QATAR UNIVERSITY

COLLEGE OF ENGINEERING

EVALUATING THE EFFECTIVENESS OF LEAN MANAGEMENT TOOLS ON ORGANIZATIONAL EFFICIENCY: A CASE STUDY OF QATAR UNIVERSITY EDUCATIONAL SERVICE PROCESS

BY

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ABSTRACT

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Title: Evaluating the Effectiveness of Lean Management Tools on Organizational Efficiency: A Case Study of Qatar University Educational Service Process

Student Learning Support Center at Qatar University

Supervisor of Project: Tarek, E, Mekkawy.

The COVID-19 pandemic has had a significant effect on many aspects. The educational service sector is one of those aspects. Due to that, many educational services at Qatar University have been changed from being delivered on campus to being provided remotely. One of these services is the Basic Calculus Program, offered by the Student Learning Support Center. This project focuses on considering this program as a case study to evaluate the efficiency of educational services. The goal of this project is to use lean management tools to demonstrate the reduction in waste, non-value-added activities, and other inefficiencies from the Basic Calculus Program service's primary delivery method to contrast the current automated approach to service delivery with the previous state and to show how to further enhancements to the automatic service delivery process affect the length of staff service.

Moreover, a survey questionnaire was used to verify the validity of the automated service delivery state after further improvement was applied to the process. As a result of this study, the lead time of the automatic service delivery process has been reduced by around 90% compared to the previous delivery state. Continuous improvements are applied to this automated service. As a result, the employee service time in the process has been saved by 50%, the attendance rate for the program

increased from 66% to 81%, and the satisfaction level with the service provided is 98%. This percentage was achieved by eliminating waste and non-value-added activity and transferring it to automate the service delivery method. The automated service has been monitored, and continuous improvement has been made by reducing the number of sessions of the program and saving the employee's service time without affecting the service efficiency or the satisfaction of the end-users with this service.

DEDICATION

I want to dedicate this project to my beloved family and friends. Thank you for your backup, inspiration, and motivation throughout my journey. I am so grateful to have you in my life.

ACKNOWLEDGMENTS

I want to thank Prof. Tarek Elmekkawy, my project supervisor, for his valuable support, guidance, and sharing of his vast knowledge on this project. I also would like to acknowledge the encouragement and support from my mother, brother, and husband during the master's program duration.

In addition, I would like the Student Learning Support Center at Qatar University to allow me to study the area of enhancement that had been made in the Basic Calculus Program Service.

Finally, although some of the data utilized in the project were based on my workplace, this project for the master's degree in engineering management was entirely completed by me. The author alone is responsible for all analyses, findings, and suggestions.

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CHAPTER 1: INTRODUCTION

1.1 Background Information

Various organizations have benefited from implementing lean methods and technologies to enhance their processes and operations (Belekoukias, Garza-Reyes, & Kumar, 2014). The impact of these strategies and technologies has been seen in operational performance metrics such as affordability, efficiency, reliability, and quality. Businesses often suffer direct expenses incurred in disaster management and indirect costs from lost time and revenue. The onset of COVID-19, for example, led to numerous disruptions in almost all sectors and industries, including the education sector. Schools were closed, and learning was disrupted due to strict COVID-19 measures, significantly disrupting education across the globe (Hoofman & Secord, 2021). In the post-COVID-19 era, learning institutions were expected to develop different programs to facilitate learning recovery, allowing lagging students to catch up with others and the established learning targets. Therefore, there was a need to quickly problem-solve, establish robust contingencies, and restore the education sector to normalcy. The first step involved conducting just-in-time assessments to identify the areas of learning needed to benefit from lean management and improve efficiency within the education sector. Still, there was a need to measure the worker's efficiency after implementing the lean management system.

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numerous disruptions in almost all sectors and industries, including the education sector. Schools were closed, and learning was disrupted due to strict COVID-19 measures, significantly disrupting education across the globe (Hoofman & Secord, 2021). In post-COVID-19, learning institutions were expected to develop different programs to facilitate learning recovery, allowing lagging students to catch up with others and the established learning targets. Therefore, there was a need to quickly problem-solve, establish robust contingencies, and restore the education sector to normalcy. The first step involved conducting just-in-time assessments to identify the areas of learning needed to benefit from lean management and improve efficiency within the education sector. Still, there was a need to measure the worker's efficiency after implementing the lean management system.

1.2 Overview of Qatar University Educational Service Process

The Student Learning Support Center (SLSC) is a department at Qatar University. Its mission was to empower students with skills and knowledge to achieve their desired academic, personal, and professional goals (Qatar University, n.d.). The Center provided various student services, including workshops, tutoring sessions, essential programs, and coaching. The Center offers multiple academic support programs, including the Basic Calculus Program (BCP), which is currently delivered remotely to the students on campus in separate male and female sessions.

Additionally, the center offered full academic support for all university students. It provided the graduates and undergraduates with comprehensive support tools and manners, especially for those who sought assistance on different educational aspects. In previous years, a study was made by the center to analyze the basic knowledge of math concepts among undergraduates. The study sample focused on the students visiting the center and asking for tutoring services. The tutoring session started by

asking the student a basic math concept related to the topics they did not understand before beginning the explanation; then, the tutor explained the topic to the student and closed the session with the starter question to evaluate the student's understanding.

As a result, the common gap that faced most students in mathematics concepts was found to be around specific mathematics courses such as calculus. To fill this gap, the center started offering a service called the "Basic Calculus Program," which consisted of four modules that discussed different concepts to improve basic math knowledge in specific calculus topics. The program awarded the students for developing their basic math concepts and encouraged them to register for the program. The requirement to get this service was to be registered in Calculus 1 or Calculus 2 courses, attend the sessions from the start, and pass the test at the end of each module. However, the Basic Calculus Program service process had several issues and problems. Due to that, the previous process needed to be studied in detail to investigate, identify the challenges and demonstrate how these challenges had been fixed in the current service process.

The simplified process flow diagram for the Basic Calculus Program service is shown in the figure below, while a detailed process flow is outlined in Appendix 1.

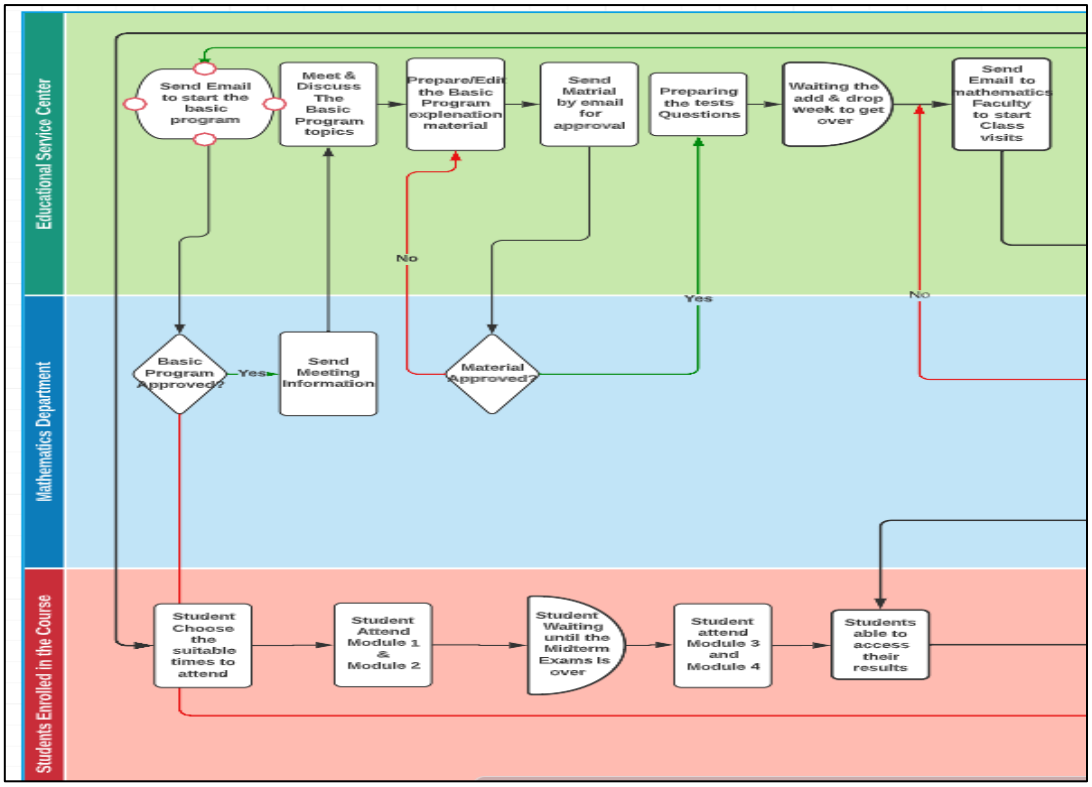

Figure 1. Process Flow Diagram for Basic Calculus Program Service Problem Statement.

The COVID-19 pandemic came with several restrictions that negatively impacted services in various sectors of the economy, including the education sector. At Qatar University, for example, educational programs and services were affected, and facilitated student services were stopped. For instance, the Basic Calculus Program was also put on hold. The program served about 3000 students with basic mathematics knowledge every semester to bridge students' poor grades by benchmarking against QU course requirements (Qatar University, n.d.).

Besides COVID-19, the university faced several other inefficiencies in conducting the program. For example, management at the Center noticed that student numbers were diminishing due to various reasons, such as the conflict in times of program sessions, students' schedules, or bookings for the venues (Qatar University, n.d.). Consequently, there was a significant reduction in the performance of the

program. In this regard, performance was measured by the number of students who successfully attended the program and passed all the modules. Besides, it took up to 4 months to comprehensively complete the preparation of the program.

Throughout the preparation and delivery of the Basic Calculus Program, many hidden requisites, tasks, and plenty of resources put time and effort into various processes that were not optimized, affecting the number of students expected to be on board and the respective benefits from the program. The current resources are needed to meet the intended purposes by eliminating potential waste within the department (Qatar University, n.d.). Furthermore, there was a need to evaluate worker efficiency in the program service after applying lean management tools. This project also aimed to improve the overall productivity of workers at the center.

1.3 Aim of the Study

The main aim was to demonstrate the efficiency of the Basic Calculus Program service before and after automating it by implementing lean management tools. Furthermore, the project aimed to establish how to direct the automated services to attract more students and increase their attendance to maximize the benefits of the service.

1.4 Research Questions

The study sought to answer the below research questions:

How was the Basic Calculus Program service implementation restructured to eliminate unnecessary non-value-adding activities and simplify the necessary non-value-adding activities in the service delivery process?

How was the automated "Basic Calculus Program" service designed to enable its resumption and meet students' needs?

How do the automated service's continuous enhancements impact employees'

productivity by increasing their efficiency in the service?

1.5 Project Objectives

The following were the objectives of the study:

a) To illustrate the eliminated wastes, non-value-add activities, and other inefficiencies from the previous delivery technique of the Basic Calculus Program service.

b) To compare the previous delivery process to the current automated process using lean management tools.

c) To demonstrate the impact on the employee service time after applying further improvements to the automated service.

1.6 Significance of Research

This research was significant because its successful completion could enable the University to continuously provide educational services to students due to the improvements made from observations made by the Center and the professors about most relative basic math topics, especially for Calculus courses. Secondly, when effectively implemented by the university, the outcome of this study will significantly fill the gap by providing adequate lectures on the essential topics that sometimes need to be better covered flexibly. Additionally, this research's findings can be instrumental as they can be helpful in the general improvement of the quality of the educational services offered by the university, which in turn gives students the ability to understand the topics with a bounce and hence positively improve their mathematical skills. Finally, the results of this research can be used for internal and external benchmarking to improve similar processes within the university or other academic institutions. Benchmarking helps institutions establish best practices for teaching and learning, compare modules, and rank their efficiencies and performances in terms of

achievement.

1.7 Scope of Research

The study was limited to SLSC at Qatar University, focusing on the Basic Calculus Program offered by the Center as part of its supportive educational services. These included modules and sessions provided to the students. Stakeholders comprise students, tutors, and all staff concerned with the program processes. The research did not cover other programs offered at Qatar University.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Organizations today are under constant pressure to improve their efficiencies and reduce waste to stay competitive in the marketplace. In the education sector, universities are no exception, as they strive to offer quality services while ensuring that resources are utilized effectively. Recently, there has been an increased interest in applying lean management tools to enhance efficiency in various industries, including the education sector (Suárez-Barraza et al., 2012). This literature review examines the measurement of worker efficiency following the successful implementation of a training model using lean management tools at Qatar University. The study will explore how the workers' performance and efficiency were measured and compared before and after the project's implementation.

2.2 Approaches to Process Improvement

2.2.1 The Theory of Constraints. One relevant theory that can be applied to measuring worker efficiency post-implementation of a lean management training model is the Theory of Constraints (TOC). This theory is based on the idea that organizations are limited in achieving their goals by one or a few constraints that restrict their performance. TOC aims to identify and manage these constraints to maximize organizational performance. In implementing a lean management training model, the TOC can be used to determine the conditions hindering worker efficiency before implementing the model (Puche et al., 2016). This information can be used to develop targeted training programs that address these constraints and improve worker efficiency.

2.2.1 The Goal-Setting -Theory. The goal-setting -theory known as the GST states that setting challenging goals can lead to higher performance. In measuring

worker efficiency post-implementation of a lean management training model, the GST can be used to establish specific and measurable performance goals for workers. These goals can be used to track worker performance before and after the training model's implementation to determine the model's effectiveness in improving worker efficiency.

2.3 Performance Measurement

One of the most critical factors in the management of an organization is performance measurement. It involves the quantification of outputs and outcomes of administrative processes and systems to determine the effectiveness and efficiency of the organization (Speklé & Verbeeten, 2014). Performance measurement in organizations is critical in determining how well the organization achieves its goals, objectives, and targets.

Performance measurement can assess organizational activities' inputs, processes, and outputs to determine how they align with organizational goals and objectives (Speklé & Verbeeten, 2014). In organizations, performance measurement monitors and evaluates the effectiveness and efficiency of various functions and processes, such as production, service delivery, and human resource management. The primary purpose of performance measurement is to provide leadership with feedback on the organization's performance, identify areas that require improvement, and make informed decisions that promote the organization's growth and success.

2.3.1 The Balanced Scorecard. The balanced scorecard is one of the most common frameworks and models for organizations' performance measurement efforts. This strategic tool can help them identify and implement effective strategies to improve their performance. It is based on four broad categories: financial, internal processes, customer, and learning and growth. The former looks at an organization's profitability, return on investment, and cash flow, while the latter measures customer satisfaction,

retention, and loyalty. On the other hand, the last focuses on the efficiency of an organization's internal processes. The growth and learning perspective consider an organization's capacity to develop and improve.

2.3.2 Total Quality Management. Another model is Total Quality Management (TQM), a customer-focused model emphasizing continuous improvement of organizational processes and systems. The TQM model aims to provide a practical and efficient framework for managing administrative functions. It involves various techniques and tools (Wai Mun & A. Ghani, 2013). The TQM model is based on the premise that quality is the responsibility of everyone in the organization and requires the involvement and commitment of all employees.

This study aims to analyze the effectiveness of lean management tools in improving the efficiency of Qatar University's educational service operations. The performance measurement can be based on the framework or the TQM model to ensure that all aspects of organizational performance are measured comprehensively. Performance measurement tools can identify areas that require improvement and develop strategies to improve organizational efficiency.

2.3.3 Efficiency and performance measurements for the education system. Efficiency is critical to any organization, ensuring that resources are used effectively to achieve maximum output. It is particularly true in the education sector, where universities strive to offer quality services while ensuring that resources are utilized effectively. Nonetheless, measuring the efficiency of educational systems is a complex task, as there are numerous factors to consider, such as the quality of education, the availability of resources, and the effectiveness of teaching.

In the context of Lean management tools in educational systems, efficiency can be measured using various metrics. These metrics can be used to assess the

effectiveness of lean tools on the efficiency of the educational system. It can measure multiple aspects of a learner's education, including the number of people who take classes, the average grade that pupils achieve, the number of completed courses, and the dropout rate among students. Additionally, the efficiency of the educational system can be measured using metrics such as the amount of time it takes for students to complete courses, the number of resources required to complete courses, and the amount of time it takes to teach courses.

Measuring performance in educational systems is critical in determining how well the organization achieves its goals, objectives, and targets. Performance measurement in educational systems can assess educational activities' inputs, processes, and outputs to determine how much they align with organizational goals and objectives (Care et al., 2018). In educational systems, performance measurement monitors and evaluates the effectiveness and efficiency of various functions and processes, such as teaching, learning, and administration. The primary purpose of performance measurement is to provide management with feedback on the educational system's performance, identify areas that require improvement, and make informed decisions that promote the educational system's growth and success.

The strategic management tool provides a comprehensive framework for measuring an educational system's performance. The model's financial perspective measures the financial performance of the educational system, in terms of tuition revenue and research funding. The customer perspective is focused on factors such as satisfaction and loyalty. The internal processes measure efficiency and effectiveness, while the learning and growth metric looks at how well an educational institution can develop and innovate. The Total Quality Management (TQM) model emphasizes the continuous improvement of educational processes and systems. The various tools and

techniques of the TQM model ensure that academic strategies are practical and efficient. The Transformation Quality Model (TQM) aims to provide a framework that will help improve educational quality. It involves the involvement of various stakeholder groups.

2.4 Lean Concept

A lean management system is a process that aims to identify and eliminate waste in an organization's operations. Toyota developed it in the manufacturing industry in the 1950s, and it has since been widely adopted in various sectors (Saleeshya et al., 2012). The Lean philosophy is about continuous improvement and respect for people. It also focuses on the pursuit of perfection. Organizations can use tools and techniques to identify and eliminate waste and improve efficiency. These include process flow diagrams, value stream mapping, and Pareto analysis.

The primary goal of the lean concept is to create value by eliminating waste. It is done by identifying processes that are inefficient and eliminating them. The goal is to improve both the efficiency and the quality of services and products. These tools help identify weak areas and can lead to developing strategies to improve them. The lean concept also emphasizes the importance of customer focus (Palange & Dhatrak, 2021). Through this process, the product or service must be designed to meet the needs of its customers. It is done through various methods, such as surveys and feedback.

The Lean concept also encourages data and analytics to inform decision-making. It is done by collecting data on the performance of processes and analyzing it to identify areas that need improvement. This data can then inform the development of strategies to improve efficiency and quality. Finally, the lean concept emphasizes the importance of continuous improvement. Organizations should continuously improve their processes to meet their customers' needs. It is done through constant improvement

tools such as Kaizen and 5S. These tools help to identify areas that need improvement and develop strategies to improve them.

The lean concept is an effective way to improve efficiency and quality in organizations. The goal is to reduce waste and improve the efficiency of products and processes. It also encourages the use of data and analytics to inform decision-making and the use of customer feedback to ensure customer needs are being met. By applying the lean concept, organizations can create value for their customers while reducing costs and improving efficiency.

2.4.1 Value add and non-value add Activities. In lean management, "value-add" refers to any activity or process that adds perceived customer value to the end product or service. In contrast, non-value-adding activities are those that do not contribute to the value of the end product or service (Statkus, 2018). The distinction between value-add and non-value-add operations is fundamental to lean management because it identifies areas where efficiency can be increased, and waste reduced. In this regard, value-added activities in the educational system contribute directly to students' learning outcomes or enhance the educational experience. Value-added activities include classroom instruction, project-based learning, teacher feedback, and assessments aligned with learning objectives (Mariyam et al., 2022). These activities are essential for boosting student learning and engagement, improving outcomes, and increasing student and teacher satisfaction.

Instead, non-value-added activities in the educational system do not contribute to the student's learning outcomes or enhance the educational experience. Non-value-adding activities include excessive paperwork, redundant administrative procedures, many meetings, and repetitive documentation needs (Heigermoser & García de Soto, 2022). These tasks can be time-consuming and expensive, leading to teacher and

administration discontent and burnout. For example, excessive paperwork in the educational system is a non-value-added task. Teachers and administrators spend considerable time filling out paperwork, reports, and documentation requirements that have little bearing on student learning (Nunes & Azevedo, 2018). This practice can result in a waste of time and effort and distract from education's primary purpose.

2.4.2 Types of Wastes. The basic principle of lean management is eliminating waste from a system. Any activity or procedure that does not add value to the final product or service is considered waste (Statkus, 2018). Lean management defines waste as any action, process, or practice that consumes resources, time, or effort without adding value to the final output (Mariyam et al., 2022). Thus, reducing waste is a crucial principle of lean management in all industries, including education. In lean management, there are various types of waste: overproduction, waiting, flaws, over-processing, overproduction, excess inventory, superfluous motion, defects in the processes, and underused talent (Boiko et al., 2020). Identifying and eliminating waste in the educational system can increase efficiency, decrease costs, and enhance student learning results. Applying lean management methods aids institutions in identifying and eliminating waste in all facets of the educational system, resulting in enhanced resource utilization and improved outcomes for all stakeholders.

2.4.2.1 Transportation. In the context of the educational system, transportation waste can arise when physical resources, such as textbooks and other learning materials, are transferred between sites unnecessarily (Iswanto, 2020). This waste can be minimized by introducing digital platforms that facilitate the sharing and accessibility of educational resources, hence decreasing the need for physical transit.

2.4.2.2 Inventory. Excess inventory waste can result when educational institutions hang onto superfluous resources or supplies, such as textbooks or classroom

equipment (Statkus, 2018). Additionally, when educational institutions keep items or resources that are no longer needed, excess inventory waste can arise, leading to wasted space and resources (Baskiewicz et al., 2019). Returning out-of-date books by an educational institution might result in excessive inventory waste and resource loss (Abu et al., 2019). This waste can be decreased by using more effective inventory management procedures and procuring only the resources required depending on demand.

2.4.2.3 Movement. Unnecessary motion waste occurs when teachers or students move between sites or classes unnecessarily, resulting in educational waste (Nunes & Azevedo, 2018; Brajer-Marczak & Wiendlocha, 2018; Boiko et al., 2020). This waste can be decreased by optimizing class schedules and lesson plans to reduce unnecessary movement and by deploying digital learning systems that enable remote access to classes and materials.

2.4.2.4 Waiting. In the educational system, waiting waste can arise when teachers or students wait for resources, feedback, or approvals (Mariyam et al., 2022; Baskiewicz et al., 2019; Statkus, 2018). This waste can be minimized by adopting more effective communication methods, streamlining administrative procedures, and expediting input and support.

2.4.2.5 Overproduction. In the context of the educational system, overproduction waste can occur when an institution generates more resources or materials than students or teachers demand, leading to resource waste. Overproduction waste can occur, for instance, when an educational institution produces more textbooks than are required, destroying resources (Mariyam et al., 2022). This waste can be reduced by completing a demand analysis and only making the required resources based on actual demand (Abu et al., 2019).

2.4.2.6 Over-processing. In the educational system, over-processing waste can arise when an institution consumes more resources or time than is required to perform a task (Heigermoser & García de Soto, 2022). It can also lead to the creation of defects. This waste can be avoided by streamlining administrative procedures and lowering the number of forms and paperwork necessary.

2.4.2.7 Defects. Defects waste can develop in the educational system when educational materials or tests contain errors or do not satisfy students' needs (Iswanto, 2020) or because of over-processing. When educational materials are defective or do not match the needs of students, defective waste can result, leading to a loss of time, effort, and money. Errors in educational materials such as textbooks can result in defects and waste, which can waste time, effort, and resources (Brajer-Marczak & Wiendlocha, 2018). Quality control techniques and periodically evaluating and updating instructional materials and assessments help reduce this waste.

2.4.2.8 Unused people's skills and resources. In the educational system, wasted talent can occur when the skills and talents of students or teachers are not utilized to their maximum potential (Mariyam et al., 2022). This waste can be decreased by giving students and teachers opportunities to develop and use their abilities and instituting mentoring and coaching programs.

2.4.3 Lean management tools and efficiency/performance measurement. In universities, performance measurement and lean management tools have been widely used to improve the efficiency and effectiveness of academic processes. One of these tools is Value Stream Mapping, a process that allows organizations to analyze and optimize the flow of information.

Performance measurement is essential in assessing workers' efficiency and

involvement in successfully implementing a project. Models such as the Balanced Scorecard (BSC) have been proposed to evaluate performance (Shafiee et al., 2014). The Performance Prism (PP) is also another model that has been proposed. The PP model focuses on understanding the customer, internal processes, learning and growth, and project results (Severgnini et al., 2018).

The application of VSM and performance measurement models can be used to assess the efficiency of workers' post-successful implementation of a project (a training model) in the University. The VSM can identify and eliminate waste and inefficiencies (Forno et al., 2014). It can also create a baseline for the current process and identify improvement opportunities. The performance measurement models can also compare workers' performance before and after project implementation. It can help identify areas where improvements have been made, and further improvement is still needed.

2.4.4 Lean Teaching. Like the principles and practices used in manufacturing, service, and government sectors, lean teaching applies lean principles and techniques to education. It is because the various transactional processes in educational institutions are designed to be repeatable. It makes it easy to implement lean in the classroom.

Lean teaching is a process that aims to improve the value of education for employers, students, and payers. It encourages everyone involved in the higher education system to develop a solution that will help improve the quality of education for all. The fundamental idea behind lean teaching is to create a supportive environment allowing continuous improvement.

In lean teaching, the focus is on eliminating non-value-added activities, optimizing processes, and improving the flow of information. In this regard, lean education uses various tools such as value stream mapping, Pareto analysis, process flow, fishbone diagram, and brainstorming, among other tools (Tyagi et al., 2015).

These tools help identify areas of inefficiency and waste that can be eliminated or improved, thus improving the overall efficiency of the education system.

Lean teaching also emphasizes the importance of involving the stakeholders in the improvement process. It helps to ensure that everyone has a say and is part of the decision-making process. It also helps to ensure that everyone is working towards the same goal and that the process is as efficient as possible.

Moreover, lean teaching also emphasizes the importance of data-driven decision-making. Using data to inform decisions makes identifying areas of improvement and waste easier. Instead of relying on intuition and opinion, decisions are made based on data and facts. It helps create a supportive environment that will allow continuous improvement.

2.4.5 Lean management as an efficiency and performance measurement tool. One of the key benefits of Lean management is its ability to improve organizational efficiency and performance. By eliminating waste and improving processes, Lean management can help organizations achieve higher productivity, reduce costs, and deliver better-quality products or services. Various lean techniques and tools, such as 5S, Kanban, and Value Stream Mapping, are designed to improve performance and efficiency (Kumar et al., 2018).

Through VSM, organizations can visualize the flow of information and materials throughout their operations. It helps them identify areas of waste and improve their processes. It helps organizations identify areas of inefficiency and waste, such as unnecessary steps, waiting times, and overproduction.

5S is a Lean technique that focuses on workplace organization and standardization. It follows a set of five steps. These include sorting, setting in order, standardizing, sustaining, and shining (Ikuma & Nahmens, 2014). The goal of 5S is to

create an organized and clean workplace. It will help reduce waste and improve efficiency.

Kaizen is a continuous improvement technique involving small, incremental process changes. The objective of a process improvement program known as Kaizen is to eliminate waste and improve the quality and efficiency of a process.

Kanban is a Lean tool that helps organizations manage their inventory and production levels. It involves using visual cues, such as cards or boards, to signal when inventory needs replenishment or when a new production run needs to be started.

2.4.6 Effectiveness of Lean Management in Educational Services. Lean management is all about eliminating wastes inherent in processes and creating value for customers or end users (Abdelhamid & Salem, 2005). Several lean management tools can be applied to solve organizational problems by identifying waste and inefficiencies and reducing or eliminating them. Examples of the tools include value stream mapping, Pareto analysis, process flow, fishbone diagram, and brainstorming, among others (Al-Aomar, 2012). These tools can also be applied to bring continuous improvement in educational institutions. Organizations must identify and use appropriate tools and develop skills to use them by following the proper methodologies to realize the benefits of these tools. Benefits of lean management tools include effective management of complexities in teams or processes; bringing enhanced efficiencies in operations; better management of ever-changing organizational priorities; end-to-end project visibility; increased team efficiency and productivity; reduced lead times; improved team morale and motivation; reduced costs; and predictable performance outcomes (Aziz & Hafez, 2013; Arbulu, Ballard & Harper, 2003).

The methods and principles of lean implementation are utilized in the same manner in the schooling system as in the service, industrial, or public agencies (Höfer

& Naeve, 2017). It is because both instructions and administration can be broken down into standardized transactional procedures that can be easily adapted to fit the specific organizational structures in schools. According to Höfer & Naeve (2017), lean management in education urges all parties involved to find and eliminate the causes of subpar results for students and those who profit from education. The goal of lean education is to make college a better investment for the three main stakeholders (students, taxpayers, and potential employers), indicating the need to evaluate the performance of workers following the implementation of the lean management system.

While lean management has been widely adopted in various industries, its effectiveness in educational services has been debated. However, evidence suggests that Lean management can effectively improve efficiency and performance in educational services. A study looked into the effectiveness of lean management in improving the efficiency of Qatar University's educational services (Al-SAADI, 2018). The study used a mixed-methods approach, including surveys, interviews, and observation, to evaluate the impact of Lean management on the educational services process. The results showed that Lean management effectively improved efficiency and performance in the educational services process at Qatar University. Through lean management, the University reduced its waiting times and improved the quality of its services.

Another study evaluated the effectiveness of Lean management in improving efficiency and performance in higher education institutions in Iran (Darestani & Shamami, 2019). The study utilized qualitative methods, including observation and interviews, to analyze how lean management affects educational institutions. The results showed that Lean management effectively improved efficiency and performance in higher education institutions. The implementation of lean management techniques

improved the quality of services and reduced waiting times.

2.4.7 Lean Value Stream Mapping as a Lean Efficiency and Performance Measurement Tool. Value Stream Mapping is a process that uses lean management principles to identify and implement opportunities in the organization. According to Lean principles, value is any activity or process contributing directly to meeting the customer's needs or requirements. The process or action that doesn't add value should be minimized or discarded. Lean management aims to eliminate waste, reduce lead time, and improve quality and customer satisfaction. VSM is a vital tool in achieving these goals.

2.4.8 Effectiveness of VSM in Educational Services. Several studies have evaluated the effectiveness of VSM as a Lean efficiency and performance measurement tool in the educational services sector. For example, a study assessed the impact of VSM on the educational services process at Qatar University (Danshvar, 2021). The study used a mixed-methods approach, including surveys, interviews, and observation, to evaluate the impact of VSM on the educational services process. The results showed that VSM effectively identified areas of waste and inefficiency in the educational services process. Through the use of VSM, organizations can identify and improve the efficiency of their operations. It can also help them reduce wait times and improve the quality of their services.

Another study evaluated the impact of VSM on the service delivery process at a private university in Bangladesh. The study used a quantitative approach, including surveys and statistical analysis, to evaluate the impact of VSM on the service delivery process (Tortorella et al., 2016). The results showed that VSM effectively reduced lead time and improved customer satisfaction. Specifically, VSM helped identify areas of waste and inefficiency in the service delivery process, which were eliminated or

minimized through process improvements.

A third study by Zain et al. (2018) evaluated the impact of VSM on the student enrollment process at a public university in Malaysia. The study used a mixed-methods approach, including surveys, interviews, and observation, to evaluate the impact of VSM on the student enrollment process. The results showed that VSM effectively identified waste and inefficiency in the student enrollment process. Specifically, VSM helped to identify bottlenecks in the process, reduce waiting times, and improve the quality of services.

2.5 Conceptual Framework

The conceptual framework is to analyze the effectiveness of lean management tools in improving the efficiency of Qatar University's Basic Calculus Program. It is based on the principles of continuous improvement and minimizing waste. The framework includes Value Stream Mapping, Process Improvement, Organizational Efficiency, and constant improvement.

Value Stream Mapping (VSM): VSM maps the flow of materials and information through the educational service process from the beginning to the end. VSM helps identify inefficiency and waste areas, such as unnecessary steps, waiting times, and overproduction.

Process Improvement: Once inefficiency and waste have been identified through VSM, process improvement techniques can be used to eliminate or minimize these areas. Process improvement techniques include standardization, visual management, and continuous improvement.

Organizational Efficiency: The ultimate goal of using Lean management tools is to improve organizational efficiency. An organization's efficiency is determined by how effectively it uses resources to achieve its goals.

Continuous Improvement: Continuous improvement is a crucial principle of Lean management. Once process improvements have been made, organizations must continuously monitor and evaluate their processes to identify areas for further improvement.

The diagram below illustrates the conceptual framework for evaluating the effectiveness of Lean management tools on organizational efficiency in the educational service process at Qatar University.

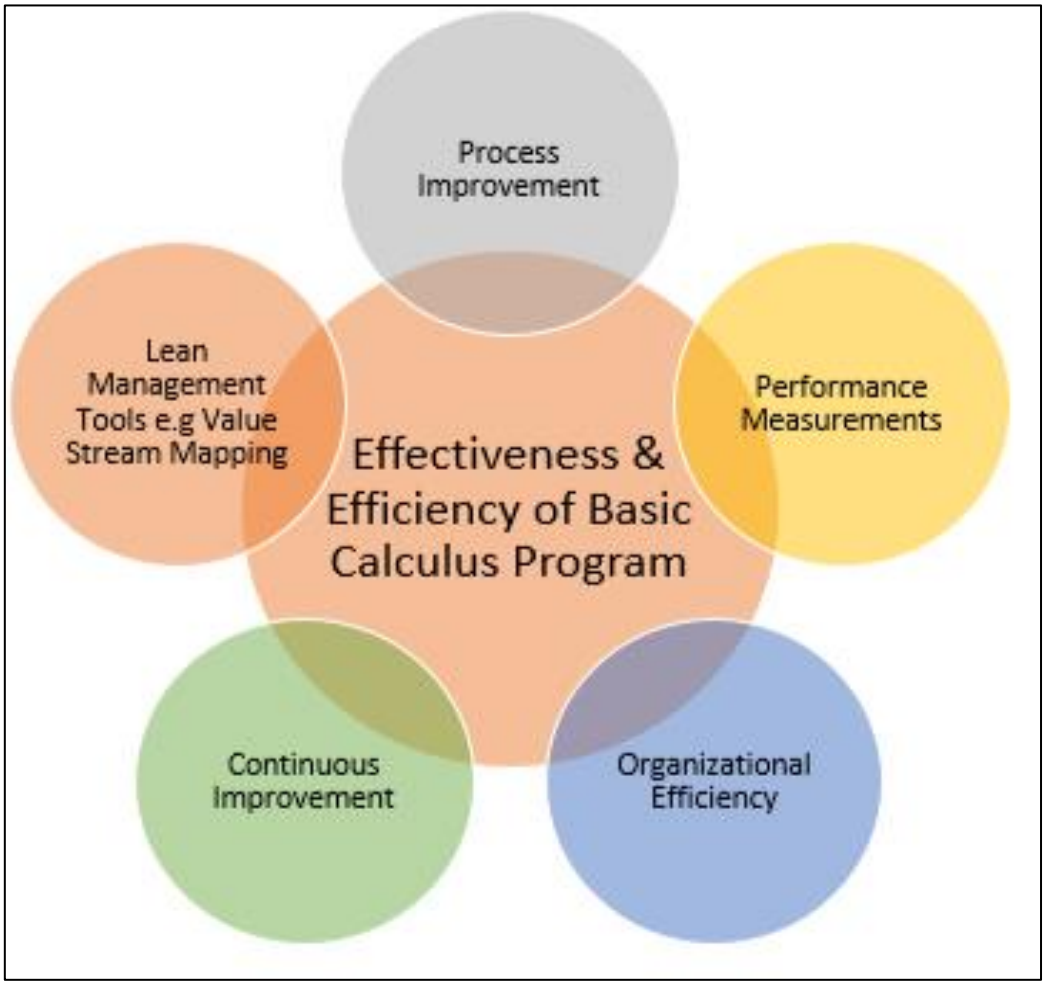

Figure 2.Conceptual Framework for Evaluating the Effectiveness of Lean Management Tools.

The diagram shows how VSM is used to identify areas of inefficiency and waste in the educational service process, which are then addressed through process

improvement techniques. These improvements lead to increased organizational efficiency, continuously monitored and evaluated for further improvement. The diagram demonstrates how the components of the conceptual framework are interconnected and work together to achieve the ultimate goal of improving organizational efficiency in the educational service process at Qatar University.

2.6 Summary of Literature Review

The literature review examines the measurement of worker efficiency following the successful implementation of a training model using Lean management tools at Qatar University. The study explored how the workers' performance and efficiency were measured and compared before and after the project's implementation. The various theoretical frameworks that are used in the design and implementation of lean management tools were discussed. These include the Goal Setting Theory and the Balanced Scorecard. Additionally, the review examined the role of Lean management tools and performance measurement in assessing the efficiency of the educational system and the importance of involving stakeholders in the process. It also discussed using a lean value stream mapping tool as a performance measurement and efficiency tool.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design

This research used a case study approach to evaluate the effectiveness of lean management tools on the efficiency of the Basic Calculus Program, which was part of the Qatar University educational service process provided by SLSC. This approach was selected because of its capability to explore or give descriptions and explanations of phenomena in their naturalistic contexts. Therefore, case studies are essential in explaining and understanding pathways and the links between newly developed policies, initiatives, or service delivery adjustments. This case study was used as a research approach to understand the educational program's context. The study will assume an instrumental type of case study whereby only a single case, in this regard, the Basic Calculus Program, was used to achieve a broader perspective of the level of efficiency of the educational program by applying lean tools. The case study approach was critical in this study as it helped explore the "what," "how," and "why" questions of the program's efficiency. Additionally, it was used to establish gaps in a process or service delivery and explain why some implementation strategies were better than others. Therefore, after selecting the case to be studied, it was elaborately defined to enhance understanding of the problem, data were obtained and analyzed, an interpretation was made, and findings were reported.

The study adopted a quantitative approach using secondary data techniques. Data was obtained from observations and the already available databases. In this regard, students' data were used in the analysis to make conclusions and recommendations for this research. All the data involving the students were processed professionally for confidentiality. The metrics used in the study were important in the analysis of performances for the previous delivery state of the program and the current state.

3.2 Research Methodology

The study used lean tools to evaluate the effectiveness and efficiency of the Basic Calculus Program improvements. Specifically, value stream mapping (VSM) was applied to establish the previous program process state and the current process state or the current condition of the efficiency and performance of the program. It was used to study the employees' service time after the delivery service was fully automated, and a comparison was made against the previous state. As a lean management tool, value stream mapping is a tool or technique applied to develop a visual guide of all the activities, inputs, and other components required to deliver a service or specific product. VSM mapping aims to analyze and optimize a product's or service's process to identify and eliminate waste. Establishing a VSM involves the engagement of all stakeholders, all process steps, inventory records, and everything displayed in a flowchart.

Relevant parameters and metrics were established at the beginning of the VSM process based on the research aim and questions. Key VSM measurements included speed, quality, and flow. The key performance indicators for VSM commonly applied to measure speed include lead and process times.

VSM's previous process state (at the campus service delivery method) was drawn on paper, considering all steps and activities involved in the Basic Calculus Program at Qatar University. The goal was to define and understand the entire process from start to end of the product or service and to be in a position to inspect and detect any leakages and inefficiencies along the way. It made it easier to identify waste and losses along the way. All the steps, activities, and other inputs were categorized into either value-add or non-value-add activities. All non-value-add activities were identified and labeled with Kaizen bursts to denote points and opportunities for process improvement. Non-value-add activities were further classified into necessary and

unnecessary non-value-add activities. From the value stream map, value-add activities were sustained to enable the continuation of the entire process. Unnecessary non-value-add activities were eliminated from the processes, and necessary non-value-add activities were either simplified, reduced, or combined to improve efficiency and reduce the overall lead time. The output of this process was a complete value stream map showing all steps and activities, along with points of waste and inefficiencies along the process map.

A current VSM process state (automated service delivery method) was drawn with Kaizen bursts. It was a visual map without leakages or inefficiencies inherent in the processes. It displayed a shortened, waste-free, and lean process with enhanced efficiencies. Next was to identify an improvement plan and programs implemented to achieve the shift from the previous to the current state, plus an estimated projected benefit. It was important in the justification of the need for the identified actions. Actions in the designed improvement plan were prioritized to determine which would bring more value and hence needed prioritization and channeling of more resources. All activities in the improvement program were implemented based on the established order of priority. The automated program elaborated on what action was being taken, why it was taken, the method of executing it, who took action, for what period, and lastly, the frequency of reviewing the status of every implementation activity. Monitoring the implementation of improvement activities was necessary to ensure program execution was on course and resources were adequate.

Additionally, VSM was drawn to display the time an employee spent delivering the service after it was fully automated. It also focused on reducing the number of sessions per module for BCP students on campus while studying workers' productivity and reducing their service delivery lead times.

A comparison between two different semesters was made. Establishing VSM for employee service time aimed to determine whether there was a significant change in the level of service efficiency provided upon the reduction of the number of sessions given to each module. By reducing the number of sessions in each module, the program sought to improve its effectiveness and the number of individuals who used those services. A survey was done to establish students' satisfaction levels based on the improvements made to the program.

After successful implementation, savings, and benefits from applying the tools were calculated based on the identified metrics and measurements. In any process, there are always opportunities for further improvements. Therefore, recommendations were made for further improvement of the VSM map. Finally, conclusions were drawn based on the results and outcomes of the VSMs. Suggestions and proposals for future research were also made.

3.3 Population

The study was conducted at Qatar University. The study population comprised students who studied calculus courses, particularly those who attended the Basic Calculus Program service.

3.4 Measurement Parameters

Besides other measurement parameters, this study's two focal performance measurements were the processing time (PT) and the lead time (LT). Other parameters included attendance, the number of papers consumed in the process, the number of sessions per module, and the satisfaction level of the service provided after more improvements were made.

3.5 Data Collection

The study used secondary sources of data obtained from Qatar University

databases. This data had already been cleaned, tabulated, and compiled and was ready for further processing and analysis. Therefore, its integrity, accuracy, and reliability were guaranteed (Johnston, 2014). Multiple data sources were used to obtain information for the study (data triangulation) to enhance data validity, which was crucial in answering the research question. Specifically, information on various academic support programs, notably the Basic Calculus Program, was gathered and analyzed to make statistical inferences. At the end of the improvements, a students' survey was done to gauge their satisfaction levels regarding the entire program duration, the number of students taking the program after the lean application, and the efficiency and productivity of workers before and after the application of the VSM project.

3.6 Data Analysis

The analysis used Microsoft Excel sheets to compute the research metrics for interpretation and discussion. Comparisons of performance and efficiencies between the performance of the previous service state VSM and the current VSM were made to establish the level of improvement. Service employee time efficiency was compared after the service had been automated in Fall 2021 and Fall 2022. The study results were presented in tabular percentages, frequency tables, and graphs for visualization. Demographic information about the participants and the responses to the closed-ended questions were summarized using graphs and tables (Pandey & Pandey, 2021).

3.7 Ethical Practice

All research activities were done ethically, and confidentiality was maintained throughout the project. Anonymity and confidentiality of all information were held throughout the study. Care was taken to ensure the events or programs remained anonymous by withholding descriptors or allocating unique codes. The data used in this research was safely stored in various formats and password-protected to prevent third-

party breaches. After completion of the study, the researcher deleted all data utilized and permanently destroyed any physical records to guarantee security.

CHAPTER 4: DATA ANALYSIS, RESULTS, INTERPRETATION, AND DISCUSSION

4.1 Introduction

This chapter analyzed the data, presented the results, interpreted and discussed the study's outcome, and recommended further improvements. The context of the study was to illustrate the efficiency of the Basic Calculus Program service following the implementation of lean management tools and the work efficiency after applying further improvements to the program. The study employed a quantitative approach using secondary data. Relevant measures were used in data analysis to arrive at the results used in making conclusions. The data were analyzed using Microsoft Excel worksheets.

4.2 Results and Findings

4.2.1 Process Flow Diagram for the Previous State of Basic Calculus Program Service. The previous state of the Basic Calculus Program service procedure was described as follows: the math unit in the center sent a request by email for Mathematics Department instructors to meet and discuss the program modules' possible topics. The topics were chosen based on math faculty advice. In this step, an agreement was reached to implement the program for the following semesters. In this meeting, a decision was made either to change the recent topics or to keep them the same for the following semesters.

After agreeing on the program topics, the center specialists prepared the material and shared it with the Math Department for approval. Approval of materials indicated preparation for each module's tests. After that, an email was sent to start preparing for the service after setting a delivery schedule. Designing the program schedules could not be initiated unless the room to conduct the service was booked and

the program's scheduled times depended on the rooms' bookings. Once the schedules were ready, they were emailed to the students.

Each module was conducted within one week. It allowed the students to choose the most suitable session time for them to attend. The modules were held as follows: the first week for module 1 and the following week for module 2. After that, the program stopped for two weeks, and modules 3 and 4 were delivered in the next weeks. Students attended the modules, the papers were marked, and the grades were documented and shared with math instructors to share with the students. Once the grades were shared, the process ended.

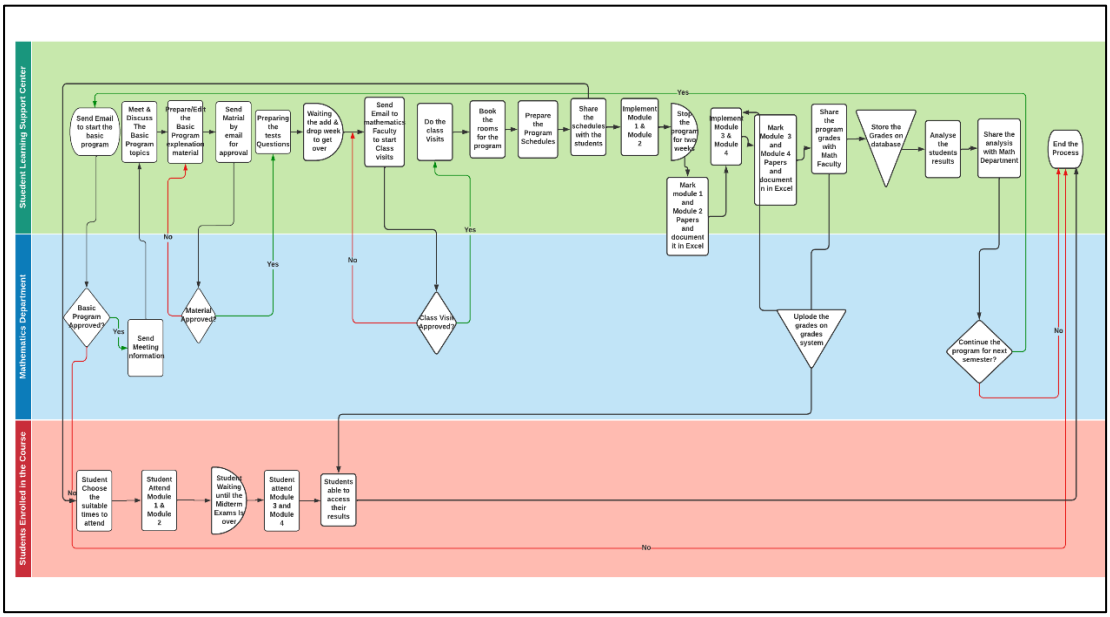

Figure 3. Process Flow for the Basic Calculus Program

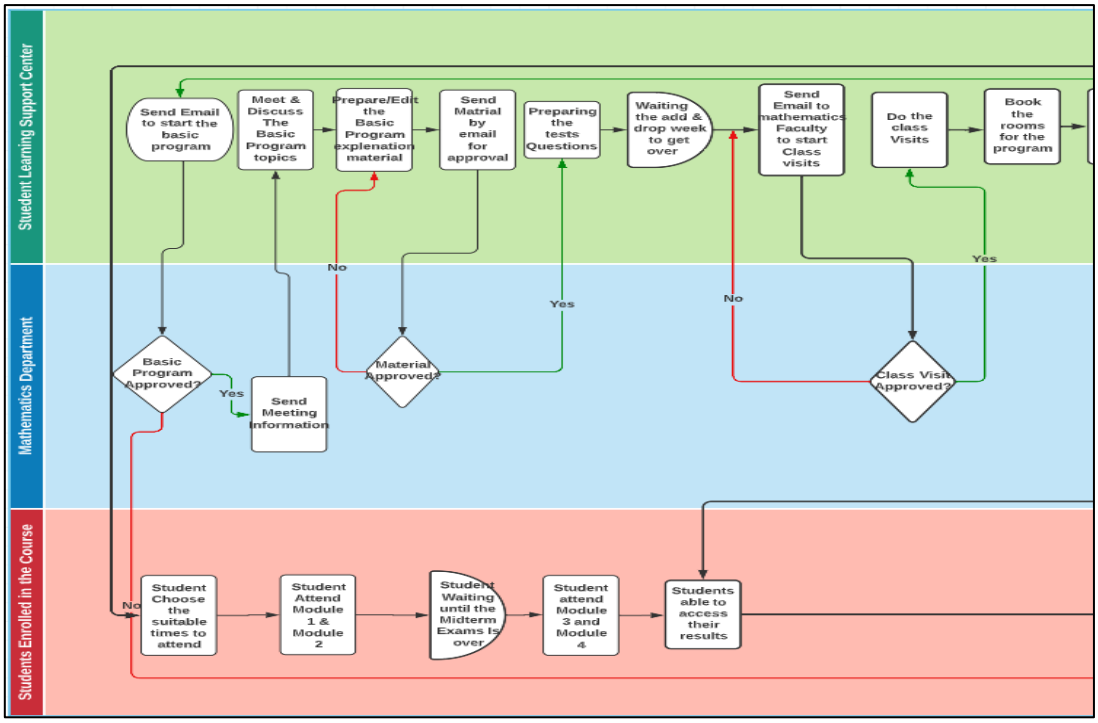

Figure 4. Detailed Process Flow Chart for the Basic Calculus Program –Part 1

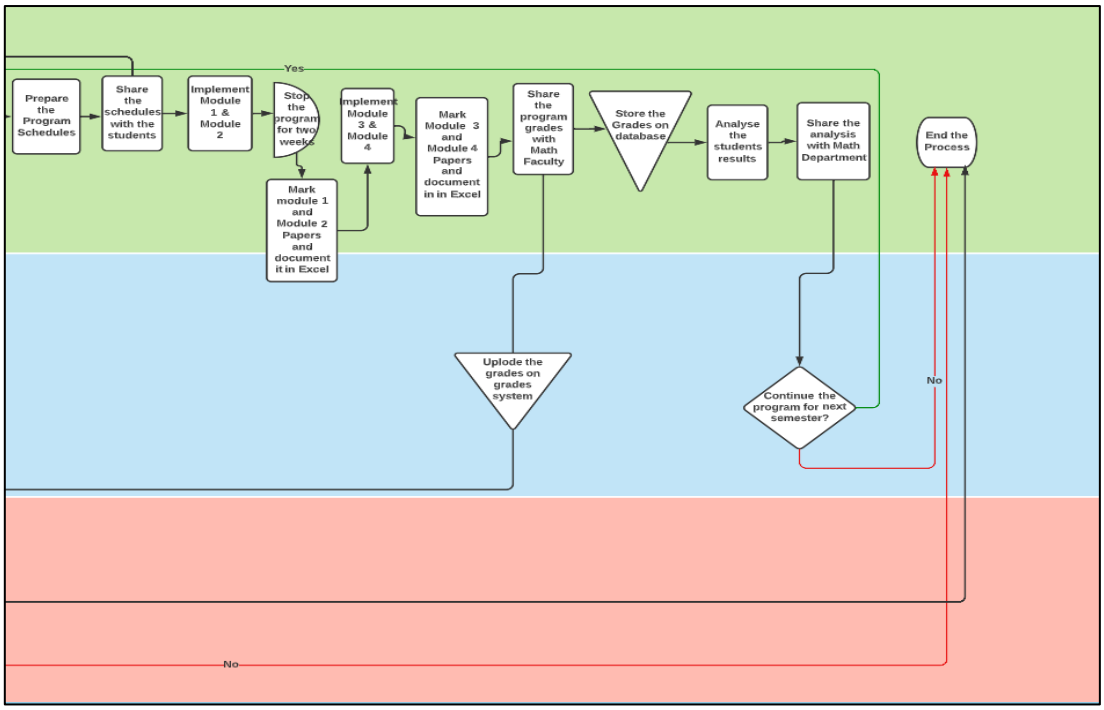

Figure 5. Detailed Process Flow Chart for the Basic Calculus Program –Part 2

4.2.2 Value Stream Map for the Previous State of Basic Calculus Program

Service. The process began with the students showing interest in pursuing the BCP. The first step involved SLSC employees receiving the students' list and emailing the math department to start service advertising. The entire step lasted 5 minutes with a processing time (PT) of 2 minutes and a lead time (LT) of 3 minutes. The second step involved the math department employees receiving the requested email from the SLSC. This step took 442 minutes, with PT taking 2 minutes and an LT of 1 full day. In the third step, the SLSC employee received the service advertising approval and started it, with the PT taking 5 minutes and LT taking three days. It was followed by the fourth step, whereby, after the service promoting was completed, the SLSC employee waited until the room was booked to deliver the program. The PT as 2 hours, while the LT was 5 days.

The fifth step involved the preparation of the program schedules by SLSC and sending them to the students, with PT taking 3 hours and the entire step taking an LT of 3 days. In the sixth step, students received emails about the basic calculus program module's times and various locations and venues where they started attending the modules. The PT for this step lasted 2 minutes, while the entire step took an LT of 1 day. Once students received the schedule in the sixth step, in the seventh step, the SLSC employee printed module 1 test papers for the same, with the PT lasting for 30 minutes while the total LT lasting for 2 hours. Additionally, 576 sheets of paper were used to print various forms and documents to complete the whole step. The eighth step was the SLSC employee moved from the department to the module 1 session location to deliver the service. The movement took 15 minutes; PT and LT were both 15 minutes. In the ninth step of the BCP process, students attended module 1 and took the quiz, which lasted 1.5 hours per quiz, and all the sessions took an LT of 5 days, consuming 4 sheets

of paper.

In the tenth step, the SLSC employee collected the test papers and returned them to the department. PT was 7 minutes, while the entire step lasted for 15 minutes. Afterward, in the 11th step, the SLSC employee marked module 1 tests taking a PT of 15 minutes while the step ran for five days. What followed in the 12th step was the SLSC employee entering students' grades in various databases, taking a processing time of 10 minutes and the entire step lasting for five days. Once Module 1 was complete, in the 13th step, the EMP employee printed Module 2 test papers for about 30 minutes, while the whole step lasted for 2 hours and consumed 576 sheets of paper. The SLSC employee moved from the department to the module 2 session location to deliver the session to the students. The 14th step took 15 minutes. Step 15 involved students attending module 2 and taking the quiz, which again lasted for 1.5 hours and ran for five days. In step 16, the SLSC employee collected the test papers and returned them to the department. The PT took 7 minutes, while the lead time lasted 15 minutes. The 17th step was where the SLSC employee marked module 2 tests for 15 minutes each, and the step lasted for five days. Similarly, in step 18, the SLSC employee entered students' grades in the database. It also lasted 10 minutes and five days for PT and LT, respectively.

In step 19, once module 2 was completed, the employee waited until the midterm exam period was over to start printing module 3 papers. This activity took 30 minutes and lasted ten days, consuming 576 sheets of paper. At the same time, in step 20, the SLSC employee checked the grade files and separated the completed module papers. The process took 1 hour, lasted five days, and consumed 1152 sheets of paper. It was followed by step 21, where the SLSC moved from the department location to the module 3 session location to deliver the session taking 15 minutes. The 22nd step

involved students attending module 3 and taking the quiz for 1.5 hours, which ran for five days.

Moreover, in step 23, the SLSC employee collected the test papers and carried them back to the department. It took him about 7 minutes, and the activity lasted 15 minutes. Again, step 24 involved the SLSC employee marking module 3 tests for 15 minutes per student, and the step ran for five days. In step 25, the SLSC employee entered students' grades in the database for 10 minutes while the activity lasted five days. The following step (26) involved printing module 4 test papers by the SLSC employee. The processing time for this was 10 minutes, lead time of 2 hours, while paper consumption amounted to 576 sheets of paper.

In step 27, the SLSC employee moved from the department location to the module 4 session location to deliver the session, which took him 15 minutes. Later in the next step, 28, the students attended module 4 and took the quiz for 1.5 hours, and the session ran for five days. Step 29 involved the SLSC collecting the test papers and carrying them to the department taking about 7 minutes, while the activity lasted for 15 minutes. In the 30th step, the SLSC employee marked module 4 tests with a processing time of 15 minutes and a lead time of 5 days. On the same note, step 31 involved the SLSC employee checking the grade files and separating the completed modules papers. The process took 1 hour, while the entire activity lasted five days. The total sheets of paper used totaled 1152. Step 32nd is where the SLSC employee shared the students' grades with the course instructor, which took a processing time of 2 minutes and lasted 5 minutes. The second last step was where the calculus instructor received the students' grades files and shared them on the math course blackboard. It took a processing time of 3 days, and the entire duration lasted 30 days. The last step of the BCP process was

where the students received their BCP grades. They could do this within 2 minutes for 40 days.

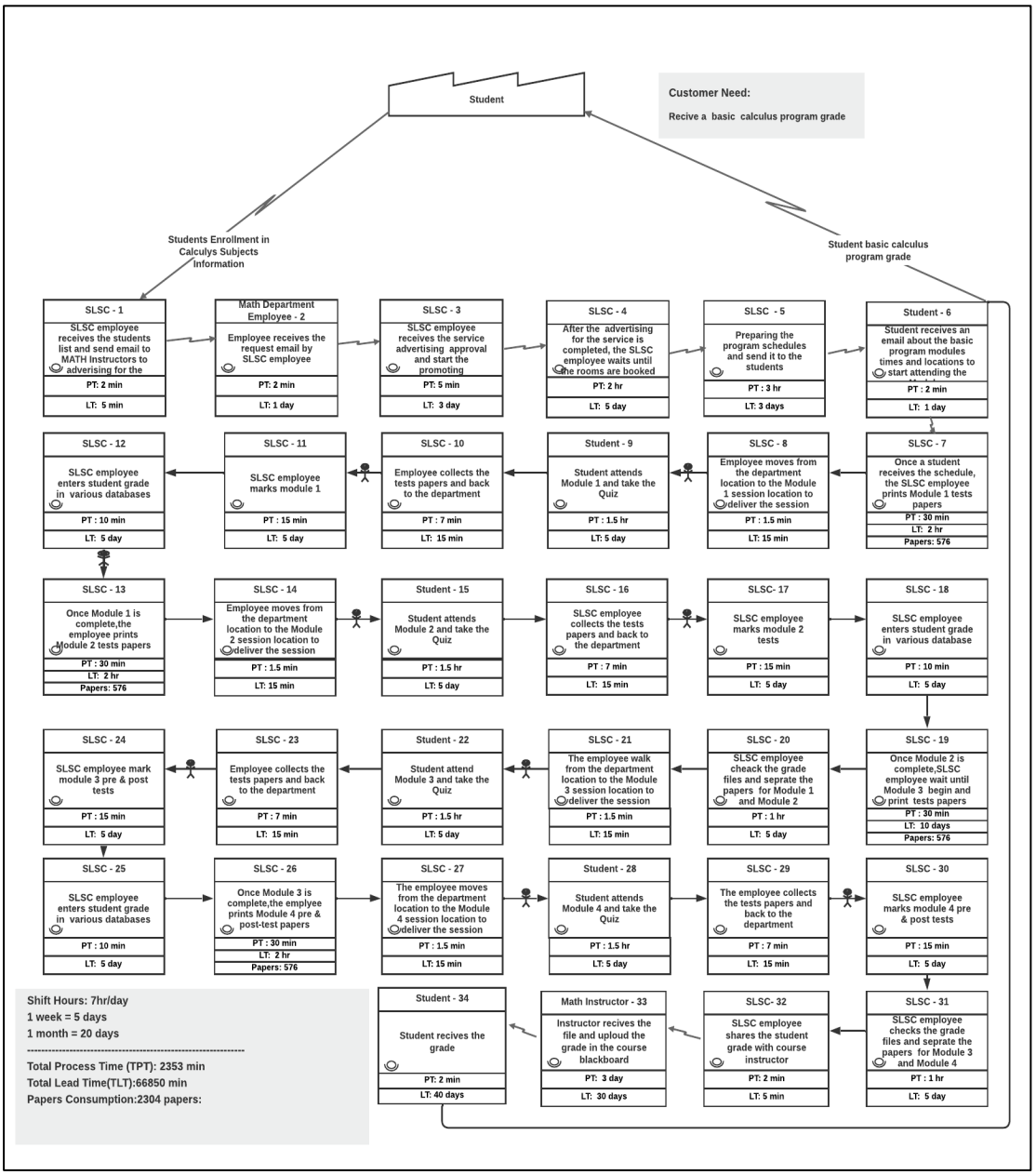

Figure 6. Previous Value Stream Map for Basic Calculus Program

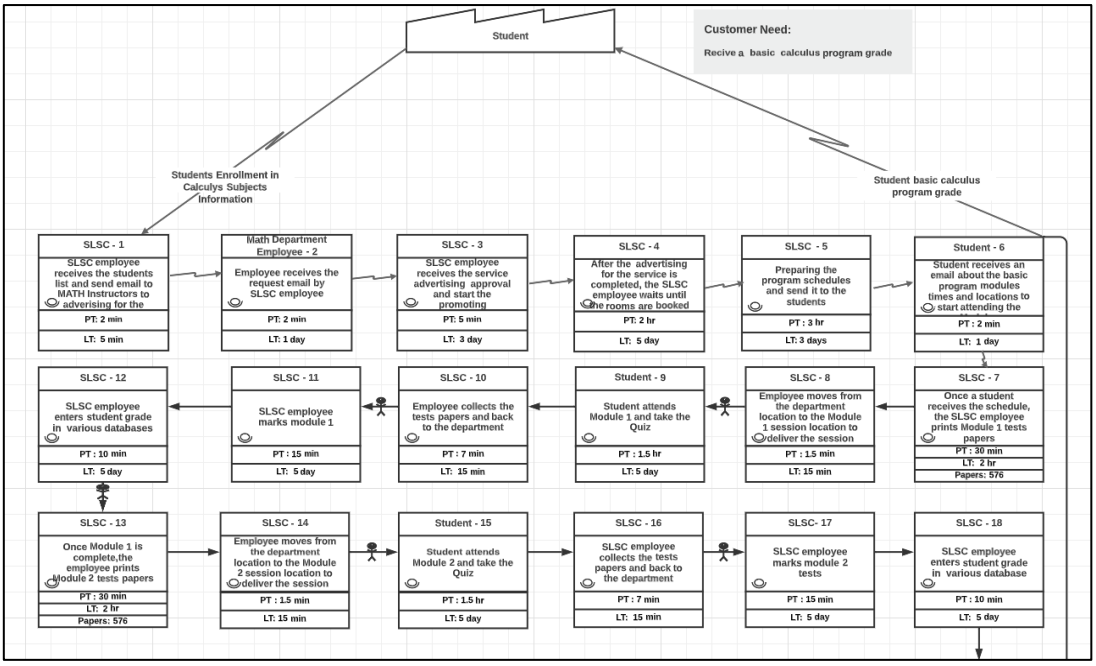

Figure 7. Previous Value Stream Map for Basic Calculus Program-Part 1

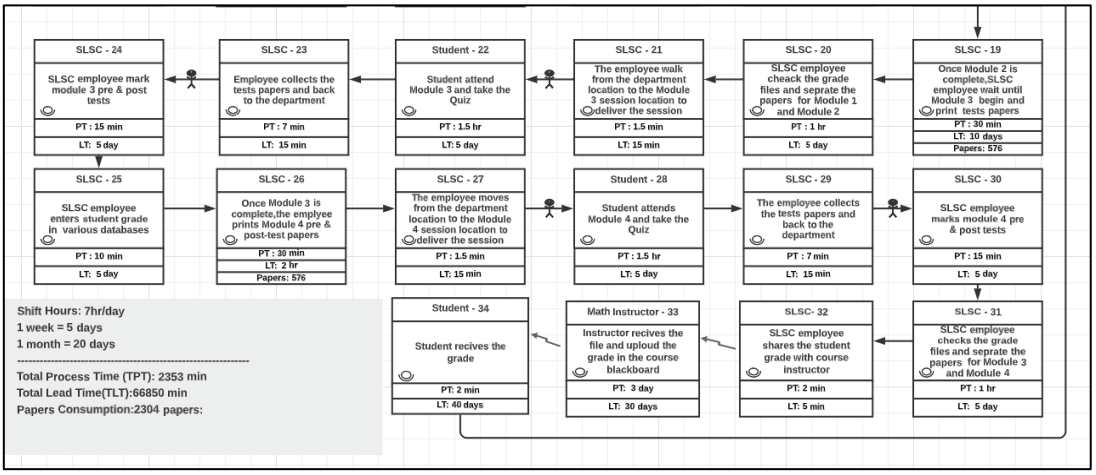

Figure 8. Previous Value Stream Map for Basic Calculus Program-Part 2

4.2.3 Identification of non-value-added Activities in the Value Stream Map for the previous state of the Basic Calculus Program. Wastes are typically inherent in every process; therefore, there is a need to continuously evaluate every step in the process to detect and identify any leakages or inefficiencies. Process wastes can be classified into various categories and forms, including transportation wastes, inventory,

movement, waiting, overproduction, over-processing, defects, and new human skills or resources in an organization. In value stream mapping, all non-value add activities are regarded as wastes. Non-value-add activities are those activities that the customers or end users are not ready to pay for as they do not consider them to add value to the final product or service directly.

All 34 steps involved in the BCP were evaluated to determine whether they were value-adding. In the previous state VSM map, all the activities and steps categorized as non-value adding were labeled and marked with Kaizen bursts. Kaizen is a Japanese term that means continual improvement. Therefore, a Kaizen burst is an iconic symbol used in a value stream map to denote an area with potential improvement opportunities.

After evaluating all 34 steps of the Basic Calculus Program, wastes and inefficiencies were detected in 16 steps. These steps were marked with Kaizen bursts to denote potential improvement areas where Kaizen projects would be implemented to reduce or eliminate the waste from the process. These included step 3 where SLSC employee received the service advertising approval; step 5 where SLSC prepared the program schedules and sent it to the students; step 7 whereby the employees printed module 1 tests papers after students had received the schedules; step 9 whereby students attended module 1 and took the quiz; step 11 which involved SLSC employee marking module 1 tests; step 12 whereby SLSC employee entered students grades in various databases; step 13 which involved the employee printing module 2 tests once module 1 was completed; step 15 where students attended module 2 and took the quiz; step 17 where SLSC employee marked module 2 tests; step 18 which involved SLSC employee entering student grades in databases; step 22 which entailed students attending module 3 and taking the quiz; step 24 whereby SLSC employee marked module 3 tests; step 25 where SLSC employee entered students grades databases; step 26 whereby employee

printed module 4 test papers once module 3 was completed; step 28 which involved students attending module 4 and taking the quiz; and lastly step 30 which involved SLSC employee marking module 4 tests. These wastes are summarized below:

i. Booking Rooms

The program schedules depended on the rooms' availability in the booking link. The lead time to finish this process was one week, while the processing time was 2 hr.

ii. Movement Motion of the Specialist

The module sessions were delivered in different locations at the university. Therefore, for each module's session, the SLSC employee needed to move from one building to another to deliver the session. The movement time was 15 min/per session.

iii. Marking Modules Tests

This activity came after delivering each module. It needed four employees to handle this task. Each student's papers required 15 min to be marked and five days as a lead time. In the total for the four modules, the processing time was: 1hr/ student while the total lead time was 8400 min/student.

iv. Documenting Students Grades

After marking the modules tests, the student's grades and student's information were entered into various databases manually. The processing time to finish this activity for the four modules was 100 min/per student within 40 days.

v. Students Grade Checking

After finishing the previous activity, another check-up was made for the grades database to avoid missing grades. It took 2 hours/per student for the four modules grades and ten days as a lead time. The number of data checked was 2304 grades with a usage of 4 employees.

vi. Sharing the Student Grades with the Instructor

After checking the files, an email was sent to each course lecturer. This activity consumed 2 minutes, and the lead time was 5 min.

vii. Uploading the Grades on Blackboard by the Instructor

SLSC employees performed all the previous tasks except for this activity. The subject's instructor did this task, and it took three days to upload the grades with a lead time of 30 days.

viii. Getting Access to the Grades

Although the whole process was made to let the student access their grade, this activity had the longest waiting time, 40 days.

ix. Papers Consumption

By the end of the service process, the SLSC employees printed out 2304 papers for different module tests.

The figure below shows the previous value stream map outlining steps with wastes and efficiencies as denoted by the Kaizen bursts.

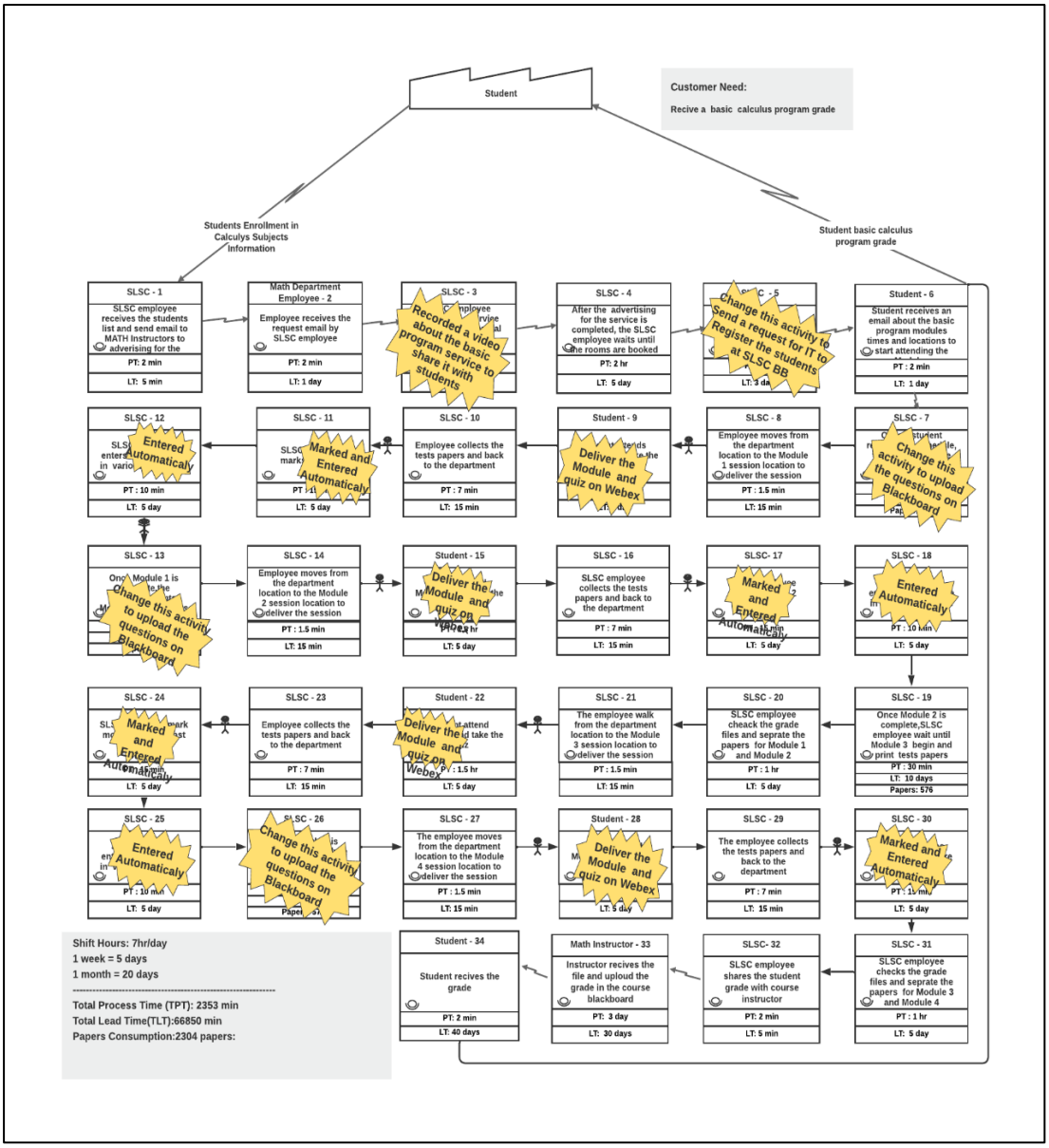

Figure 9. Previous Value Stream Map for Basic Calculus Program with Wastes inherent in the Process Steps

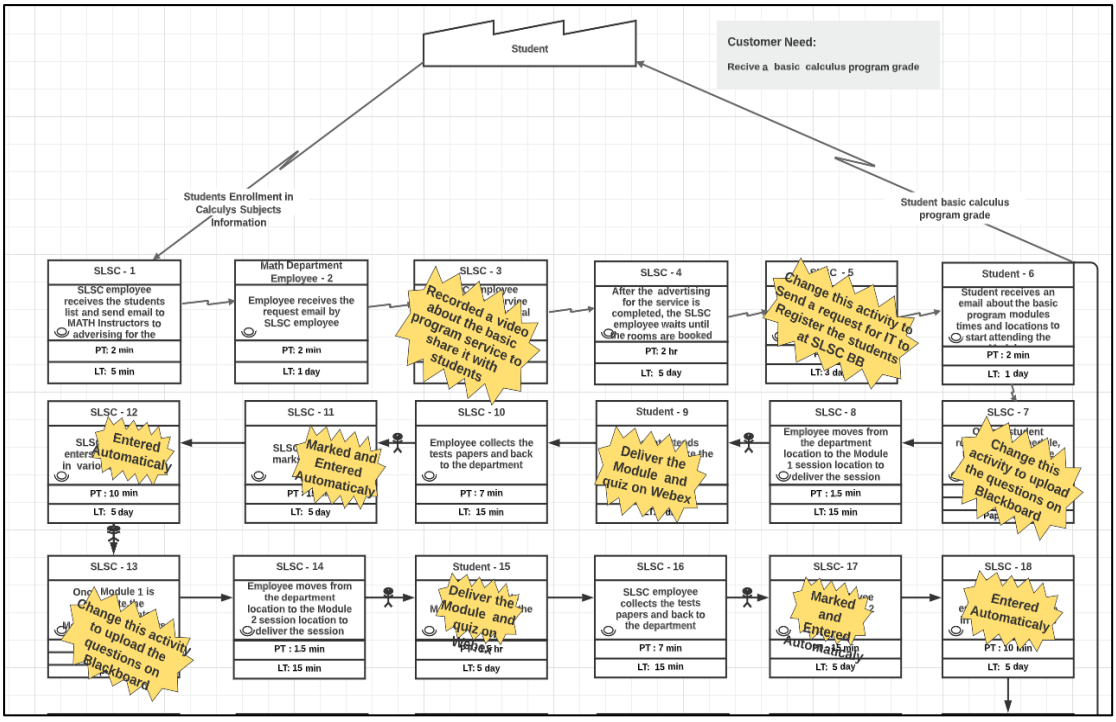

Figure 10. Previous Value Stream Map for Basic Calculus Program with Wastes inherent in the Process Steps – Part 1

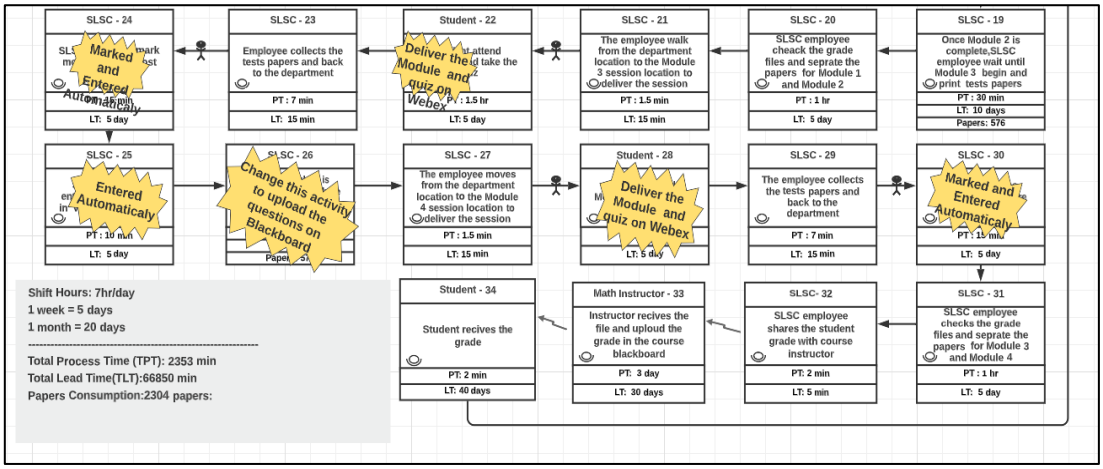

Figure 11. Previous Value Stream Map for Basic Calculus Program with Wastes inherent in the Process Steps – Part 2

4.2.4 Wastes in the Basic Calculus Program. All non-value-add activities in the process flow were regarded as wastes. However, it was important to note that some non-value add activities were necessary (for example, training of administrative staff

who offered the services). In contrast, other activities were unnecessary (for example, printing a document in color or producing several copies of the same document). All the 16 steps detected to generate wastes and inefficiencies along the BCP were classified as unnecessary non-value-add steps.

a) Paper Waste

In the program service, there was abnormal paper consumption. It affected other costs, such as workplace inventory, waste, inks, printers' electrical energy consumption, and purchasing costs. The main usage of the papers was for module tests plus the attendance sheets. This waste was eliminated by uploading the modules tests on an e-learning platform, and the students could access the platform and do the test.

b) Transportation and Motion Wastes

The module sessions were always conducted in different college buildings. The reason was that there were not enough rooms in the center to deliver the services, leading to motion waste. For each session, the employee moved from the office to the specified location, which consumed 30 min/per session. There were 10 hours wasted moving from place to place.

c) Waiting

Waiting for waste in the service process tasks were illustrated as the following: waiting for service advertising approval, waiting for the add and drop period to get over to receive the booking rooms link, waiting for the exam period to pass on to complete module 3 and module 4 in the program, waiting for the employee to finish entering the grades in different databases, waiting for the subject's instructors to upload the grades for the students.

d) Unnecessary Non-Value-Add Wastes

Marking the test papers and manually entering these grades was time-

consuming for the employees. Most of the time, those tasks interrupted the employees from completing other job responsibilities. It was eliminated from the process after automation. Also, the accumulated test papers that needed to be marked turned into another waste type which was work in process. Also, the employee's speed in marking these papers led to waste since employees performed the same task differently.

4.2.5 Improved Program Process. The goal of carrying out value stream mapping is to illustrate the previous state process by detecting and eliminating wastes and inefficiencies inherent in the processes. In this regard, necessary non-value-add activities were either reduced, simplified, or combined with increasing their efficiencies and reducing the magnitude of the losses. On the other hand, unnecessary non-value-add activities were eliminated from the process. Since all the identified wastes were unnecessary non-value-add steps, the appropriate action would be to eliminate them from the process and make the process leaner to achieve the current VSM map.

Furthermore, Distance Learning Platforms were used to improve the service. The mechanical redesign of the service used WebEx and Microsoft Teams to deliver modules. Besides these, the Qatar University blackboard was utilized to conduct the module tests.

The elimination of non-value-add steps improved the current service, the combination of some steps, and the automation of most steps of the Basic Calculus Program, as outlined below:

Step 3: Combined with step 4, recorded video to replace service advertising approval.

Step 4: Combined with step 3, recorded video to replace service advertising approval.

Step 5: Replaced with an automated version.

Step 7: Replaced with the automated version, use the Blackboard platform to upload questions.

Step 8: Eliminated.

Step 9: Replaced with an automated version, delivered on the WebEx platform.

Step 10: Eliminated.

Step 11: Replaced with automated version, marked automatically on the blackboard platform.

Step 12: Replaced with automated version.

Step 13: Replaced with the automated version, use the Blackboard platform to upload questions.

Step 14: Eliminated.

Step 15: Replaced with an automated version, delivered on the WebEx platform.

Step 16: Eliminated.

Step 17: Replaced with automated version, marked automatically on the blackboard platform.

Step 18: Replaced with automated version, entered into the central database automatically by linking the Excel sheet uploaded from Blackboard to the main database system.

Step 19: Eliminated.

Step 20: Eliminated.

Step 21: Eliminated.

Step 22: Replaced with an automated version, delivered on the WebEx platform.

Step 23: Eliminated.

Step 24: Replaced with automated version, marked automatically on the blackboard platform.

Step 25: Replaced with automated version, entered the central database automatically by linking the Excel sheet uploaded from Blackboard to the main database system.

Step 26: Replaced with the automated version and used the Blackboard platform to upload questions.

Step 27: Eliminated.

Step 28: Automated version and delivered on the WebEx platform.

Step 29: Eliminated.

Step 30: Replaced with automated version, marked automatically on the blackboard platform.

Step 31: Eliminated.

The table below shows the improvement program used to achieve the current state of the BCP.

Table 1. Improvement Program

Step No.	Previous Condition	Action	The person doing the Action	Duration	Status of Action	Current Condition
3	SLSC employees receive the service advertising approval and start the service promoting	Recorded a video about the basic calculus program service to share it with students	SLSC	Two weeks	Closed	Step Automated
5	Preparing the program schedules and sending them to the students to register for the program	IT registers the student automatically on the Center's blackboard	IT Department	Two days	Closed	Step Automated

Table 1. Improvement program (table continued from previous page)

Step No.	Previous Condition	Action	The person doing the Action	Duration	Status of Action	Current Condition
7	Once a student receives the schedule, the SLSC employee prints module 1 test papers.	Change this activity to upload the questions on Blackboard	SLSC	One week	Closed	Step Eliminated
9	Students attend module 1 and take the quiz	Deliver the module session and quiz on WebEx	SLSC	Three days	Closed	Step Automated
11	SLSC employees mark module 1 tests	Marked and entered Automatically	Blackboard Platform	One day	Closed	Step Automated
12	SLSC employees enter student grades into various database	Entered automatically	SLSC	One day	Closed	Step Automated
13	Once module 1 is complete, the SLSC employees print module 2 test papers	Change this activity to upload the questions on Blackboard	SLSC	Two weeks	Closed	Step Eliminated
15	Students attend module 2 and take the quiz	Deliver the module session and quiz on WebEx	SLSC	Three days	Closed	Step Automated
17	SLSC employee marks module 2 tests	Marked and entered automatically	Blackboard Platform	One day	Closed	Step Automated
18	SLSC employees enter student grades into various database	Entered automatically	SLSC	One day	Closed	Step Automated
22	Students attend module 3 and take the quiz	Deliver the module session and quiz on WebEx	SLSC	Three days	Closed	Step Eliminated
24	SLSC employee marks module 3 tests	Marked and entered automatically	Blackboard Platform	One day	Closed	Step Automated
25	SLSC employees enter student grades into various database	Entered automatically	SLSC	One day	Closed	Step Automated
26	Once module 3 is complete, the SLSC employees print module 4 test papers	Change this activity to upload the questions on Blackboard	SLSC	Two weeks	Closed	Step Eliminated
28	Students attend module 4 and take the quiz	Deliver the module session and quiz on WebEx	SLSC	Three days	Closed	Step Automated
30	SLSC employee marks module 4 tests	Marked and entered automatically	Blackboard Platform	One day	Closed	Step Automated

4.2.6 Value stream map for the current state of Basic Calculus Program after Implementation of Value Stream Mapping. After implementing the improvement program, the 22 unnecessary non-value-add activities were eliminated from the BCP process. A new value stream map (current condition) was drawn to display the new lean process map. The current VSM was designed to have 12 necessary steps that were value-adding to the BCP, as outlined below:

Step 1: SLSC employees received the students' list and emailed the Math Department to do the service advertising.

Step 2: The math department received a video explaining the basic calculus program concept to share with the student in the class.

Step 3: SLSC employee uploaded test questions on the blackboard.

Step 4: Prepared the program schedules with session links and sent them to the students.

Step 5: SLSC requested the IT department automatically register the student on the SLSC blackboard.

Step 6: Students received an email about the basic calculus program modules' times and sessions' links to start attending the modules.

Step 7: The students attended a Demo Session, and the SLSC employee guided the student to prevent any technical issue that could occur in the future.

Step 8: Students attended module 1 remotely. The SLSC employee delivered the session, and the student took the quiz during the session and received the module grade.

Step 9: Students attended module 2 remotely. The SLSC employee delivered the session, and the student took the quiz during the session and received the module grade.

Step 10: Students attended module 3 remotely. The SLSC employee delivered the

session, and the students took the quiz during the session and received the module grades.

Step 11: Students attended module 4 remotely. The SLSC employee delivered the session, and the students took the quiz during the session and received the module grades.

Step 12: Students received the basic calculus program grades on the blackboard.

The figure below represents the current Value Stream Mapping after the execution of the preceding modifications to the previous VSM.

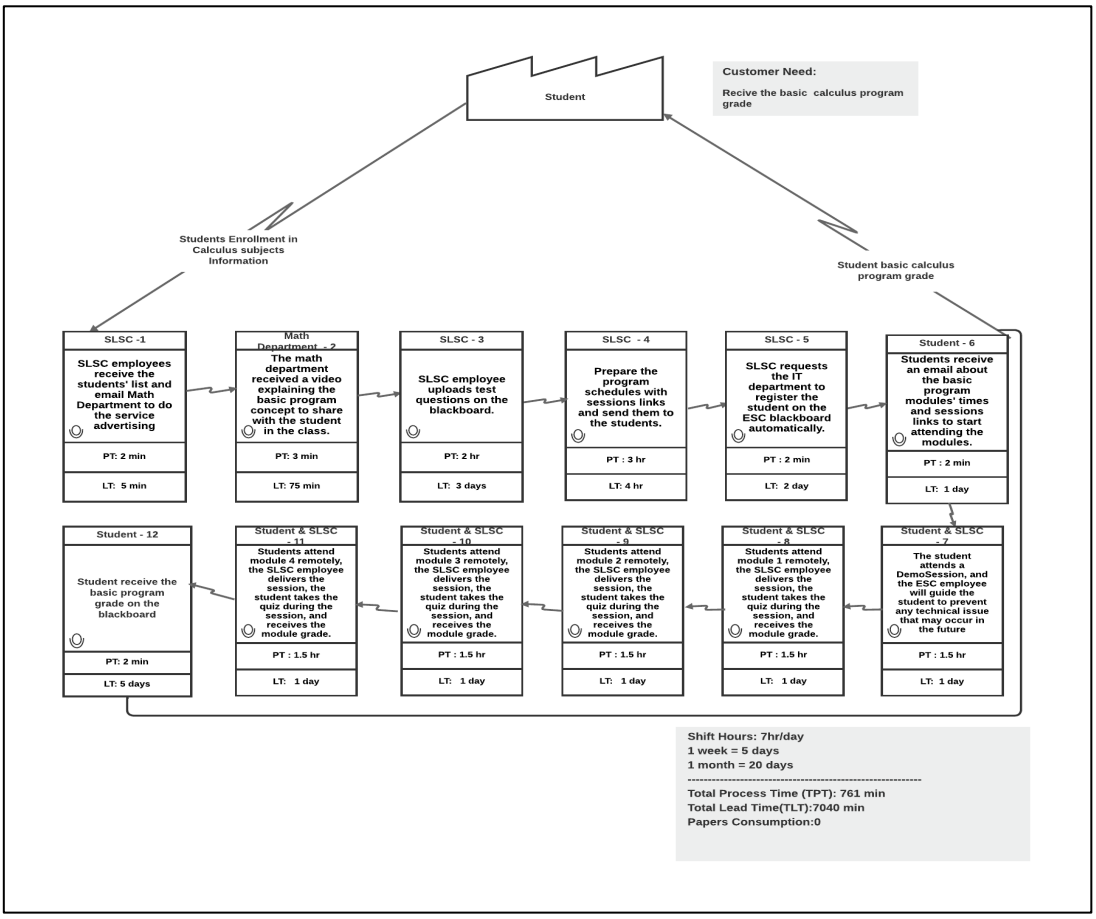

Figure 12. Value Stream Map for Current Automated State of Basic Calculus Program

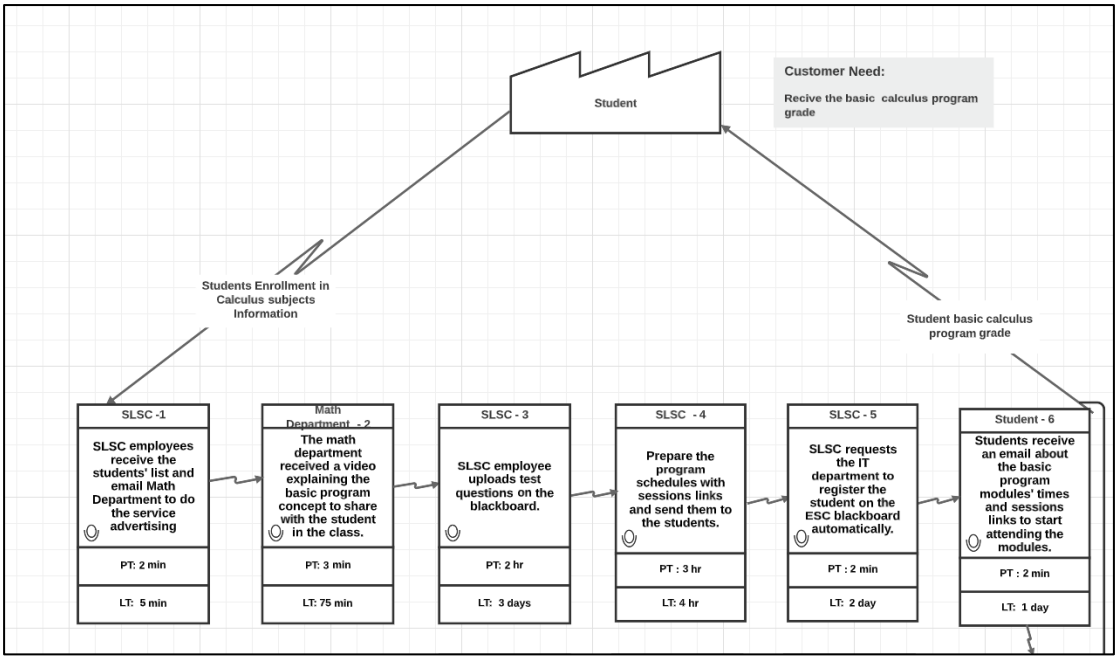

Figure 13. Value Stream Map for Current Automated State of Basic Calculus Program – Part 1

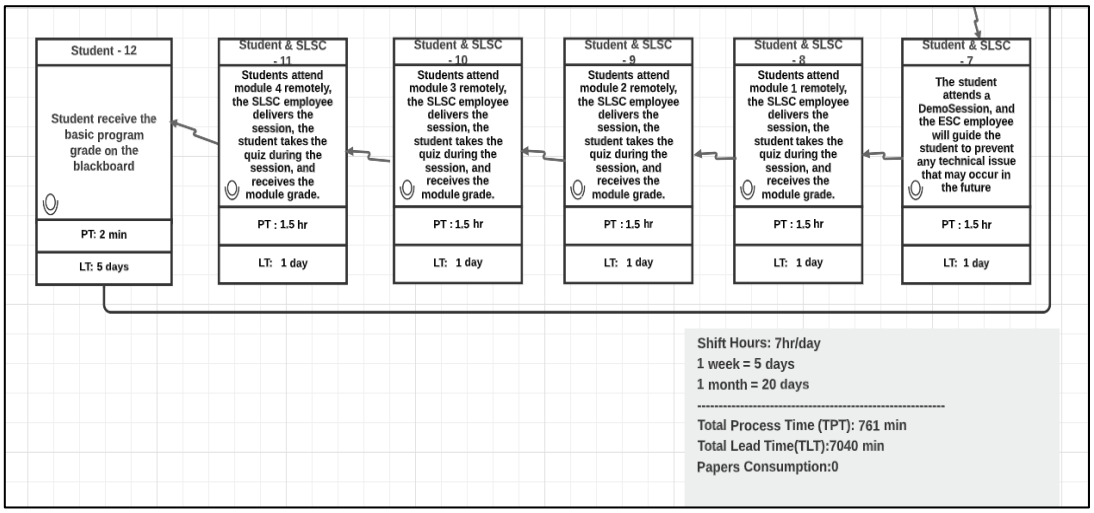

Figure 14. Value Stream Map for Current Automated State of Basic Calculus Program – Part 2

4.2.7 Comparison of Previous versus Current Processes States for Basic Calculus Program

Table 2 below compares previous versus current process states for Basic Calculus Program.

Table 2. Previous Service State Vs. Current Service State Comparisons

Performance Metric	Previous VSM	Current VSM	% Improvements
Process Time (minutes)	2353	761	67.7%
Lead Time (minutes)	66850	7040	89.5%
Papers Consumption	2304	0	100%

The total process time for the previous VSM state was 2353 minutes, while the entire process time for the current VSM state was 761 minutes. It showed a 67.7% improvement in processing time due to the automated service delivery method. It was achieved by eliminating waste and inefficiencies along the Basic Calculus Program, most of which were achieved through automation. It led to a saving of 1592 minutes (3.79 days). Likewise, the total lead time for the BCP was reduced from 66,850 minutes to 7,040 minutes in the previous and current VSMs, respectively. It translated to an improvement of 89.5% in total lead time. Additionally, there was a complete elimination of paperwork by 100%, from 2,304 sheets of paper to zero, in the entire BCP process.

The significant reduction in lead time was attributed to the elimination of the numerous waiting times inherent in the process steps. Furthermore, after the improvements, students received their final grades within five days instead of 40 days. The result demonstrated the effectiveness of value stream mapping in improving the Basic

Calculus Program and the efficiency of workers in the department.

4.2.8 Further Improvement on the Current VSM by Enhancing the Employee Service Time.

4.2.8.1 Semester of Fall 2021. All the improvements made from the previous VSM to the current VSM were implemented during the Fall 2021 semester. In the Fall of 2021, the employee responsible for delivering this service initially worked 6 hours a day, where he entirely dedicated himself to basic calculus program service. The long duration of delivery of this service, in turn, affected the timely execution of other tasks; hence, subsequent tasks ended up with significant delays. The figure below shows the automated process's VSM of employee service time (Fall 2021).

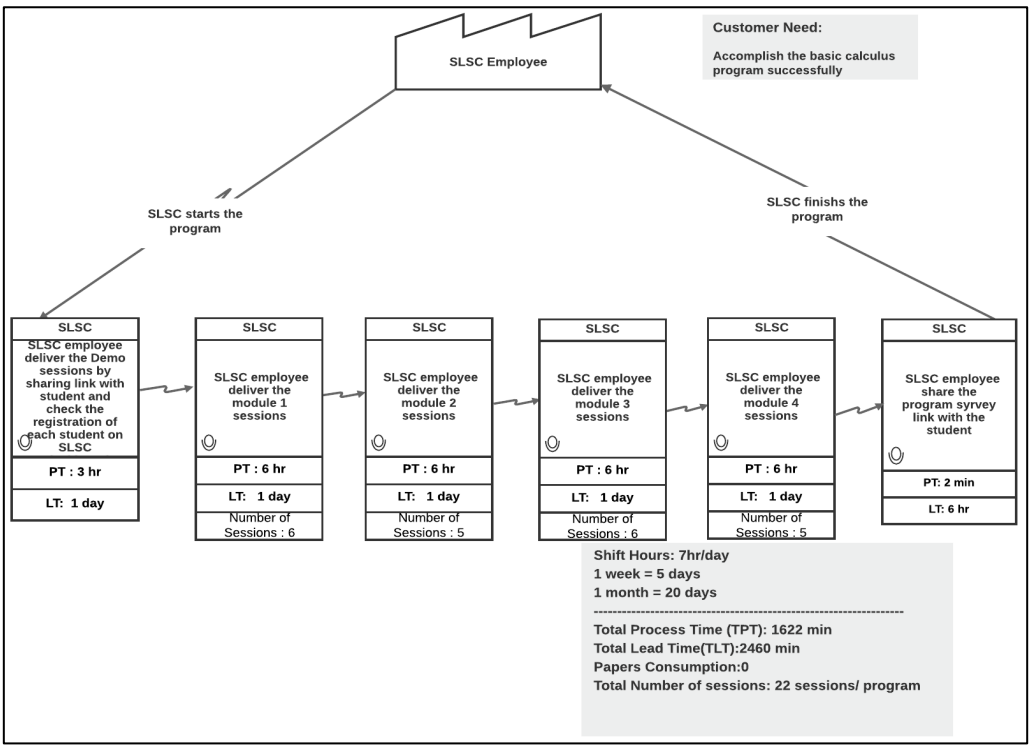

Figure 15. Value Stream Mapping of Employee Service Time for the Automated Process (Fall 2021)

4.2.8.2 Semester of Fall 2022. The lean concept depends on continuous

improvement. Further enhancements were made to the automated service (Fall 2021) by reducing the number of sessions per module to increase the effectiveness of employee services. It was achieved by changing the platform service from WebEx to Microsoft Office to improve the accuracy of student time attendance, duration spent in the sessions, and student number attendance for the center records. In addition, choosing the module sessions' delivery times to be within the times the students could attend the program, such as evening times. The improvements had a significant impact on reducing the time spent by each worker on their service deliveries in the Fall of 2022. In this case, the employee responsible for delivering this service could work on and complete the delivery for only 3 hours per day, allowing adequate time to support the execution of other tasks. After the enhancement, the figure below shows the Value Stream Mapping of employee service time for the automated process (Fall 2022).

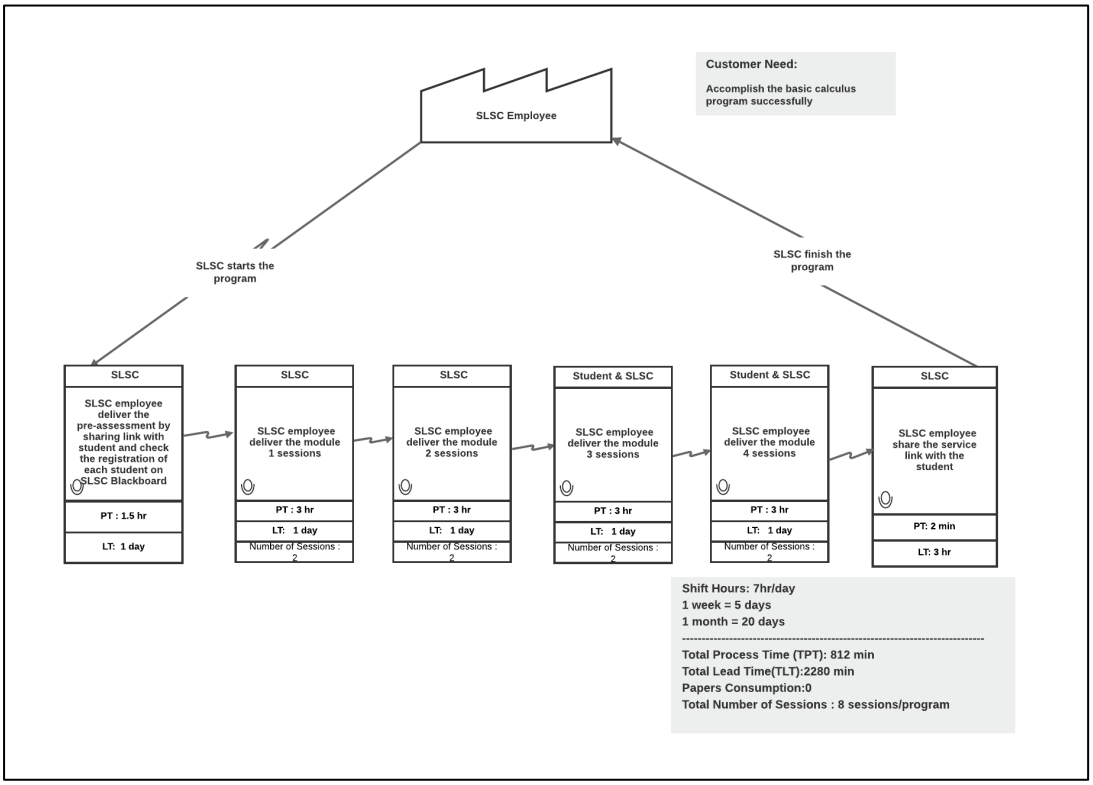

Figure 16. Value Stream Mapping of Employee Service Time for the Automated Process (Fall 2022)

4.2.8.3 Modules Reduction. The table below summarizes the BCP during the Fall 2021 semester and Fall 2021. The service was divided into four modules in Fall 2021, each with four to seven sessions. Each session lasted 1 to 1.5 hours, and 22 sessions were available weekly throughout all four modules. The overall number of sessions daily was between 6 and 7 hours, and two people handled the service. Table 3 below outlines information related to BCP Service in Fall 2021.

Table 3. Represents Information Related to BCP Service Fall 2021

Semester	Number of Modules	Number of Sessions per Module	Session Duration	Number of Workers per Module
Fall 2021	4 Modules	5 to 6 sessions	1 hour	2
Total	4 Modules/week	22 sessions /week	6 hours	2

The Basic Calculus Program offered during Fall 2022 is detailed in the table below. The service was divided into five modules, the first of which had two 1.5-hour sessions that comprised the whole first module. One worker would be allocated to each of the two programs providing the service, and the total number of sessions per day for the Fall 2022 service would be 15 hours. The Fall 2022 service only featured two employees, compared to Fall 2021, which had two workers per module with the same number of sessions and session length. Table 4 below outlines information related to BCP Service in Fall 2022.

Table 4. Represents Information Related to Basic Calculus Program Service in Fall 2022

Semester	Number of Modules	Number of Sessions per Module	Session Duration	Number of Workers per Module
Fall 2022	5 Modules	2 Session	1.5 hours	One worker for each program
Total	Five modules / six days	Ten sessions / six days	3 hours	1worker

4.2.8.4 Comparison for Fall 2021 versus Fall 2022.

i. Employee Service Lead Time and Process Time

Both lead times and process times were compared to determine the level of improvement brought about by the enhancement made in Fall 2022 versus Fall 2021 from an increasing worker efficiency perspective. Table 5 below shows the process of employee service time for Fall 2021 vs. Fall 2022.

Table 5. Employee Service time of Fall 2021 vs. Fall 2022

Performance Metric	Fall 2021 VSM	Fall 2022 VSM	% Improvements
Process Time (minutes)	1622	812	50.1%
Lead Time (minutes)	2460	2280	7.3%

The table above demonstrated that further improvement by reducing the number of sessions per module from 6 sessions to 2 sessions per module improved the total employee process time by 50%. The significant reduction in processing time resulted

from changing and adjusting the delivery service times of the sessions to the evening period when the students had adequate free time away from lectures.

ii. Number of Sessions

Table 6 below shows the number of module sessions in Fall 2021 vs. Fall 2022.

Table 6. Number of Modules Sessions Fall 2021 vs. Fall 2022

Performance Metric	Fall 2021 VSM	Fall 2022 VSM	% Improvements
Number of sessions (Sessions)	22	8	63.6 %

iii. Number of Students Attended the Program vs. Number of Registered Students in Related Calculus Courses

To validate the reduction in service delivery time, the number of students who attended Fall 2021 was 66%, while it rose to 82% in Fall 2022 after the reduction. It was an indicator that service efficiency had improved. Table 7 below shows the number of attended and registered students in the Fall 2021 vs. Fall 2022 Semesters.

Table 7. Number of Attended and Registered Students in Fall 2021 vs. Fall 2022 Semester

Semester	Fall 2021	Fall 2022
Number of attended students to BCP.	951	1407
Number of registered students in calculus courses related to BCP	1437	1723

4.2.9 Survey Results. A survey was conducted to establish the student's satisfaction level with the quality of service provided. The survey areas included the ability of SLSC employees to manage and handle the service process and the SLSC employee capability to explain the mathematics topics to the student. The responses were collected from a sample size of 482 in Fall 2021 and 572 in Fall 2022.

4.2.9.1 Knowledgeability of the SLSC in delivering the program in Fall 2021 and 2022. The delivery of BCP by SLSC employees in Fall 2021 and 2022 varied. During the survey, the participants illustrated their satisfaction and confidence in learning mathematics topics in the program before and after the process improvement technique. It is presented in Table 8 below:

Table 8. Knowledgeability of the SLSC Employee in Delivering the Program in Fall 2021 and 2022

Fall 2021	Fall 2022
From the sample size of 482, 77.26% strongly agreed that the delivery of the program was perfectly done, with 21.18% agreeing to the same. Hence, 98.44% agreed that the delivery and preparation of the content was well done. However, only 0.31% somehow agreed, 0.61% disagreed, and 0.61% strongly disagreed.	From the sample size of 572, 76.38% strongly agreed that the delivery of the program was perfectly done, with 21.26% agreeing with the same. Hence, 97.64% agreed that the delivery and preparation of the content was well done. However, only 2.1% somehow agreed, and 0.26% disagreed.

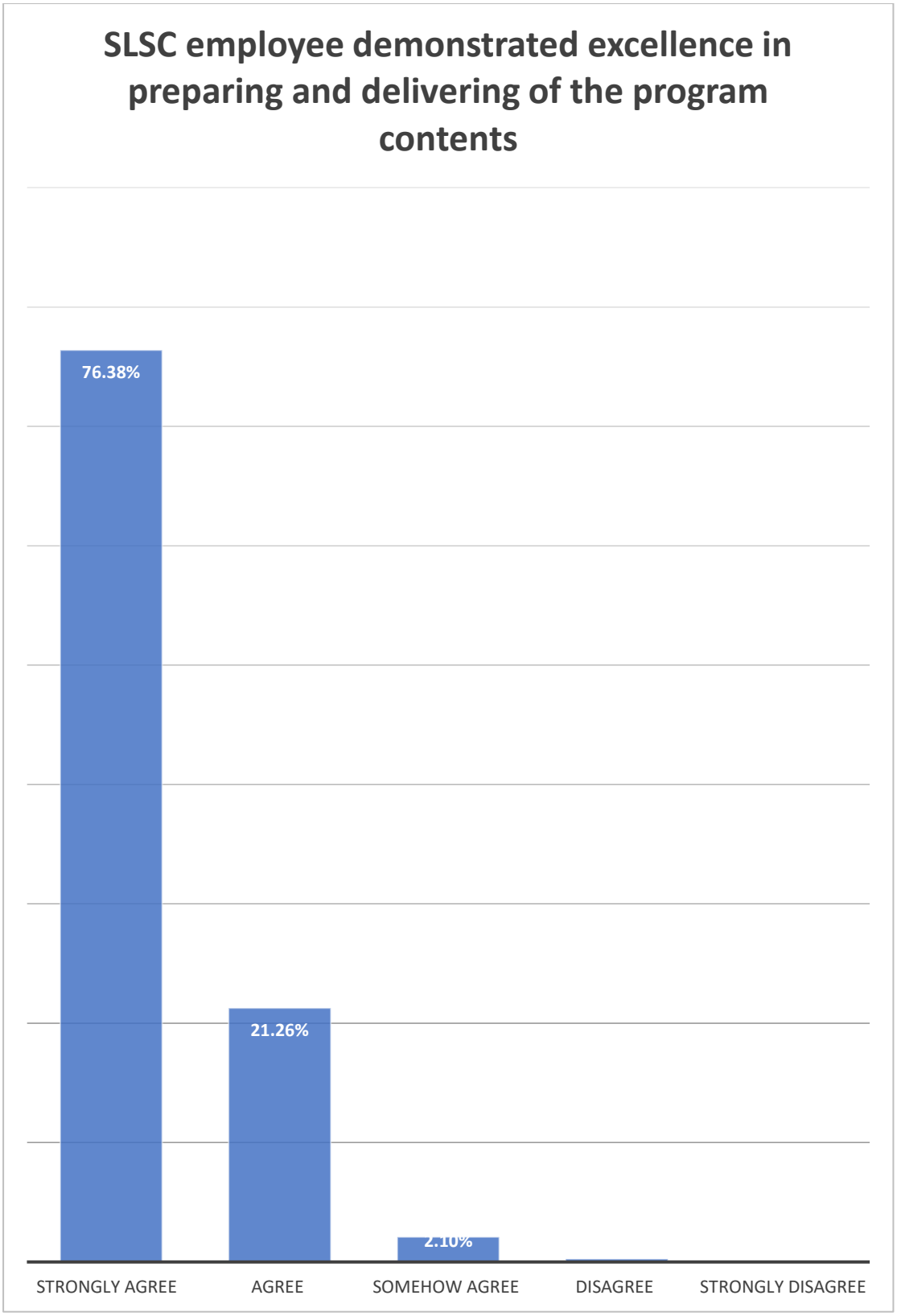

Figure 17. Graph Showing the Quality of Handling of Basic Calculus Program Contents (Fall 2022)

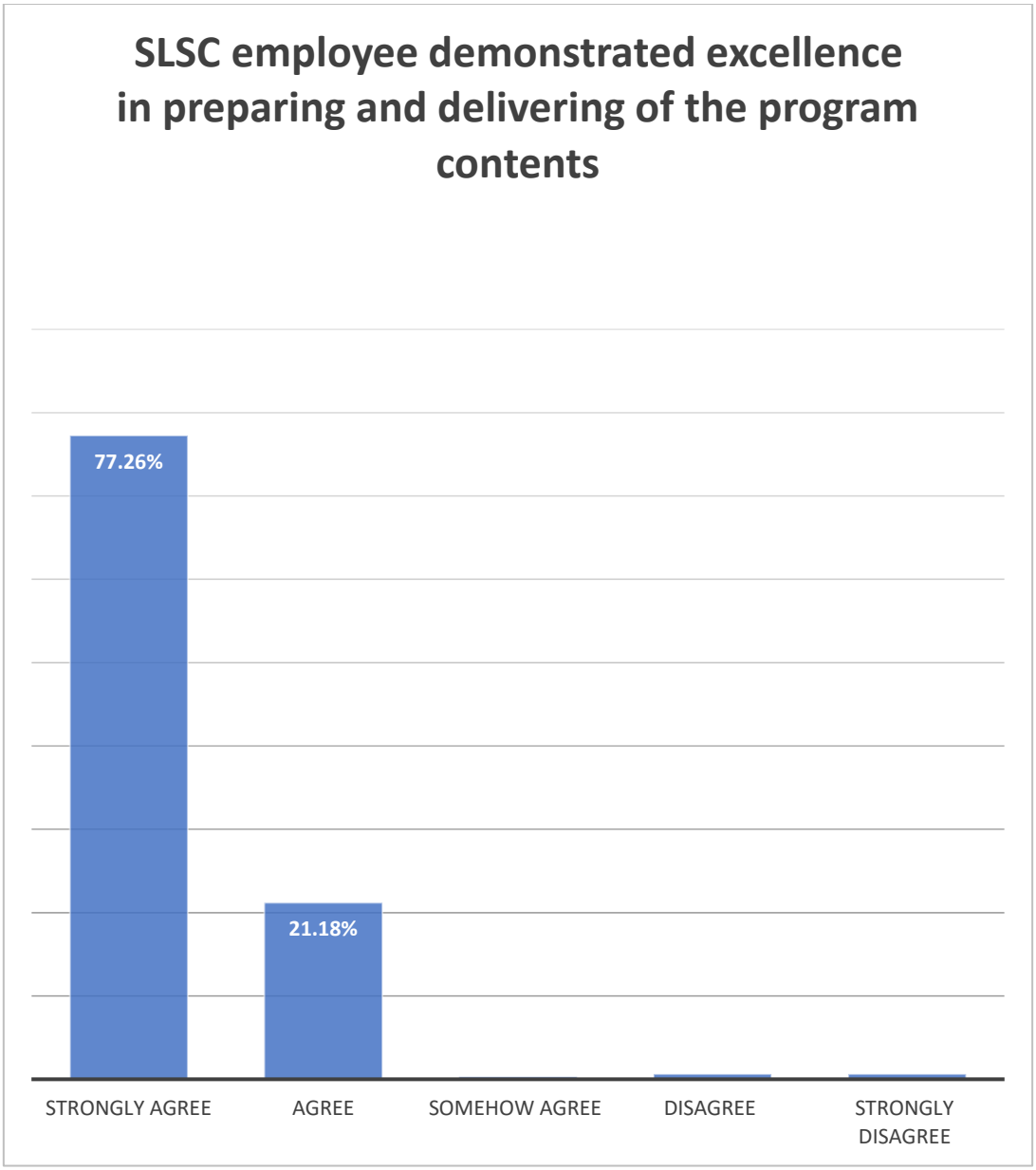

Figure 18. Graph Showing the Quality of Handling of Basic Calculus Program Contents (Fall 2021)

4.2.9.2 The Efficiency of the SLSC Employee in Math Topic Explanation

Notably, from the questionnaire responses, straightforward instruction in understanding BCP indicated learner satisfaction. These variables showed the productivity of the lean system. Table 9 below shows the questionnaire response between Fall 2021 and Fall 2022:

Table 9. The Efficiency of the SLSC Employee in Math Topic Explanation

Fall 2021	Fall 2022
From the data collected, 75.39% strongly agreed to receive clear instructions, while 22.74% agreed. However, only 1.56% somehow agreed. There were 1% who strongly disagreed, and 0% disagreed.	From the data collected, 80% strongly agreed to receive clear instructions, while 17% agreed. However, only 3% somehow agreed. There was 0% disagreement with receiving clear instructions.

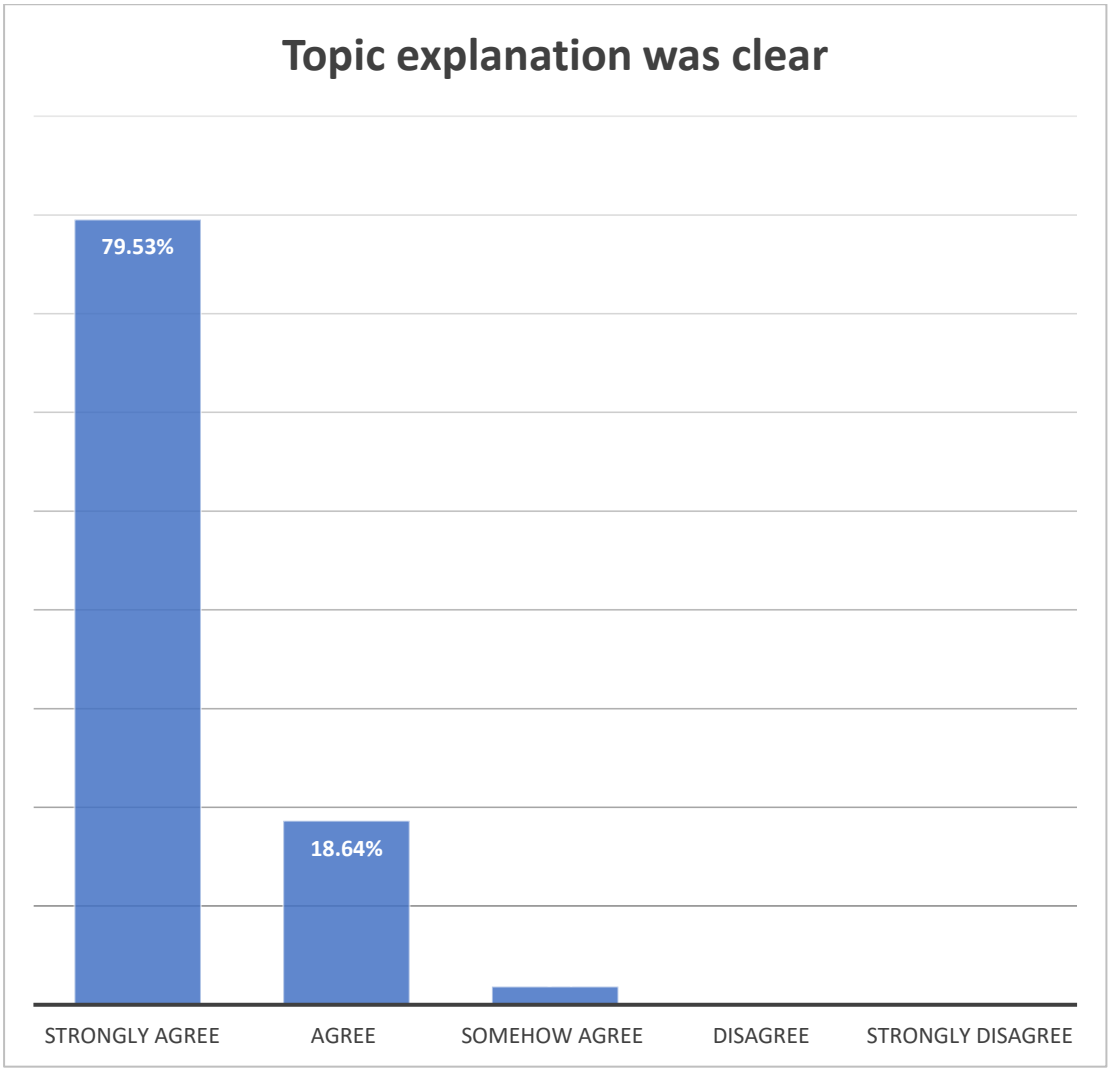

Figure 19. Graph Showing the Students' Satisfaction on Receiving a Clear Explanation on the Basic Calculus Program(Fall 2022)

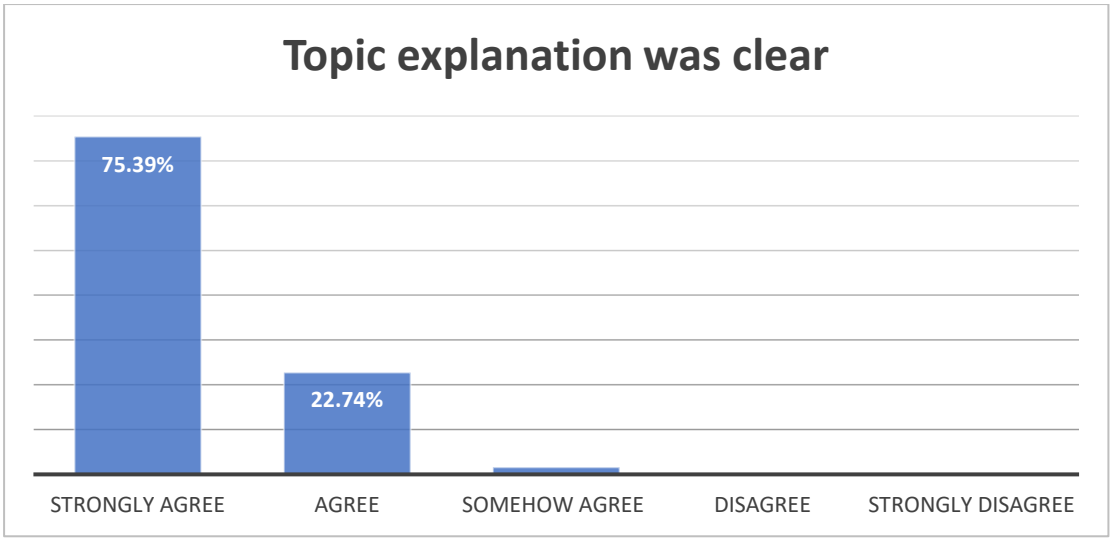

Figure 20. Graph Showing the Students' Satisfaction on Receiving a Clear Explanation on the Basic Calculus Program(Fall 2022)

***4.2.9.3 SLSC* Survey.** SLSC built the questionnaire, and the survey questions focus on many service aspects. The selected questions for the study purpose are shown in Appendix B. These displayed questions were the only ones focused on the service quality from the explanation part and how SLSC employees handled the session well during modules sessions. The results of those questions can be related to measuring the end customer's satisfaction level, which is the students here. The questions can be asked based on the need of the researcher to study the quality of the educational service.

4.3 Discussion for Fall 2022 Delivery Service Process Results and Findings

In the previous section, the data visualization showed the correlation between the new lean system in teaching mathematics topics and student satisfaction. However, further enhancement led to a reduction in the number of working hours and the ability to increase services from 4 modules to 5 modules.

4.3.1 Raise of Students' Attendance Vs. Students Registered. The rise in the total number of students who attended the program in the Fall of 2022 demonstrated that the decrease in sessions had no adverse effect on student attendance (Aslam et al.,

2020). Additionally, the reduced number of employees required to run the program in the Fall of 2022 implied that the new method was more efficient in resource utilization. It required fewer people to handle the same number of sessions at the same length. It indicated that the service delivered the same level of instruction and support to students with fewer resources, which was a sign of effective process improvement (Bortolini et al., 2021). It may have contributed to the rise in attendance since students might have attended classes that matched their schedules. Regarding student attendance and resource usage, the results of the module reduction indicated that the new process improvement was effective. Attendance increased, and worker demand decreased, indicating that the new method effectively accomplished its objectives.

4.3.2 Effectiveness of Mathematics Program Delivery Process. The study's results showed that the changes made to the service improved the efficiency of BCP. The fact that the students thought their professors were good at teaching them about the subject showed how important it was for educational programs to be well-prepared (Kazancoglu & Ozkan-Ozen, 2019). Excellent teaching is critical to the success of the students. It underscored how important it was for SLSC employees to have a clear understanding of the concepts that were taught in the mathematics curriculum and the ability to teach those concepts to students in an effective way. The high level of confidence of students towards the program and content delivery by SLSC employees showed that the new system improved teaching preparation and delivery and increased the number of modules from 4 to 5.

4.3.3 System Change Effect on Worker Efficiency. The data gathered in the Fall of 2021, and the Fall of 2022 demonstrated that installing the lean system had significantly improved the tutoring program. These changes were made evident by the statistics gathered. Most students agreed they should get clear instructions and benefit

from participating in the program. According to Ruano et al. (2019), the planning and execution of the lean process include a myriad of tools and methods needed to develop and simulate the learning environment. In addition, the fact that the program received many recommendations in both years provided further evidence that adopting the lean system did not negatively affect the program's quality. These findings provide evidence that the lean approach successfully boosts the efficiency of tutoring programs and the levels of satisfaction experienced by students. As a result, it is strongly suggested that other tutoring programs investigate the possibility of adopting the lean approach to reach the same level of success.

4.3.4 Student Satisfaction and Worker Efficiency. The outcome of the survey showed that students were generally happy and approved of the changes that were made. They were satisfied with the new way of doing things as far as running the Basic Calculus Program was concerned.

It was essential to provide students with directions that were easy to follow to ensure that they comprehended the material being taught. Students had a greater chance of better understanding and remembering the material when given clear instructions. It led to increased performance and success rates. It suggested that the lean process improvement introduced in the Fall of 2022 resulted in more precise instructions, which led to higher levels of satisfaction and confidence experienced by the students participating in the calculus program.

4.4 Summary of Results and Findings

Before COVID-19 and before the implementation of the lean management tool (VSM), there were 34 steps involved in the entire process of BCP, from the time students applied to undertake the program to when they received BCP grades. At the end of the improvement program, these were reduced to 12 steps through automation.

The total duration of processing activities in every step, referred to in this study as "total process time" (TPT), was 2,353 minutes. The period required by a student to go through the entire program from the time of application to receiving grades referred to as the "total lead time" (TLT), took 66850 minutes (1,114 hours, equivalent to 46.42 days). The assumptions made in the calculations included five working days at Qatar University, with 7 hours of work per day and 20 working days per month, exclusive of weekend days.

Additionally, the total amount of paper consumed for the entire program was 2304. After automating the BCP service, further improvement was established by reducing the sessions provided for each module to improve the workers' efficiency. This reduction was validated by the 50% saving in employee service time and the 98% level of student satisfaction.

4.5 Recommendations for Further Improvements

The spirit of continual improvement indicates that once an improvement has been realized and sustained, audits should be frequently conducted to identify further improvement opportunities. Even though positive improvements and further enhancements had been achieved that made the Basic Calculus Program more efficient, there were still additional opportunities for improvement that the Center could undertake.

i. Implementation of module 5 after the midterm exams

It was intended to give students a chance to earn grades if they did not perform well in exams.

ii. Combining the modules that contain similar topics in one session

It was intended to enhance the lead time of the services offered, thereby improving efficiency.

iii. Increase the number of modules up to 6 modules

It would help cover more topics related to mathematics courses and help the students increase their understanding of the basic requirements for most of the lessons.

iv. Replication of the improvement program and its learnings

Replicating the improvements to other programs within the department and other departments within the University of Qatar would save the institution significant time and resources from doing similar projects right from the beginning. In other words, the results found in this study could be applied to similar services provided by different departments at the university. The results show that the students prefer distance learning methods, mainly if the educational service provides known knowledge from the high schools or basic topics that the students are familiar with and need refreshment. Transferring all similar services to BCP in the same automated service state is possible. In that case, the university will increase the efficiency of most educational services, especially the foundation program. It can be conducted through a study of possible services that can be performed remotely without affecting the benefits that could be achieved by the students from this service by using the most suitable times for the students compared to their main subject schedules to deliver the required service, and by providing the necessary facilities to conduct services professionally based on the department and student needs.

CHAPTER 5: CONCLUSION AND SUGGESTIONS FOR FUTURE STUDIES

5.1 Conclusion

The primary value of implementing these value stream maps is to give the service's end users, the students in this situation, a unique experience that provides them with the required knowledge most efficiently. Implementing the skeletal system had a good influence on the efficiency and efficacy of the mathematics program. It was because the lean system prioritized eliminating waste. The decrease in module sessions did not impact attendance, and the newly implemented procedure was more resource-efficient. Because of the improvements made to the way the program was offered and the adjustments made to the program delivery, such as lowering the number of hours taught each day and raising the total number of modules, the level of student satisfaction and confidence was high. Increased satisfaction and confidence were the direct results of the clear instructions supplied by the lean system, which led to improved performance and success rates. The high referral rate provided strong evidence that the lean approach was effective in enhancing both the productivity of tutoring programs and the degree of satisfaction experienced by students. As a result, it was strongly suggested that other tutoring programs investigate the possibility of adopting the lean approach to reach the same level of success.

5.2 Future Studies

Future studies could focus on the impact of other tasks that could be conducted while this service was implemented. Secondly, future studies could focus on leveraging other lean management tools to optimize the efficiency of the Basic Calculus Program and other departments within Qatar University. In addition, the survey questions could be enhanced to include further deep questions to understand the students' requirements and improve their satisfaction level.

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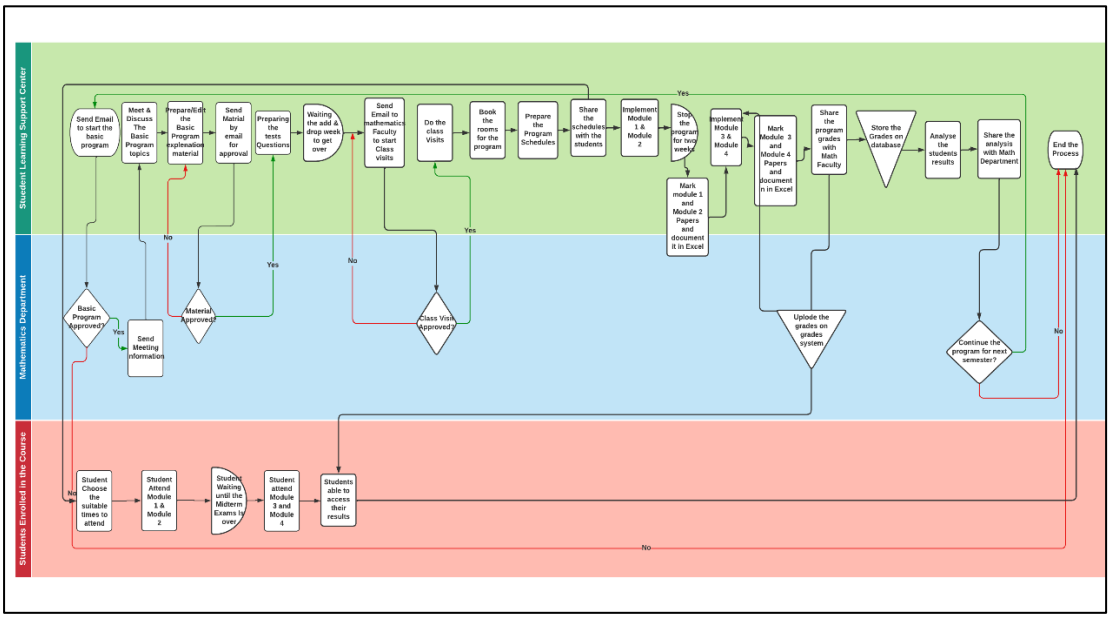
Appendix A. Detailed Process Flow for the Basic Calculus Program



Appendix B. Survey Questionnaire

Survey Questionnaire for assessing students' level of satisfaction with the improvements of the Basic Calculus Program

1. SLSC employee demonstrated excellence in preparing and delivering the program contents _ أظهرموظف مركز دعم تعلم الطلاب تميزا في إعداد وتقديم البرنامج

- **Strongly Agree _** موافق بشدة
- **Agree _** موافق
- **Somehow Agree _** موافق إلى حد ما
- **Disagree _** غير موافق
- **Strongly Disagree _** غير موافق بشدة

2. Explanation was clear شرح المادة كان واضحاً

- **Strongly Agree _** موافق بشدة
- **Agree _** موافق
- **Somehow Agree _** موافق إلى حد ما
- **Disagree _** غير موافق
- **Strongly Disagree _** غير موافق بشدة