ORDER PLACEMENT PROCESS ENHANCEMENT BY USING SIX SIGMA DMAIC: A CASE STUDY OF INTERNATIONAL DEVELOPMENT ORGANIZATION

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ABSTRACT

This study focuses on delays in the procurement process at the International Development Organization (IDO), which provides infrastructure, project management, and procurement services for donors. The aim was to reduce procurement lead time to the minimum and improve the order placement process using the Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology. Data from January to June 2024 was collected through the IDO ERP system. The root causes of delays were identified through analysis, observation, and the use of improvement tools like the Detailed Process Flow Chart, Run Chart, and Pareto Analysis. These tools helped pinpoint possible delays, redundancies, and major reasons for inefficiencies. Improvement plans were created through brainstorming sessions and implemented effectively, resulting in a significant reduction in the average procurement lead time. Control plans were established for continuous improvement, ensuring the enhancements could be sustained over time. Overall, the study achieved its objectives and streamlined the procurement process.

Keywords: *Procurement, Six Sigma DMAIC, Process Flow Chart, Run Chart, Pareto Analysis*

บทคัดย่อ

การศึกษานี้มุ่งเน้นไปที่ความล่าช้าในกระบวนการจัดหาขององค์กรพัฒนาระหว่างประเทศ (IDO) ซึ่งให้บริการด้านโครงสร้างพื้นฐาน การบริหารโครงการ และการจัดหาสำหรับผู้บริจาค เป้าหมายคือการลดระยะเวลาการจัดหาให้น้อยที่สุดและพัฒนากระบวนการสั่งซื้อ โดยใช้วิธีการ Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) ข้อมูลตั้งแต่เดือนมกราคมถึงมิถุนายน 2024 ถูกเก็บรวบรวมผ่านระบบ ERP ขององค์กร สาเหตุหลักของความล่าช้าถูกระบุผ่านการวิเคราะห์ การสังเกต และการใช้เครื่องมือปรับปรุง เช่น แผนภูมิการไหลของกระบวนการโดยละเอียด รันชาร์ต และการวิเคราะห์พาเรโต เครื่องมือเหล่านี้ช่วยระบุความล่าช้า ความซ้ำซ้อน และสาเหตุหลักของความไม่มีประสิทธิภาพ แผนการปรับปรุงถูกพัฒนาผ่านการประชุมระดมความคิดและนำไปใช้ได้อย่างมีประสิทธิภาพ ส่งผลให้ระยะเวลาการจัดหาเฉลี่ยลดลงอย่างมีนัยสำคัญ นอกจากนี้ ยังมีการพัฒนาแผนควบคุมเพื่อการปรับปรุงอย่างต่อเนื่อง เพื่อรักษาการพัฒนาที่เกิดขึ้นในระยะยาว การศึกษานี้บรรลุวัตถุประสงค์และช่วยปรับปรุงกระบวนการจัดหาให้มีประสิทธิภาพมากขึ้น

คำสำคัญ: การจัดหา Six Sigma DMAIC แผนภูมิการไหลของกระบวนการ รันชาร์ต การวิเคราะห์พาเรโต

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INTRODUCTION

With over an extensive year of specialized experience, IDO where the researcher works is the provider of choice for many partners procuring high quality goods, works and services in each year, on behalf of partners which include donors and recipient governments, intergovernmental and non-governmental organizations, international and regional financial institutions and the other foundations. IDO partners benefit from a focus on quality sustainable procurement, globally competitive prices, and emergency response. In 2023, IDO procured $40 million in goods and services for its partners in the Asia Region. Hence, procurement is an essential part of the work of IDO.

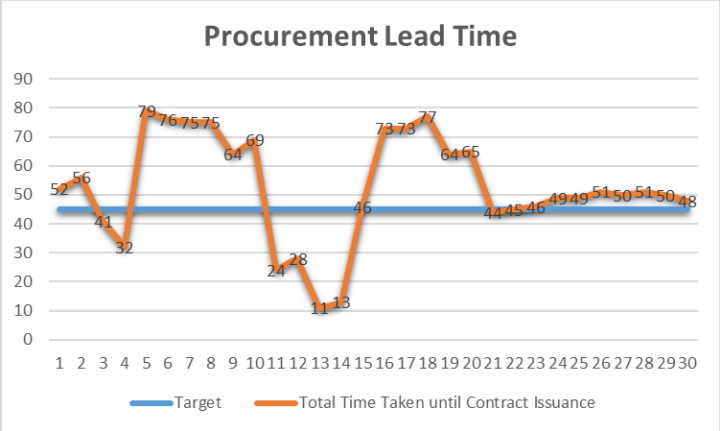
The partners and end users have expressed dissatisfaction with IDO's extensive procurement procedure, which has resulted in delays in the arrival of items and potential stock outs. The main reason for all the delays in delivering goods was identified due to the extensive time taken of the procurement process. The designed procurement lead time by the organization was 45 days from sourcing the suppliers until the contract issuance to the suppliers, based on the procurement method, as shown in Table 1.

Table 1: Designed Procurement Lead Time

Procurement Lead Time			
Sourcing	**Solicitation**	**Evaluation**	**Award & Contract**
1-3 days	3-10 days	7-25 days	1-7 days

For better identification of the problem, the historical data was randomly collected for 30 procurement cases, to know the procurement process timeline. It was found that the time taken from sourcing until the contract issuance to the selected qualified suppliers was more than the targeted 45 days in most of the procurement processes, as shown in Figure 1.

Figure 1: Historical Procurement Lead Time (Days)



Hence, the research question is **"How is Six Sigma applied to shorten the procurement process lead time to a very minimum period?"**. Six Sigma DMAIC is applied to identify the root causes of order delays in procurement process and to find a solution using the Six Sigma quality tool. The objectives of this research were as follows:

1. To apply DMAIC concept to find out the root causes of the procurement delay.
2. To enhance the procurement process by shortening the procurement lead-time.

3. To ensure the continuous improvement in efficiency by monitoring and controlling the process.

In this study, the procurement covers only for the health sector goods such as pharmaceuticals, diagnostics kits and various laboratory consumables. Normal delays due to the other logistical issues, any other complicated interference in the supply chain and the delay in supply chain due to the lack of capacity for the warehousing infrastructure at the end user's side were excluded in this study. The historical procurement data from January to June 2024 was collected through IDO ERP system. Historical data for 6 months period was not a sufficient sample size, if more data would have allowed, the problem analysis would be more accurate.

REVIEW OF RELATED LITERATURE

Procurement

Procurement is the process of acquiring goods and services from suppliers or vendors in the supply chain. It entails everything from seeking and selecting suitable suppliers to negotiating contracts and managing relationships (CIPS, 2022). Basically, procurement tries to guarantee that businesses have access to the resources they require at the right time and at the lowest feasible cost while maintaining quality. This strategic function is critical in supply chain management because it optimizes operations, mitigates risks, and maximizes value for both buyers and sellers (CIPS, 2022). Effective procurement management is a critical component of effective project delivery. To address the procurement delays, scientific methodologies are essential to develop effective and efficient processes. According to Han, Chae, Im, and Ryu (2008), Lean management, just-in-time, and pull scheduling are some of the scientific methodologies that are available. However, Six Sigma stands out because of its methodologies or metrics for analyzing the amount of inadequacy using an organized methodology.

Six Sigma

Six sigma is a continuous improvement methodology that uses statistical methods to eliminate variability and waste in business processes. Motorola developed it in the 1980s, and it has subsequently been used by a wide range of enterprises. The goal is to eliminate variability and bring operations closer to perfection, which will result in higher customer satisfaction and cost savings (Antony & Banuelas, 2001). Six Sigma implementation requires a structured approach known as DMAIC (Define, Measure, Analyze, Improve, and Control). This standard leads practitioners through each stage of problem solving and continuous improvement activities (Antony & Banuelas, 2001).

DMAIC

Motorola introduced the DMAIC method in the 1980s as part of their Six Sigma process. According to Jirasukprasert, Garza-Reyes, Kumar and Lim (2014), DMAIC model is an important part of Six Sigma which can be described as a structured approach for solving problems. It is especially effective in cases where a process is unstable or underperforming. In the Define phase, it is to precisely describe the issue or area for change. This includes thoroughly understanding the customer's needs and expectations, identifying project objectives, and specifying the scope of the process in question.

In the Measure phase, it is to evaluate the current performance of the procedure. The goal is to collect process performance data and establish a baseline. In the Analysis step, it is to identify the sources of problems or variations in the process using the collected data. The Improve stage eliminates flaws and important variations, determines the maximum acceptable range for key variables, and redesigns the process to stay inside that range.

The last phase is Control which sustains and standardizes the improvements made by establishing control plans, developing the workforce, and documenting the changes (Jirasukprasert et al., 2014).

Flow Chart

Process Flowchart is a simple step by step process of activities carried out in the process. It is a fundamental component of the Six Sigma methodology, specifically within the DMAIC framework (Dineshkumar & Suganthi, 2015). Flowcharts help to identify key steps and potential improvement areas and are ideal for simplifying complex processes (DeLadurantey, 2024).

Pareto Analysis

According to Cervone (2009), the Pareto analysis is commonly used for decision making process. It is a simple approach that helps identify the most crucial activity as well as the most significant problem in a situation when several issues need to be resolved. Vilfredo Pareto, an Italian economist, developed a statistical concept that forms the basis of this approach.

Pareto analysis is also known as the 80-20 rule, which states that 80 percent of results come from 20 percent of activities which is where the priority should be focused. According to Haughey (2011), Pareto analysis is a tool for decision-making under statistical techniques; concentrate on improving 80% of problems.

Statistical Process Control (SPC)

Statistical Process Control (SPC) is one of the Total Quality Management (TQM) strategies for increasing quality and decreasing variation (Hessing, 2014). Dr. Kaoru Ishikawa introduced these quality control procedures to Japan's workers in 1968. SPC tools are required to control and improve the process. It helps identify quality problems and reduce variability in product output, delivery, maintenance, and equipment utilization. Furthermore, SPC aims to collect data, identify variations, analyze through brainstorming, determine causes and consequences, and continuously improve (Mystica & Suganthi, 2015).

Control Chart (Run Chart)

Control charts are significant tools for SPC in improving quality. Walter Shewhart introduced control charts in 1924, and they are still known as Shewhart control charts today (Hessing, 2014). Control charts are used to monitor production and provide "early warning" indicators of potential "out-of-control" operations (Şengöz, 2018). According to Purani and Alom (2022), the run chart is one of the most useful tools in quality improvement and a graphical tool to demonstrate historical data plot versus time. The run chart helps to see how the system process is currently performing before any quality improvement work is done. It then allows to compare results from the improvement to see how much of an impact has had after the implementation.

RESEARCH METHODOLOGY

The main objective of this research is to apply DMAIC concept to find out the root causes of the ordering process delay at the IDO. The aim is to enhance the procurement process by shortening the procurement lead-time. The researcher introduces the methods and approaches used to pinpoint and address the underlying causes of this problem. This section will utilize the DMAIC model, which played a pivotal role in the methodology used to shorten the procurement lead-time.

Define the Problem

This phase involves defining the problems by using the translation of Voice of Customers (VOC) to Critical to Quality (CTQ), Problem Statement and Six Sigma Project Charter. Given that the researcher works in the procurement department of IDO, the problems were discovered through the partners and the end-users as per Table 2 below, which were affecting the Supply Chain Management of the organization.

Table 2: Translation of VOC to CTQ

No.	Voice of Customers (VOC)	Key Issue	Critical to Quality (CTQ)
1.	Delay in delivery of goods	Faster delivery	The client receives the goods within the specified timeframe in the agreement.
2.	Potential stock out of some products due to the delay	Faster stock in	Eliminate all the delays to happen the delivery before stock out of the goods for the clients to maintain product availability. And the procurement team to ensure the timely delivery.
3.	Very long procurement process as delay in placing orders at the right time	Faster procurement process	Shorten the procurement process to avoid delays in placing orders at the right time, and to place orders within 45 days from the date of procurement request received.

Data Collection

To understand the scope of the project by the historical data, the researcher collected the data of the procurement cases in 2024 from January to June from IDO ERP system. It has a total of 120 procurement cases. It was found that the number of days taken for the procurement process was more than 45 days in most of the procurement process. The result of the average procurement lead time was 68 days which was much over the designed lead time 45 days and found to be critical.

Project Charter

To produce a thorough analysis of this study, the researcher compiled all the data and created a Six Sigma Project Charter as illustrated in Table 3.

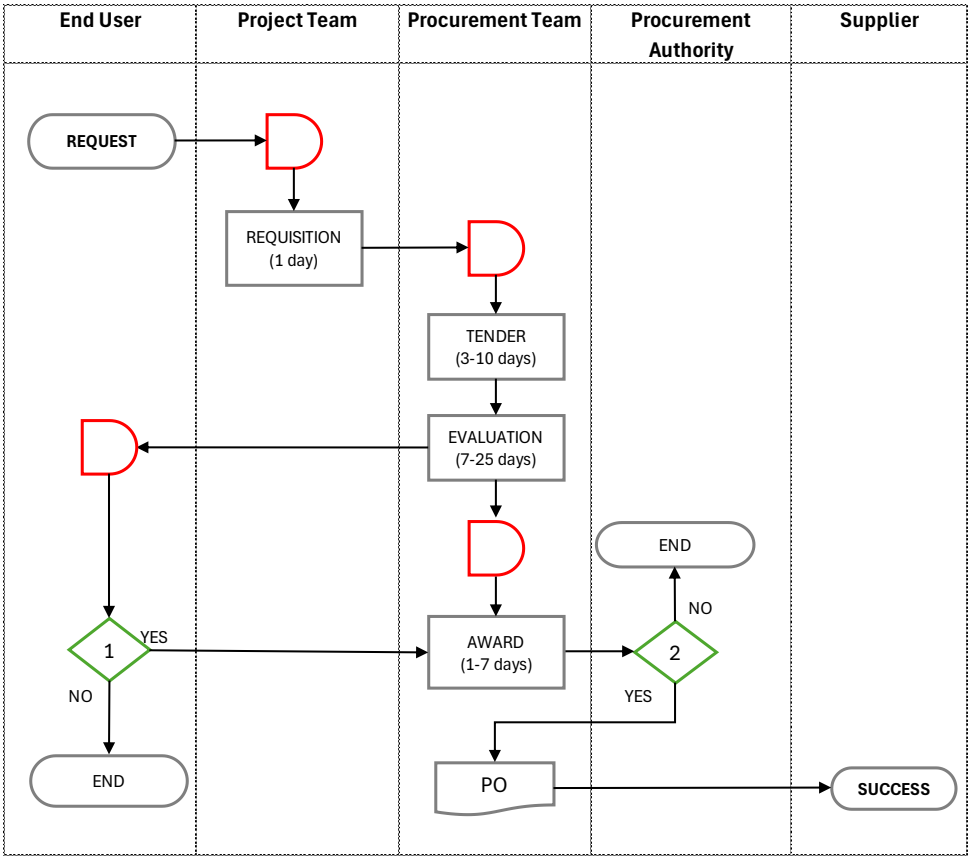
Table 3: Order Placement Process Enhancement Project Charter

Project Name: Performance improvement in the order placement to the supplier.
Business Case: To ensure timely orders to avoid the delay in delivery which can cause the potential stock out of the products at the end-users' warehouses.
Problem Statement: Not placing the order to the supplier in the right time, resulted the late delivery of the various health sector commodities to the partners and the end-users.
Goal Statement: The order must be placed as fast as possible within 45 days.
Project Scope: The project will focus on the procurement of pharmaceuticals and diagnostics kits which are very critical items for the project implementation and will ensure that the orders are placed in timely manner to avoid the stock out condition.

Measure the Problem

The collected data of long procurement lead time made the performance not to meet the designed lead time. Measure is the phase of assessing the performance and ensuring to realize the target of the errors based on the standard measurement. The researcher's goal in this phase was to quantify the issue by drawing the detailed process flow chart as per Figure 2, indicating the parties responsible for each step, and if there is any delay in each step and focusing on every step of the procurement process to understand the activities of all parties related to the process.

Figure 2: Detailed Process Flow Chart

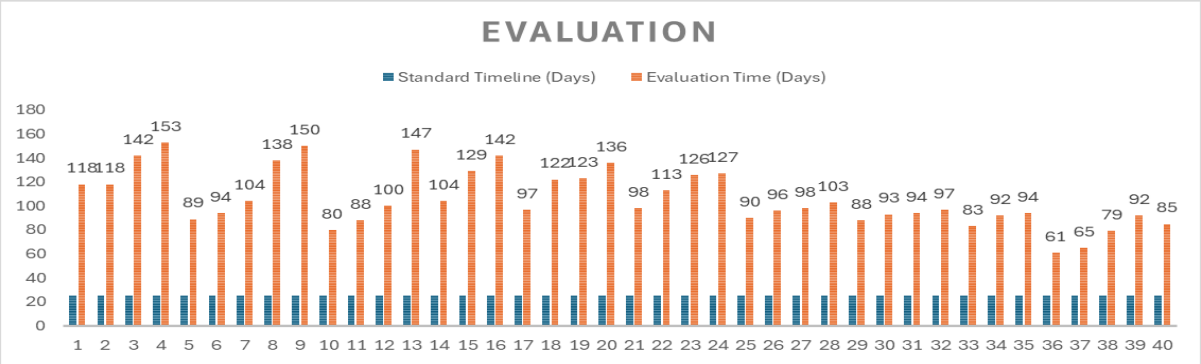


The process has delays and possible redundancies as per the flowchart overview illustration. The researcher will examine the issue to determine its underlying cause and the existing procedure in the next phase.

Analyze the Problem

During the previous phase to define the problem, the researcher focused on the 120 procurement cases in which the purchase orders were issued between January to June 2024. However, out of 120, 40 cases were found that the procurement process took longer than the designed procurement lead-time 45 days. Therefore, the researcher collected data of 40 cases from the system report, to identify the number of days taken in each step of the procurement process. After analysis, it was found that each period of procurement steps; sourcing, solicitation and award and contract were within the set timeline, however the delay happened mainly in the processes of Evaluation, as the evaluation period took from 61 days to 153 days (as shown in Figure 3) which was much beyond and over the designed evaluation lead time which is maximum 25 days.

Figure 3: Histogram for Evaluation Step



After identifying the focus point which the critical delay happened in the process, the researcher collected the delay reasons from the procurement reports after the processes have completely finalized, to identify the delay problem in evaluation process. The summary of delay reasons is shown in Figure 4.

Figure 4: Summary of Delay Reasons

As per the figure above, the delays happened due to "delay in getting clarifications from the suppliers" in total of 18 cases, due to "delay in getting client approval on the recommendation" in total of 14 cases, due to "delay in getting feedback on reference checks" in 6 cases and due to "unavailability of technical experts during evaluation" in 2 cases. Hence, the researcher focused on scope down the problems found by implementing the Pareto Analysis to identify 80% of the causes with the focus on improvement efforts, as per Figure 5, and found that 2 major causes to be focused: - Delay in getting clarification from the bidders and Delay in getting client approval on the recommendation.

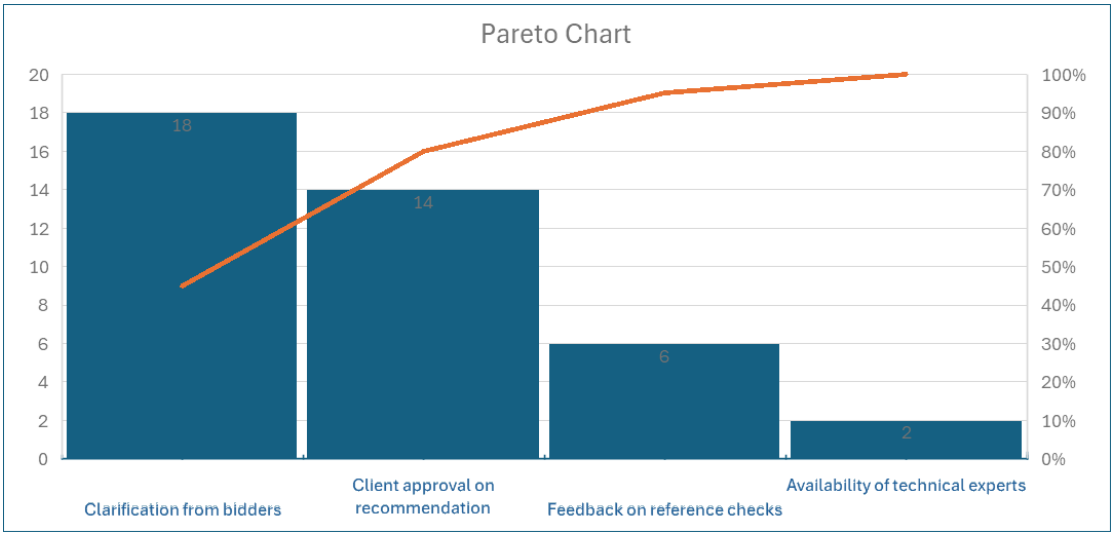
PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

Proposed Improvement Plan

After the delay reasons were exposed in Analyze stage, the researcher needed more attention to develop effective solutions, to reduce the long evaluation process and for future development. Hence, the researcher set up the brainstorming meeting within the procurement team on 10 July 2024, to present the issues found and to generate lots of thoughts to get the

possible solutions. The objective of the brainstorming meeting was to make sure all the improvement plans are realistic and comprehensive.

Figure 5: Pareto Chart by Issues Found



Then the improvement plans to the analyzed problems along with the responsible parties were developed. Furthermore, those plans and actions were discussed with the senior management of the Procurement Department of IDO and set the tentative date to implement the plan to be effective on 15 July 2024. A summary of the details of the action plan for the implementation was shown in Table 4 below.

Table 4: Detailed Summary of Problem and Improvement Action Plan

Problem	Improvement Plan and Actions	Responsible Parties	Tentative Date for Implementation
Delay in getting clarification from the bidders during the evaluation	Based on the complexity of the tender, the pre-bid meeting for the bidders shall be carried out during the solicitation period, to explain all the tender requirements, so that the bidders can submit their bids as per the tender requirement.	Procurement Team	15 July 2024 onwards
	The number of clarification requests to the bidders during the evaluation must be reduced, as much as possible.	Evaluation Panel	15 July 2024 onwards
	To reduce, the supplier orientation program is required for the bidders to understand how to submit the bids and documentation to IDO.	Procurement Team	15 July 2024 onwards
Delay in getting client approval on the recommendation	To clearly mention the rejection of any offers, the reasons for rejection (if any) during the evaluation, so that the end user can take the faster decision on the recommendations.	Evaluation Panel	15 July 2024 onwards
	To submit the recommended product details in advance prior to the technical evaluation meeting.	Procurement Official	15 July 2024 onwards

Implementation
The implementation of the proposed action plans has been started on 15 July 2024. To ensure the performance during implementation, the researcher monitored and reviewed all the procurement cases, for which the procurement request received on 15 July 2024, that the orders were supposed to be issued to the suppliers by the end of August 2024.

Plan 1: Carrying out pre-bid meetings for the bidders during solicitation
The information about the location, date and time of any pre-bid meeting was specified in the solicitation documents, based on the complexity of the tender requirement. In addition, mandatory or optional attendance requirements, mode of conducting pre-bid meeting as physically or electronically, were clearly stated in the solicitation documents. The pre-bid meetings were carried out as an open forum during which questions from the potential bidders are addressed.

Explanation of all the tender requirements and all the questions and answers given in the meeting were collected by the procurement officials. The written meeting minutes were prepared and appended to the solicitation, then equally distributed to the bidders through direct notification to the bidders who attended as well as by posting it through the system in order to notify all the prospective bidders.

Plan 2: Reducing number of clarifications during the evaluation
To optimize the frequency of the clarification request during the evaluation, the supplier orientation program will be organized by the IDO procurement team via both personally and virtually, for the bidders to understand how to submit the bids and documentation to IDO. Such Bidder Awareness Programs are scheduled on a quarterly basis.

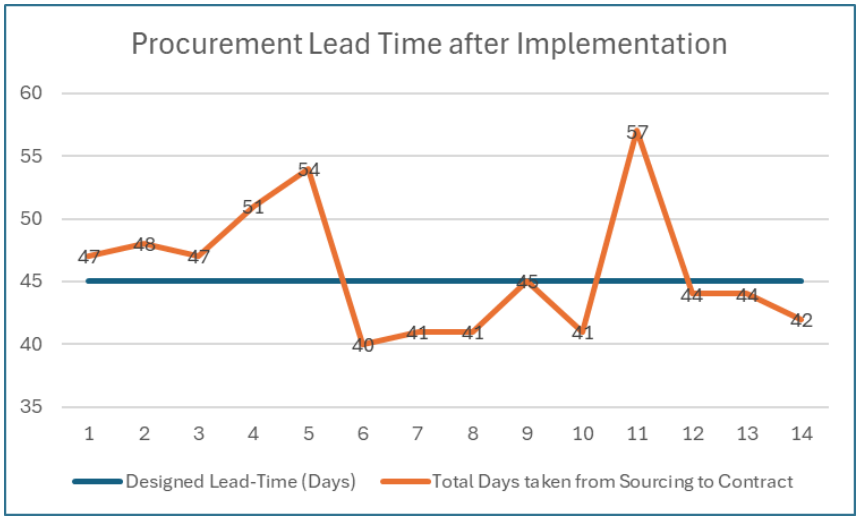
Plan 3: Clearly mentioning the rejection of any offers
During the technical assessment, the offers were rejected when they contain material deviation, i.e. when the specifications of the items quoted vary in one or more significant aspect(s) from the minimum required technical specifications and other requirements. The reasons for the rejection were also clearly remarked in the technical evaluation sheets. This helps in getting necessary approvals from the client on the recommendations made in a faster way.

Plan 4: Submitting the recommended product details in advance to the client
The procurement officials submitted the details of product recommendations to the clients within 24 hours of completion of all evaluation steps and requested to confirm their approval within 48 hours of the request.

After proposing the recommended action plans to carry out during evaluation and by monitoring the procurement cases 15 July 2024 onwards, it may reduce the long evaluation process.

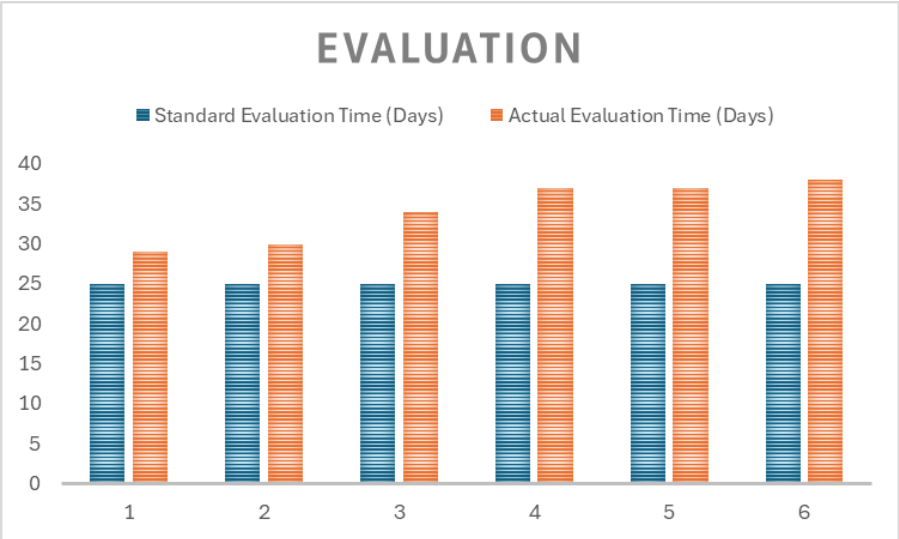
Control
Control is the last phase of the DMAIC process. It focuses on ensuring that the proposed solutions are implemented effectively and can be sustained over time. To validate the improvement and monitor the process performance, the researcher collected the data of the procurement cases from the system report, for which the project team submitted the procurement request on 15 July 2024, after the implementation of the above improvement action plans. It has a total of 14 procurement cases, and their procurement lead time was shown in Figure 6.

Figure 6: Procurement Lead Time (After Implementation)



The time taken for the overall procurement process from sourcing until the contract was between 40 days to 57 days. Though some of the delay was over the designed procurement lead time 45 days as shown in figure above, the delay time was significantly reduced as the average procurement lead time was decreased to 46 days within a short implementation period, which was a lot better than 68 days previously identified in previous phase. However, it was also found that the procurement lead-time of a total of 6 cases out of 14 were over the targeted 45 days. Hence the researcher again investigated the delayed cases to know the delay had happened in which procurement stage and what was the reason for the delay. It was observed that the delay was still happening in the evaluation stage (as shown in Figure 7) due to "the unavailability of technical experts during the evaluation" from the data collected from the finalized procurement reports.

Figure 7: Histogram for Evaluation Step



Therefore, the researcher again set up the brainstorming meeting, as the second phase, with the Procurement Manager and the Project Team on 7 September 2024 and developed the improvement action plan and recommendations to be effective immediately, for the client approval delay problem as per the Table 5 below.

Table 5: Detailed Improvement Action Plan (Second Phase)

Problem	Improvement Action Plan (Second Phase)	Responsible Parties	Proposed Date for Implementation
Unavailability of technical experts during the evaluation	To develop a roster of technical experts across all the required sectors.	Project Team	Immediate

The analysis revealed that the delays in completing the evaluation of a few cases were due to the unavailability of technical experts. To address the issue in future procurement processes, IDP is developing a roster of technical experts across all required sectors and stand-in resources will be designated in an immediate effect. This will ensure that if any expert is unavailable, an alternative can be readily accessed, minimizing the impact on bid evaluations. The plan was also discussed and approved by the senior management for the immediate implementation and the implementation is ongoing.

Maintain the Improve State

Finally for the continuous improvement, the researcher developed a control plan with the help of procurement manager and the procurement officials within the team. This was done because once the improvement has been made, it is necessary to ensure that the process continues to maintain the improvement over time. This will also ensure that the procurement timeline meets 45 days as targeted.

Control Plan 1: Control on Evaluation

The procurement official will plan the team members for the evaluation panel in advance and ensure their availability for the bid evaluation without any delay. The evaluation panel will limit the clarification requests to the bidders, and the procurement official will coordinate with the evaluation panel to get the clarifications from the bidders in a faster way. Moreover, the project team will be ensuring the availability of technical experts with alternatives.

Control Plan 2: Control on End-user's Approval

The procurement official will request a specific contact from the end-user to coordinate and clarify any points in the recommendations made. This will help in reducing the delays in getting the approvals from the end-user. Once the financial evaluation is completed, the procurement official will provide the recommended product details to the end-user for approval and request for a faster approval.

Control Plan 3: Control on Overall Process

The procurement officials are responsible for carrying out the procurement tasks, and raising any issues in the process, in case if any, to take corrective actions. The supervisor will monitor each procurement cycle daily.

Control Plan 4: Seek Continuous Improvement

Continuously look for opportunities to enhance the effectiveness and efficiency of the control plan. This ensures that the process continues to improve in case of any challenges. Regular weekly reviews of the control plan by the Procurement Manager, supervisor and the procurement officials are essential. The findings from these reviews can be used to determine if the control plan is effective as it is or requires further improvement. The control plan should be adaptable and allow for ongoing improvements. By implementing this control plan, the

organization can proactively manage risks, improve efficiency, ensure compliance, and drive further improvement in the implemented processes.

CONCLUSIONS AND RECOMMENDATIONS

This research focuses on analyzing the various reasons for the delay in procurement process of IDO and taking corrective actions to improve the process cycle by using Six Sigma DMAIC model. The research objectives have essentially been met as elaborated in the previous chapters and remarkable improvement has been achieved as can be seen from the comparison of the data before and after implementation. In Define phase, translation of VOC to CTQ and project charter were used to define the existing problem. In Measure phase, the detailed process flowchart was used to see the possible delays and redundancies in the process for analyzing the problem in next step. In Analyze phase, the necessary data were collected and used Pareto analysis to identify the focus point of the process, the delay reasons and the issues to be focused. In Improve phase, the improvement action plans were developed and implemented. Finally, in Control phase, the run chart was used to track and monitor the changes in performance over time during the process of implementation.

In conclusion, the study aims to shorten the procurement process time to 45 days to meet the designed procurement lead time by the IDO, by applying DMAIC methodology. The data collected after implementation shows that the research objectives are achieved, proving that DMAIC can improve the effectiveness of the procurement process. IDO can reduce the procurement process lead time to a very minimum period so that the Supply Chain does not affect stock out situations due to the delay in placing orders. At the same time IDO will benefit from the use of Six Sigma DMAIC model and achieve the timely implementation of the development projects around the world.

It is also important to acknowledge limitations in this research that the normal delays due to the other logistical issues and any other complicated interference in the supply chain are not included in this study. In analysis phase, this study only sought to solve the problems leading to the top value of the delay reasons occurred in the evaluation process. Hence, the implementation methodology used in this study may not be suitable for other processes as there are differences across the businesses and the operational processes. Moreover, this study is only based on historical data for 6 months period that is considered as a limitation of this research study. In addition, due to the time constraints for the data collection in implementation stage, the result limits the depth and comprehensiveness of the research. Data collection is a very critical step since DMAIC model can only be effective and efficient if the data being analyzed is correct and accurate. Hence, for future research, the researcher recommends exploring alternative methodologies for developing more robust solutions. To enhance the research, future studies can broaden the scope by examining the entire procurement process from sourcing until delivery, allowing for more comprehensive and beneficial solutions.

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