through optimization of the approval, verification, procurement, and payment stages, and successfully reduced the Total Lead Time from 49 days to 23 days, as well as reducing non-value added activities, and increasing Value Added Time (%VA) from 22.45% to 39.13%. Despite the increase, there is still an opportunity for further optimization through digital system integration and increased coordination between divisions to further improve procurement effectiveness.

Based on the steps taken in conducting the VSM (Value Stream Mapping) analysis above, both Current State Mapping and Future State Mapping, then we carried out the simulation process using Powersim dynamic system modeling, and obtained the results as in Figure 12 and Figure 13.

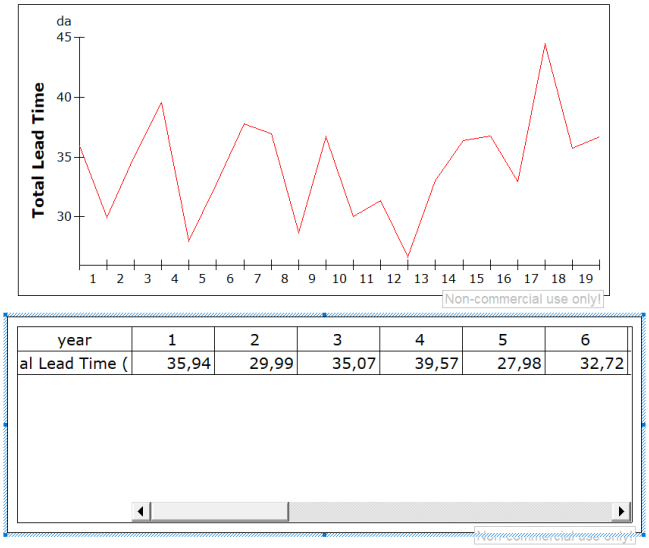

FIGURE 12. POWERSIM (BEFORE)

(Source : Noto & Cosenz, (2020)

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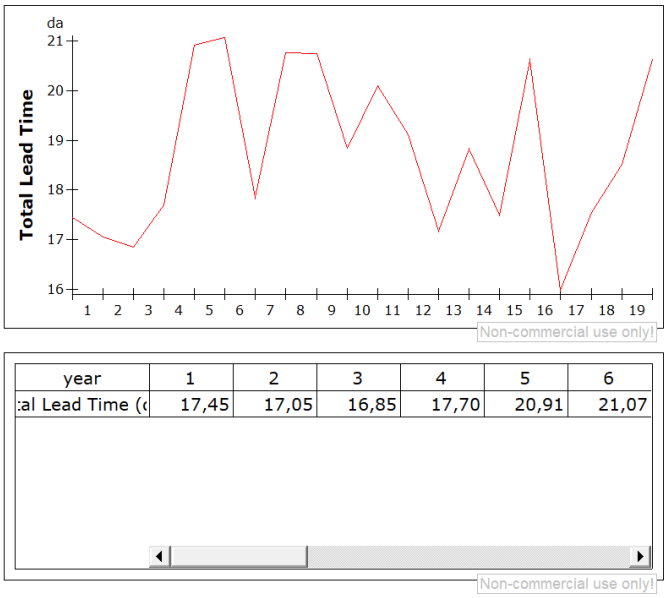

year	1	2	3	4	5	6
:al Lead Time ((	17,45	17,05	16,85	17,70	20,91	21,07

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FIGURE 13. POWERSIM (IMPROVEMENT SCENARIO)

(Source : Noto & Cosenz, (2020)

Based on the simulation before and after the improvement, there was a significant reduction in total lead time in the procurement process, before the improvement steps the total lead time ranged from 27.98 days to 39.57 days, while after the improvement steps the lead time decreased to around 16.85 to 21.07 days. The graph after the improvement also shows lower fluctuations, indicating better stability in the process. This indicates that the improvements made, such as digitalization or workflow simplification, have succeeded in increasing procurement efficiency by reducing waiting times and obstacles in the approval and payment process.

The Improve phase focuses on developing and implementing solutions that address the root causes identified during the Analyze phase. In the procurement context, this may include streamlining workflows, introducing automation tools, enhancing communication protocols, or redesigning approval hierarchies. Lean tools like the Future State Value Stream Mapping (VSM) and simulation models such as Powersim help visualize and test proposed changes before full-scale implementation. The goal is to eliminate non-value-added activities and reduce lead time significantly. By piloting improvements and measuring their impact, organizations can validate that the changes lead to measurable gains in efficiency, accuracy, and customer satisfaction within the procurement process.

5. Control

The Control stage in the Six Sigma DMAIC methodology aims to ensure that the improvements implemented in the Improve stage can be maintained sustainably and do not revert to the initial condition. This involves developing a control plan, which includes documentation of all improvements and establishing a new Standard Operating Procedure (SOP) for procurement, which serves as a guideline to maintain efficiency and consistency in procurement operations within the educational institution. The new SOP establishes standard processes that act as benchmark parameters for future procurement activities.

In order for the implementation of improvements to run well and effectively, training and socialization to all employees is also an important part of the control stage. Employees involved must be given training related to the use of monitoring tools, established control limits, and corrective actions that need to be taken if deviations occur.

Periodic evaluation is essential to maintain the sustainability of the improvements that have been made. Therefore, the organization must conduct regular internal audits, collect feedback from operators and customers, and apply the Plan-Do-Check-Act (PDCA) method to ensure continuous improvement. All steps in this control stage must be well documented so that they can be used as references in the future. This documentation includes the results of

monitoring, corrective actions that have been taken, and recommendations for further improvement. By implementing control measures systematically, organizations can ensure that the benefits of Six Sigma DMAIC initiatives are maintained, processes continue to run efficiently, and product or service quality continues to be maintained according to established standards.

The Control phase ensures that the improvements made during the Improve phase are sustained over time and do not regress. This involves establishing standardized procedures, developing new Standard Operating Procedures (SOPs), and implementing monitoring systems to track key metrics like procurement lead time and process compliance. Regular training and communication help align all stakeholders with the updated processes. Control tools such as control charts, dashboards, and internal audits are used to detect deviations early and trigger corrective actions. By fostering a culture of continuous improvement and accountability, the Control phase secures long-term efficiency and reinforces customer satisfaction in procurement operations.

LIMITATION

Despite the promising findings, this study has several limitations. First, the research was conducted in a single educational institution, which may limit the generalizability of the results to other service sectors or organizations with different procurement systems and structures. Second, the data collection relied heavily on internal documentation and stakeholder interviews, which may introduce bias or omit undocumented inefficiencies. Third, while simulation using Powersim provided insights into potential improvements, the model's accuracy depends on assumptions and may not fully reflect real-world complexities. Lastly, the study focuses on short-term outcomes, and long-term sustainability of improvements was not extensively evaluated.

CONCLUSION AND RECOMMENDATION

By implementing the DMAIC method steps in this procurement process, the factors causing the lead time can be identified, namely the verification and approval process of procurement and long payments, staff competence and clarity of tasks, a manual procurement system, lack of management commitment in encouraging digitalization, and lack of performance evaluation. The solutions that can be taken by implementing the DMAIC method steps are the need to simplify the process, improve staff skills, develop the system digitally, have a management commitment to encourage improvement and conduct periodic performance evaluations/audits.

With the help of VSM (Current State Map and Future State Map) tools, it can be described the reduction in lead time from the original Lead Time of 49 days to 23 days and the% Value Added (%VA) from 22.45% to an increase of 39.13%, from the Powersim Dynamic System modeling, an improvement in the reduction in lead time was obtained which previously ranged from 27.98 days to 39.57 days to around 16.85 days to 21.07 days. As with the Solution above, the implementation of these steps to be effective, namely by implementing a periodic monitoring and evaluation system to identify potential deviations and opportunities for further improvement, in addition to training and socialization to all related parties, the implementation of a digitalization system in procurement and finally of course a commitment from Management is needed to encourage improvement.

Based on the results of this study, there are several opportunities for the development of further research in the future, including expanding further research by exploring the application of lean procurement in other service sectors such as Health or transportation, in addition to being able to examine a more in-depth analysis of the factors that influence the success of the implementation of digitalization. Also the impact of procurement process digitization on operational efficiency and customer satisfaction. With this approach, future research can provide broader insights into the optimization of Lean Procurement and Six Sigma DMAIC in the service sector.

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