QATAR UNIVERSITY

COLLEGE OF ENGINEERING

IMPROVING THE PROCESS OF ADOPTING STANDARDS IN QATAR USING LEAN THINKING

BY

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ABSTRACT

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Masters of Science in Engineering Management

Title: Improving The Process Of Adopting Standards In Qatar Using Lean Thinking

Supervisor of Project: Dr. Tarek El Mekkawy.

To achieve the goals of Qatar National Vision 2030 in terms of economic development, Qatar Standards (QS) are adopting international standards to ensure that the manufactured or imported products meet the security, safety, health, and environmental requirement as per the accredited standards and technical regulations to guarantee that trade flows as smoothly and freely as possible. Every year, Qatar Standards (QS) works with its committee members (industry, academia, control authorities) to develop and identify standards based on response to industry or other stakeholders' requests. Therefore, this project aims to apply Lean thinking methodology to improve the process of adopting standards. Value Stream Mapping (VSM), Fishbone diagram (Ishikawa diagram), and Pareto analysis are used as Lean thinking tools to analyze the different activities of the process in order to identify the different kinds of waste and non-value-added activities in the procedure and hence remove or at least minimize their negative impact on the process performance. First, the current process was described using a process mapping flowchart, and then Value Stream Mapping (VSM) was applied to study the current process's steps. The non-value-added activities were analyzed and minimized by using the Fishbone diagram and Pareto analysis. Finally, the future process was established, and hence a 36.6% reduction of the processing lead time has been achieved. Finally, this research project proves to bring a

valuable contribution by adding more value and less waste to the process of adopting a standard in Qatar.

DEDICATION

I dedicate my master's project to my family, for their greatest motivation and continuous support.

ACKNOWLEDGMENTS

I would like to thank my family and friends, who supported me in reaching my goals. Thanks to Dr. Tarek El Mekkawy, my project supervisor, for the enormous advice, assistance, and support until completing my master's project.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Background

Lean thinking is a process improvement methodology used to enhance the process by reducing the activities that do not add value to the customer. Lean thinking involves tools that minimize waste to achieve customer requirements. Applying lean thinking in service organizations like offices, healthcare, and financial institutions would improve the quality of the process and enhance the workforce's efficiency.

Nowadays, international standards play an essential role in the economy by facilitating business interaction and speeding innovative products to the market. Implementing standards in industries and commerce become crucial for high-quality products and services that satisfy customer requirements. Qatar Standards (QS) is the national standards organization in Qatar. It is responsible for standardization activities, including developing and adopting national standards, distributing and selling national standards, and suggesting the legislation related to the standards and metrology. The organization is the source of information, documents, and statistics about the standards in Qatar. It also participates in standardization activities undertaken by regional and international organizations. The Standards and Metrology Department, under Qatar Standards (QS), develop and adopts international standards in terms of health, safety, and environment, which benefit in avoiding technical barriers to trade and increase consumer protection. Therefore, implementing lean thinking in adopting a standard process is necessary to increase Qatar Standards (QS) stakeholder satisfaction by reducing process lead time.

1.2 Problem Statement

Despite challenging times, Qatar's economy continues to grow, and it remains one of the most competitive and robust economies in the region. To achieve the objectives of its National Vision, Qatar has balanced its strategies and plans by including integrated economic policies that raise the non-hydrocarbon sector's participation in Gross Domestic Product (GDP). Along these lines, Qatar Standards (QS) has to develop and adopt national standards to meet the country's needs in terms of manufactured or imported products.

The implementation of standards in industries and commerce became extremely relevant to have a high-quality product. Adopting a standards process includes many types of wastes (e.g., waiting time, variation, and motion) that should be identified and eliminated. Based on the current method of adopting a standard, the process takes almost one year. Improvement is required in the ongoing process to reduce the processing time, enhance the process, and meet customer demands. Therefore, lean thinking is applied to the current process to reduce non-value-added activities by identifying their root causes and, hence removing them.

1.3 Objectives

The project objectives:

1. Study the application of lean thinking to the process of adopting standards in Qatar.
2. Apply Value Stream Mapping (VSM), the Fishbone diagram and Pareto analysis to identify the waste's root causes and hence eliminate them from the current process.
3. Propose the new, improved process and its Value Stream Mapping (VSM).
4. Compare the performance of the current and improved processes.

1.4 Methodology

Lean thinking approach is the adopted methodology in this project to improve the adoption of the standards process and reduce the non-value-added activities in the method. To enhance the process, Value Stream Mapping (VSM), Fishbone diagram, and Pareto analysis used as a lean thinking tool.

The first step of the methodology is the literature review; this step provides a complete review of lean thinking application in the service sector. The literature review also discussed implementing the Value Stream Mapping (VSM), Fishbone diagram, and Pareto analysis in the service industry. Then Value Stream Mapping (VSM) applied to analyze the existing procedure and design the future state for the procedure. Applying Value Stream Mapping (VSM) develops a clear understanding of the ongoing process and has an accurate picture of the process. Afterward, the Fishbone diagram was developed to identify the causes and effects of waste in the process. The Fishbone diagram assisted in generating more ideas about the reasons for the delay in the process. After establishing the Fishbone diagram, the Pareto principle applied to determine the causes of the non-value-added activities in order of severity or impact from most massive to smallest. The Pareto analysis was conducted to find the top 20% of root-causes of 80% of the issues. Furthermore, the Pareto chart utilized to perform a graphical analysis of the data to make the waste's leading causes easier. Finally, Value Stream Mapping (VSM) is used to visualize the future process and design an implementation plan for improvements. Multiple steps have to be followed to implement lean thinking methodology, as shown in figure 1.

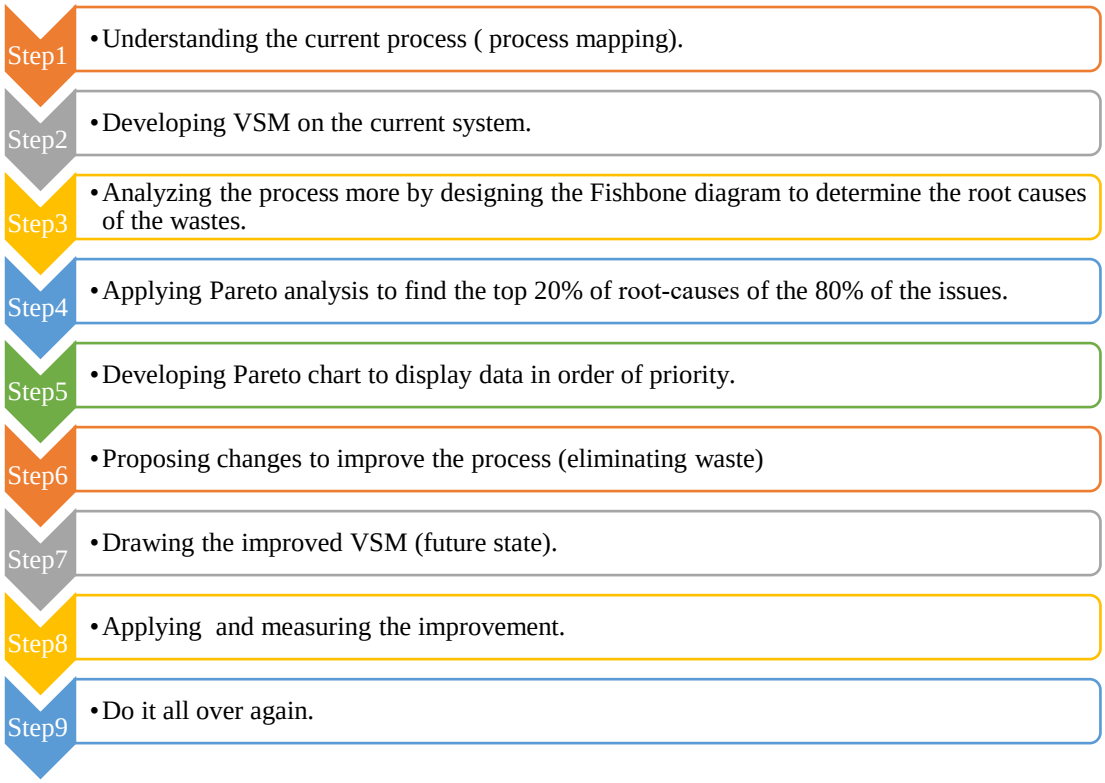


Figure 1. Lean Thinking Methodology to Improve Adopting Standards Process

1.5 Report Outline

This project is about applying lean thinking methodology on the process of adopting standards to enhance the process. The report consists of seven main chapters, including the introduction. The chapters organized as follows:

Chapter 1: This chapter provides an introduction and background about lean thinking and Qatar Standards (QS). In addition, it describes the aim of this project as well as the objectives of the research. Finally, it shows the adopted methodology that has been followed to enhance the process of adopting standards.

Chapter 2: This chapter provides a complete review of lean thinking applications in the service sector. It also discusses implementing the Value Stream Mapping (VSM), Fishbone diagram, and Pareto analysis in the commission organizations.

Chapter3: This chapter describes the methodology and design implemented in the project. It also explains the lean thinking tools implemented to determine the root causes of waste in the process.

Chapter 4: This chapter describes the current process in detail. It also illustrates the application of Value Stream Mapping (VSM), Fishbone diagram, and Pareto analysis to analyze the ongoing process. Additionally, this chapter discusses and explains the wastes in the current process and describes the future state after applying the Value Stream Mapping (VSM). Finally, different types of measurements for the current status of the process and the future state are discussed and compared to check whether improvements and proposed changes are efficient and effective.

Chapter5: This chapter summarizes the main points and results; also, it provides a recommendation to improve the process further in the future.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a complete review of lean thinking applications in the service sector. Additionally, it discusses the implementation of Value Stream Mapping (VSM), the Fishbone diagram, and Pareto analysis in the service organizations. Section 2.1 begins with a summary of lean thinking history and explains the seven waste processes between process activities. Section 2.2 highlights the implementation of lean thinking in the service sector. Following this, sections 2.3 and 2.4 include an introduction to the Value Stream Mapping (VSM) method and the application of Value Stream Mapping (VSM) in the healthcare sector. Section 2.5 introduces the Fishbone diagram concept and its application in service firms. Moreover, the Pareto principle and its implementation in the organizations was discussed in section 2.6. Finally, this chapter includes a summary that highlights the main point in each section.

2.1 Introduction to Lean Thinking

The Japanese automotive industry established lean thinking philosophy within the Toyota Production System (TPS) in 1950. The Engineer Taiichi Ohno invented the principle of lean thinking after World War II. His theory focused on removing waste, empowering workers, reducing inventory, and increasing productivity. Lean is a philosophy that attempts to identify and eliminate waste through continuous improvement. Moreover, it provides a better quality of products with lower costs and fewer efforts. Lean production is an assembly line methodology initially developed for Toyota and automobiles (MELTON, 2005).

Lean thinking aims to identify and reduce waste in all business perspectives by adding value from the client's point of view. Waste is described as any activity that does not benefit the customer and the end product (Dixit, Dave, Singh, 2015). It is essential

to understand the types and causes of waste to enhance the process. There are seven wastes needed to be detected to improve the process. Table1 shows the seven types of wastes and their definition.

Table 1: Seven Forms of Waste Activities

Type of waste	Definition
Overproduction	Producing more products than required by the customer.
Defects	When products or services deviate from what the customer requires or the specification.
Transportation	Movement of materials from one area to another and it does not add value to the product.
Waiting	When products or tasks are not moving, the waste of waiting occurs.
Over processing	Activities performed but not needed or adding more features that bring more value than required.
Inventory	Excessive inventory that results from "just in case" inventories.
Motion	Unnecessary motions between workstations or excessive machine movements.

These are the main types of wastes that may occur in any process. Non-add value activities need to be eliminated to improve the process and enhance the lean system (Sachdeva, Gupta, Rajkumar, 2017). The lean thinking approach intends to decrease the waste in the process by applying lean manufacturing tools such as Cellular manufacturing, Just in time (JIT), Kanban System, Production Smoothing, Total productive maintenance (TPM), Continuous Improvement, Kaizen, 5s, and Value stream mapping. Applying these tools will improve the production and efficiency by getting the most out of each resource. However, some lean tools may be more

applicable for one process than another (Sundar, Balaji, Kumar, 2014).

2.2 Lean in Service Sector

Lean service is an improvement tool and practices applied in the service sector to enhance the service's existing quality and ensure many favorable commercial and economic consequences. Additionally, it improves the performance of the workers in the organization. It is essential to the service organizations to meet every customer's requirements in the service sectors and always stay ahead of their opponents (Suresh, Aramvalarthan, 2016). Lean service applies to organizations that are short of information and face delay in task performance. Due to the increase in non-value-added activities in the service sector, many service organizations encounter high costs with slow processes, which lead to lower service quality and customer dissatisfaction. Work in Progress (WIP) is one of the leading wastes in service firms, such as reports essential to develop, unchecked e-mails, and important phone calls, which cause delays in task performance. This suspension in the procedure is because of the 20% of activities that create a delay of 80%. It is essential to apply lean in the service sector to meet customer expectations by providing high-quality service and enhance the process by using less but the right resources. Besides, non-value-added activities need to be analyzed to decrease cost and complexity. Furthermore, organizations should concentrate on activities that add value from the customers' point of view. In this way, they will better know the clients' requirements and how important they are prepared to spend to improve service quality. (Mahmutaj, Lura & Shrestha, Priti, 2011).

Recently, lean service adds more benefits to the healthcare system by removing duplicated processes and additional methods such as documenting patient information in various places and moving the patient to different rooms, and waiting for doctors and

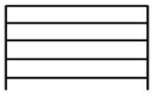
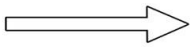
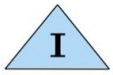
specialists. Despite the comprehensive implementation of lean in healthcare, the benefit of applying lean is low, and failure percent is between 50 and 95 percent (Thelen, 2016). There are three main reasons for the failure of using lean in the health care sector (1) Absence of adaptation caused by not clarifying the presentation of lean practices, which focus on enhancing the value, process, and flow, (2) Absence of readiness which generated by the shortage of understanding about the lean theory, the absence of a method to solve worker problems, or the need for suitable training systems, (3) Lack of a systemic approach which effected by lack of the experience to create and develop the work, share the resulting information from work, and build employee to apply lean. However, lean thinking tools such as Lean Six Sigma (LSS) are used as a daily tool for continuous improvement in the healthcare process. Lean applied most frequently to reduce patient waiting times and delays, increase hospital capacity and performance, and reduce errors connected to the document flow (Matt, Arcidiacono, Rauch, 2018). Lean philosophy is not limited to the manufacturing industries, and considering the growth in the number of patients in the hospitals applying lean in healthcare firms, it is essential to enhance the healthcare system performance and increase overall patient satisfaction.

2.3 Value Stream Mapping Overview

Value stream mapping (VSM) is one of the most important lean tools which first used by the Toyota Production System (TPS) and known as “material and information flows.” Value stream mapping (VSM) is a lean manufacturing tool that develops a flow chart to define and analyze the current state of the process and design a future state. Additionally, it is used to identify and eliminate waste, decrease process lead-time, and improve workflow. The established flow chart displays the movement

of the information and the operation of the materials. Value stream mapping (VSM) is separated into significant picture mapping and detailed mapping (Singh, Garg, Sharma, 2010). Value stream mapping (VSM) uses a set of unique symbols to visualize a process. Table 2 describes the symbols used to draw the current and future state of the process. Martin and Osterling (2014) summarized the advantages of Value stream mapping (VSM) as following, (1) Applying Value Stream Mapping (VSM) helped in analyzing processes in office and service and enhanced work environments and workforce. (2) The implementation of Value Stream Mapping (VSM) in the service sector benefits from increasing organizational knowledge about the work systems that carry value to clients, helping in better strategic decision making, and work design. (3) Value Stream Mapping (VSM) helps to present a clear understanding of the procedure and an accurate picture of how work progressed from a request to a request to fulfill that request. Furthermore, Value Stream Mapping (VSM) is encouraged to visualize the work progress for a process starting from the customer request to achieve that demand. The mapping method extends the knowledge of the process that adds value to customers and reflects the workflow from a customer's point of view. Consequently, the process of Value Stream Mapping (VSM) presents efficient methods to implement strategic directions for more reliable decision making and work plans.

Table 2: Value Stream Mapping (VSM) Symbols

Symbol	Description
	Process
	External Supplier
	Customer
	Data Box
	Movement of Inventory
	Information flow
	Electronic information flow
	Inventory

2.4 Value Stream Mapping in Healthcare System

Nowadays, lean healthcare becomes an essential concept to be applied in every hospital. Lean healthcare is the application of lean theory in the healthcare sector. Value stream mapping (VSM) is a critical lean tool that benefits in enhancing healthcare performance. It has been successfully implemented Value stream mapping (VSM) in various healthcare applications, from clinics to complicated emergency departments. It helped minimize the non-value-added activities produced in the processes, ensuring higher productivity, lower costs, and better quality of products and services (Tortorella

et al., 2016). Emergency rooms are an essential part of the healthcare system, but it has many wastes that need to be eliminated and reduced. According to Khurma et al. (2008), the lean methodology applied in the healthcare system to identify waste related to the emergency room, such as transportation, over-processing, waiting, and motion. Therefore, the lean approach incorporates Value Stream Mapping (VSM) to eliminate waste in the healthcare industry.

Moreover, Manos et al. (2006) state that for more reliable results, Value Stream Mapping (VSM) in healthcare should be implemented in association with a continuous Plan-Do-Check-Act (PDCA) cycle. Willoughby et al. (2010) conducted a study on the waiting and servicing time for patients visiting emergency rooms. The study found that patients spent most of the time waiting in the emergency room. Using Value Stream Mapping (VSM), the value-added activities, waste, and lead times for nursing patients were calculated. As a result, by implementing the PDCA process, the researchers developed useful improvements. However, the researchers faced challenges during the method performing include:

- Having a steady flow of lean activity during the project.
- Absence of confidence in the portion of the workers.
- The need for specialists and preparation of the workforce regarding given duties and obligations and lean methodologies, including Value Stream Mapping (VSM).

Another, studies conducted by Dickson, Singh, Cheung, et al. (2009) and Dickson, Anguelov, Vettericketal (2009), the research concentrated on decreasing waste in the current Value Stream Mapping (VSM). The non-value-added activities and waiting time reduced by involving both the Plan-Do-Check-Act (PDCA) and enabling the frontline workers. The designed future Value Stream Mapping (VSM) process, which depends on the frontline workforce's enhancement, was successfully applied to

decrease patient visit time and fulfill customer requirements. Additionally, Value Stream Mapping (VSM) creates a flow chart of both the ongoing state and the future vision for the process, and it provides a horizontal improvement of processes. It is recommended to integrate Value Stream Mapping (VSM) to other lean tools to handle system variation, shows the dynamics among system components, and establish the future state before it takes place. Thus, the Value Stream Mapping (VSM) becomes a necessary tool for the healthcare environment, driving the organization to decrease waste and costs and improve service quality and customer satisfaction (Machado, Scavarda, Vaccaro, 2014).

2.5 Fishbone Diagram

The Fishbone diagram or (Ishikawa diagram) is an improvement technique used to determine the leading causes. Ishikawa diagram established in the 1960s, and it was named after Kaoru Ishikawa, a Japanese quality control statistician (Juran, 1999). The Fishbone diagram is a cause and effect diagram that presents a systematic way of determining the cause and effects of a problem and contribute to those effects (Watson, 2004). Ishikawa diagram permanently outlines a design that represents the relationships between affect and its various causes. The skeleton of a fish structure benefits to think in a very organized way. Developing an Ishikawa diagram helps identify the leading causes of a problem or quality characteristic, assists teamwork cooperation, and involves team understanding. Additionally, it identifies areas where data should be gathered for additional study. The diagram can also determine the causes (Ciocoiu, Carmen & ILIE, Gheorghe, 2008). Usually, after developing the Fishbone diagram, the analysis continues with other representation methods. Applying quality tools becomes necessary to enhance the quality of the organizations. There are seven essential quality

tools used in organizations, some of them are specific for particular fields, and practices and others are generic and applicable to any situation. The quality tools help derive solutions to a problem in the organization by providing information about this problem. A Fishbone diagram is a graphical tool to identify the causes that produce quality problems, and it is used to understand the relation between a problem and all possible causes (Liliana, 2016). Furthermore, there is a need to understand the organization's risks and their causes to achieve the seeking objective.

Furthermore, organizations require to identify the risk that may occur during their processes and activities. By recognizing those risks applying quality tools such as the fishbone diagram will reduce the risks, leading the organization to have an opportunity to drive change and improvement. Establishing the Ishikawa diagram in the service sector will help identify the root causes and the effects of risks that may occur during the process. The most significant benefit of applying the fishbone diagram is that it transforms risk into a graphic format. Moreover, it helps in a fast understanding of risks and encourages discussion by highlighting the essential risk activities. Ishikawa diagram will enhance the awareness of the organizations' risks and ensure the consistency of goods or services. Identifying risks in service firms will also improve customer confidence and satisfaction and enable organizations to respond to change productively (Jen, 2010).

2.6 Pareto Principle

The Pareto Principle, also known as the 80/20 rule, was named after Vilfredo Pareto. The principle defines that 80% of consequences come from 20% of the causes. Pareto rule explains that the relation between inputs and outputs is not equivalent. The first investigation of the Pareto Principle was in Italy in the relationship

between land and population. Pareto noted that 80% of the country owned by 20% of the community. After studying several countries, he observed that the Pareto Principle applied abroad. For the most part, the 80/20 rule is an observation that things in life are not always distributed equally. After identifying 80% of consequences and 20% of the causes Pareto chart is used to establish the bar graph. The main benefit of applying the Pareto chart is to classify data and determine the longest bars on the left and the shortest to the right to visualize which situations are more critical. The Pareto Principle is widespread and can be implemented in various sectors, such as manufacturing, management, and human resources. Table3 shows the areas of application of the Pareto principle (Ivančić, 2014).

Table 3: Areas of Application of the Pareto Principle (Ivančić, 2014).

Areas of application of the Pareto principle	Examples
Organization	80% of production is completed by 20% of the operator. 20% of workers will 20% of workers will provide 80% of the product. 20% of the project states spend 80% of all stocks. 20% of meetings give 80% of the valuable idea.
Quality	80% of all outcomes demonstrated by 20% of reasons. 20% of errors result in 80% of all problems.
Market	80% of all return proceed from 20% of steady clients. 80% of transactions come from 20% of stocks. 80% of objectioncome from 20% of buyers. 80% of marketing done by 20% of the marketing team. only 20% of internet pages give 80% of accurate information.
Warehouse	20% of inventory uses up 80% of warehouse space. 80% of goods proceeds from 20% of suppliers.

In its current form, Pareto's strategic purpose begins with concentrating on the group of applications (demands, clients, market units) that provide the highest of the organization's outcomes (incomes, interests, recover on investment). The 80/20 rule indicates that most applications are not practical and should be minimized. In strategic management, Pareto analysis is connected to the outline of an organization's internal situation. It is particularly beneficial to distinguish internal strengths and weaknesses by estimating an organization's internal sources and skills, which are the cause of its

focus capability and, subsequently, builds an aggressive benefit. Pareto analysis can begin by studying the incorporation of company information from a practical view, related to a SWOT analysis method. The factors to analyze concerning their performance would be investment, management, infrastructure, supply chains, production, delivery channels, purchasing, and innovation sources. The Pareto impact also appeals to various aspects, such as clients, salesforce, and reputational equity. Managing a Pareto principle of business simultaneously with the significant strategic aspects is an actual application that must be undertaken regularly to guarantee that incompetence is not replicated and that active factors are exploited. (Foss, Hallberg, 2013).

2.7 Summary

To sum up, the lean thinking philosophy developed from Japanese industries, especially from Toyota Production System (TPS) in the mid of 1950 by Engineer Taiichi Ohno. Lean manufacturing maximizes the value of the product through the reduction of waste by applying suitable lean tools. Lean thinking is widespread, and it can be implemented in a wide range of sectors and industries. This literature review shows the benefits of implementing lean philosophy as well as Value Stream Mapping (VSM) in healthcare. The application of lean manufacturing tools in the healthcare system helped improve the process and reduce the patients' waiting time. Furthermore, the use of quality tools such as the Fishbone diagram and Pareto principle in organizations helps identify the root causes and the effects of risks that may occur during the activities. Finally, this chapter provided essential knowledge that will be used to achieve the objectives of this project and implement the methodology more probably.

CHAPTER 3: RESEARCH MOTHODOLOGY

This chapter aims to explain the methodology used in the project and the applied tools to determine the waste in the process. In this project, Value Stream Mapping (VSM), Fishbone/Ishikawa diagram, and Pareto analysis are applied to determine the main problems that delay adopting the standards process.

3.1 Value Stream Mapping Tool

The guiding principle of the Lean thinking methodology is the identification and elimination of waste. In any organization, one of the biggest drains on profitability and performance is waste. Lean waste can occur in the form of time, material, and worker. However, it may also be linked to the utilization of skillsets as well as weak outlining. For simplicity, waste is defined as any action or step in a method that does not add value to the customer. In other words, waste is any process that the customer does not require to pay for. The activities that benefit the customers are only a small part of the entire work process. Value Stream Mapping (VSM) is a lean thinking tool that presents a visual representation of the organization's movement of documents and information. Value Stream Mapping (VSM) benefits in distinguishing, explain, decrease waste and finally perform a sufficient flow through all the processes. Figure 2 shows six-steps to perform waste elimination using Value Stream Mapping (VSM).

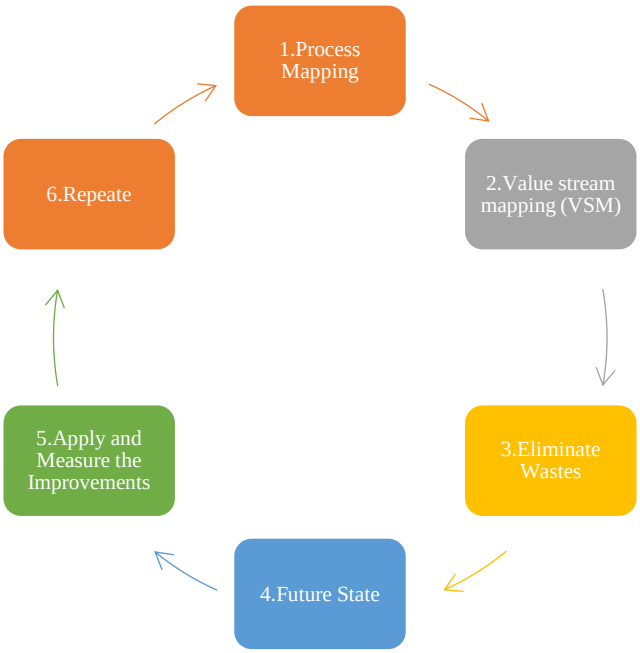


Figure 2. The Steps to Perform Waste Elimination Using Value Stream Mapping (VSM).

3.2 Fishbone Diagram

A Fishbone diagram (also called a cause and effect diagram or an Ishikawa diagram) is used to categorize the possible reasons for a problem to determine its root causes. The fishbone diagram uses a brainstorming approach to obtain the causes and develop a mind map that shows all the known problems graphically. The causes are listed on the left side of the diagram, which might contribute to the problem, as shown in Figure 3. The root causes split into significant cause categories (methods, people, materials, environment, equipment, or measurements). The purposes identified will be placed in the appropriate cause categories. Moreover, the effects are listed on the right side of the diagram to know the reasons.

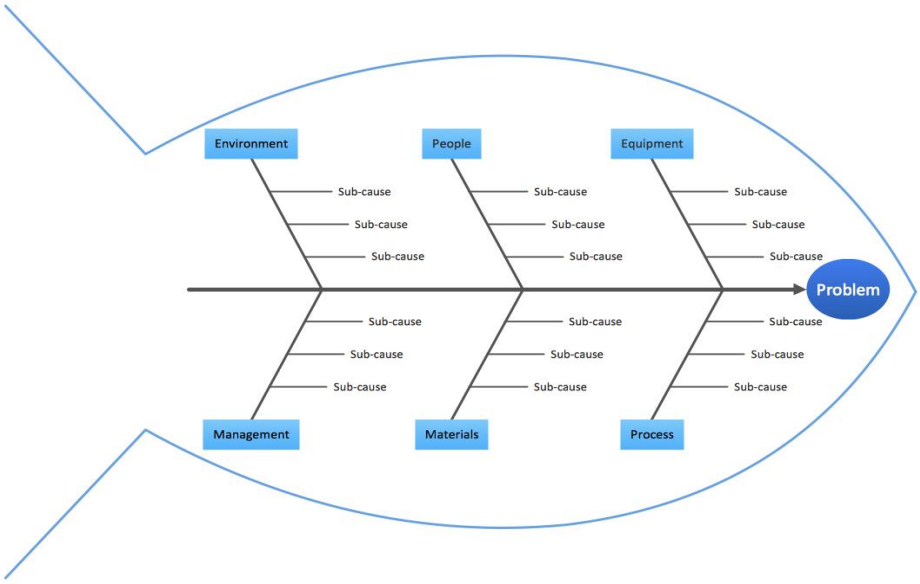


Figure 3. Fishbone Diagram Layout (Fishbone Diagram Training: Ishikawa Training 2016)

Figure 4 shows the steps that have been taken to develop the fishbone diagram for the root causes of the problem (Delay in the adopting standards process):

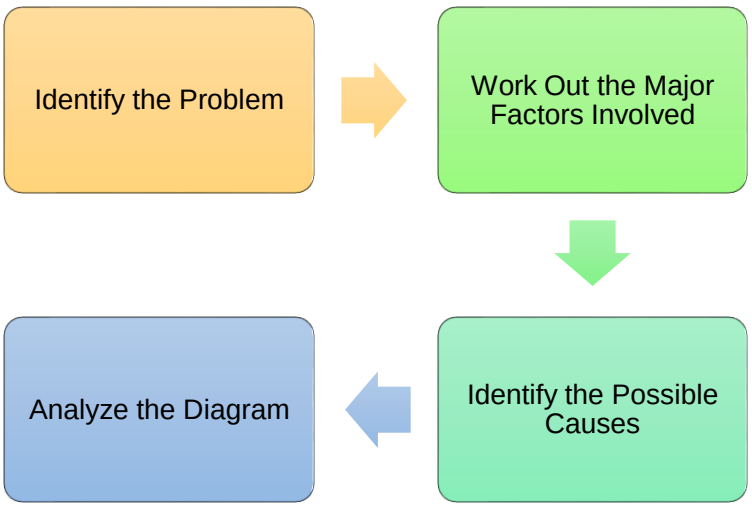


Figure 4. Steps of Fishbone Analysis

3.3 Pareto Analysis

The Pareto analysis technique is a creative way of looking at causes of problems. Pareto diagram or 80-20 % rules tend to determine the critical causes and hit that cause to achieve 80-20 rules. This rule states that some causes, 20% may cause 80% of the problem.

A Pareto chart has the following purposes:

- Distribute the less significant difficulties from the multiple possible problems to concentrate on the enhancement efforts.
- Manage data according to preference or importance.
- Identify which problems are the most significant.

Pareto Analysis is applied in this project to determine the top section of purposes that need to be addressed to solve the majority of problems regarding the delay in the adopting standards process and to improve the process in terms of time, resources, quality, customer satisfaction. The following steps have been taken to apply Pareto analysis, as shown in Figure 5.

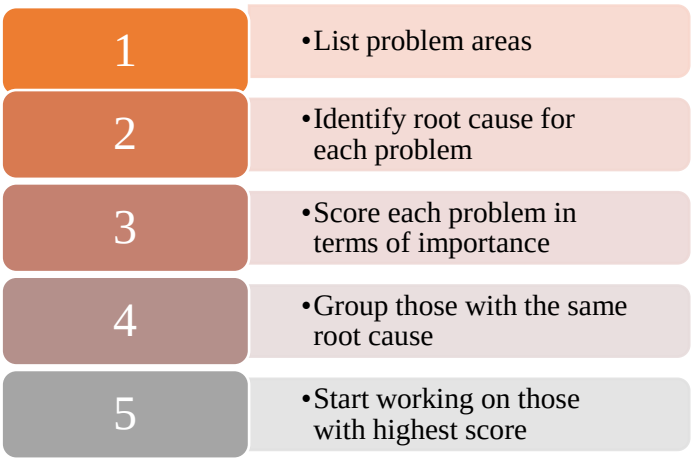


Figure 5. Pareto Analysis Steps

CHAPTER 4: APPLICATION OF LEAN THINKING

This chapter describes the current process in detail. It also illustrates the application of Value Stream Mapping (VSM) to analyze the ongoing process and carefully study the relationships between them to have an accurate picture of the procedure. After studying and understanding the existing process of adopting standards, process mapping, and analyzing the process's current state's steps through Value Stream Mapping (VSM). After applying Value Stream Mapping (VSM), it was noticed that there are many issues, waste, and non-value-added activities that need to be addressed and analyzed furthermore. The causes contributing to the result have to be understood to enhance the process's outcome. The Fishbone Diagram is used to identifies the root causes. After establishing the Fishbone Diagram, the following step is to implement Pareto analysis to classify the top causes. The Value Stream Mapping (VSM) tool is applied to define the different types of waste included in each step of the process, eliminate all unnecessary activities and wastes, and develop the new process. Finally, different measurements for the current state of the process and the proposed process (future state) will be discussed and compared to check whether improvement and proposed changes are efficient and effective and whether their values are reached.

4.1 Current Process

The first step to start the lean thinking process is to study and understand the current process. This section explains the process of adopting standards and how the procedure performed, and the flow of the material, people, and information. Figure 6 shows the process map of the existing method of adopting standards based on "Adoption of International Standards as Regional or National Standards Part 1: Adoption of International Standards (ISO Guide 21)."

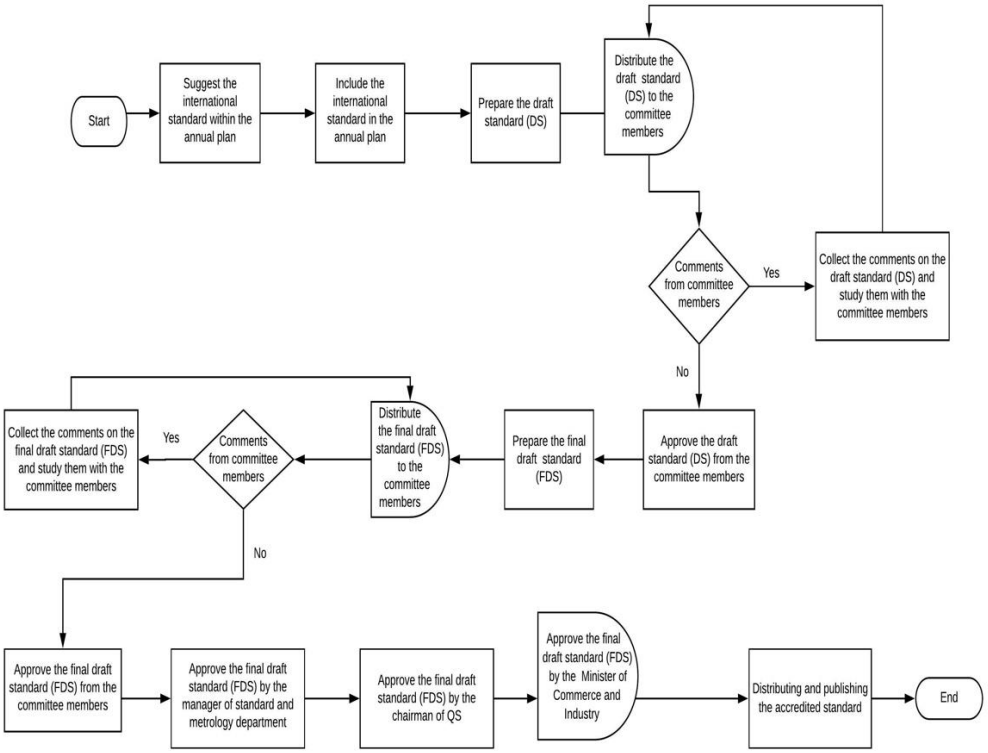


Figure 6. Current Process Map for the Adopting Standards Process (GCC Standardization Organization (GSO))

4.2 Value-Stream Mapping of the Current Process

This section presents details about the current system. It also describes the implementation of Value Stream Mapping (VSM) to analyze the ongoing process and carefully study the relationships between them to have an accurate picture of the process.

The first step to establish the current state of the process is gathering all the necessary information regarding the activities/actions performed to complete the adopting standards process. As a result, an interview with three expert engineers from the different sections in the Meteorology and Standards department was conducted. The project aim was explained in detail for them and the lean thinking concepts and, mainly

speaking, the VSM tool. Based on their input and recommendation, it was decided to use the average waiting and processing times for each action because they changed from each section due to several factors and reasons. However, based on the expert engineer's ten years of experience, all the waiting and processing times are the average recordings of these activities.

The current procedure shows both inputs, such as process time and waiting time, to explain the overall duration. The procedures are well explained in detail as follows:

- Client contact Technical Department (Head of Department) by email or phone.
- The Head of the Department notifies Technical Engineer to provide and study the required standard by the client.
- Technical Engineer fills the needed form to provide the required international standards.
- Technical Engineer sends the form to the Standards Sale Section.
- Standards Sale Section checks the validity of the required international standard and provides it to the Technical Department.
- Technical Engineer studies the international standard in detail.
- Technical Engineer suggests an international standard in the annual plan.
- The Head of Department approves the suggested international standard.
- Technical Engineer prepares the draft standard (DS).
- Distribute the hard copy of the draft standard (DS) to the committee members.
- If there are comments from committee members, Technical Department will have a meeting with committee members to study and discuss the feedback.
- The Head of the Department and committee members approve the draft standard (DS).

- The Head of the Department notifies the Technical Engineer to prepare the final draft standard (FDS).
- Distribute the hard copy of the final draft standard (FDS) to the committee members.
- If there are comments from committee members, Technical Department will have a meeting with committee members to study and discuss the feedback.
- The Head of the Department and committee members approve the final draft standard (FDS).
- Technical Engineer writes an official letter for the Standard and Meteorology Department Manager to approve the final draft standard (FDS).
- The Manager of the Standard and Meteorology Department approves the final draft standard (FDS).
- Technical Department writes an official letter for Qatar Standards (QS) Chairman to approve a final draft standard (FDS).
- The Chairman of Qatar Standards (QS) approves the final draft standard (FDS).
- The Office of Chairman of Qatar Standards (QS) writes an official letter for the Minister of Industry and Commerce to approve the final draft standard (FDS).
- The Minister of Industry and Commerce approved the final draft standard (FDS).
- Issue a Ministerial decree to adopt international standards as Qatari standards.
- Distribute and Publish the accredited standard.

The technical engineers need to understand activities to proceed further until the accredited standard is published. Additionally, the client should also be aware of the process's main steps before proceeding to the accredited standard since it takes a long time. However, some activities in the current process need to have hard copy

documents, which increases the delay. Moreover, Qatar Standards (QS) wants to establish an automated system that helps all customers track their documents. The advantage of this step is to minimize the total time of the process by eliminating the non-value-added activity.

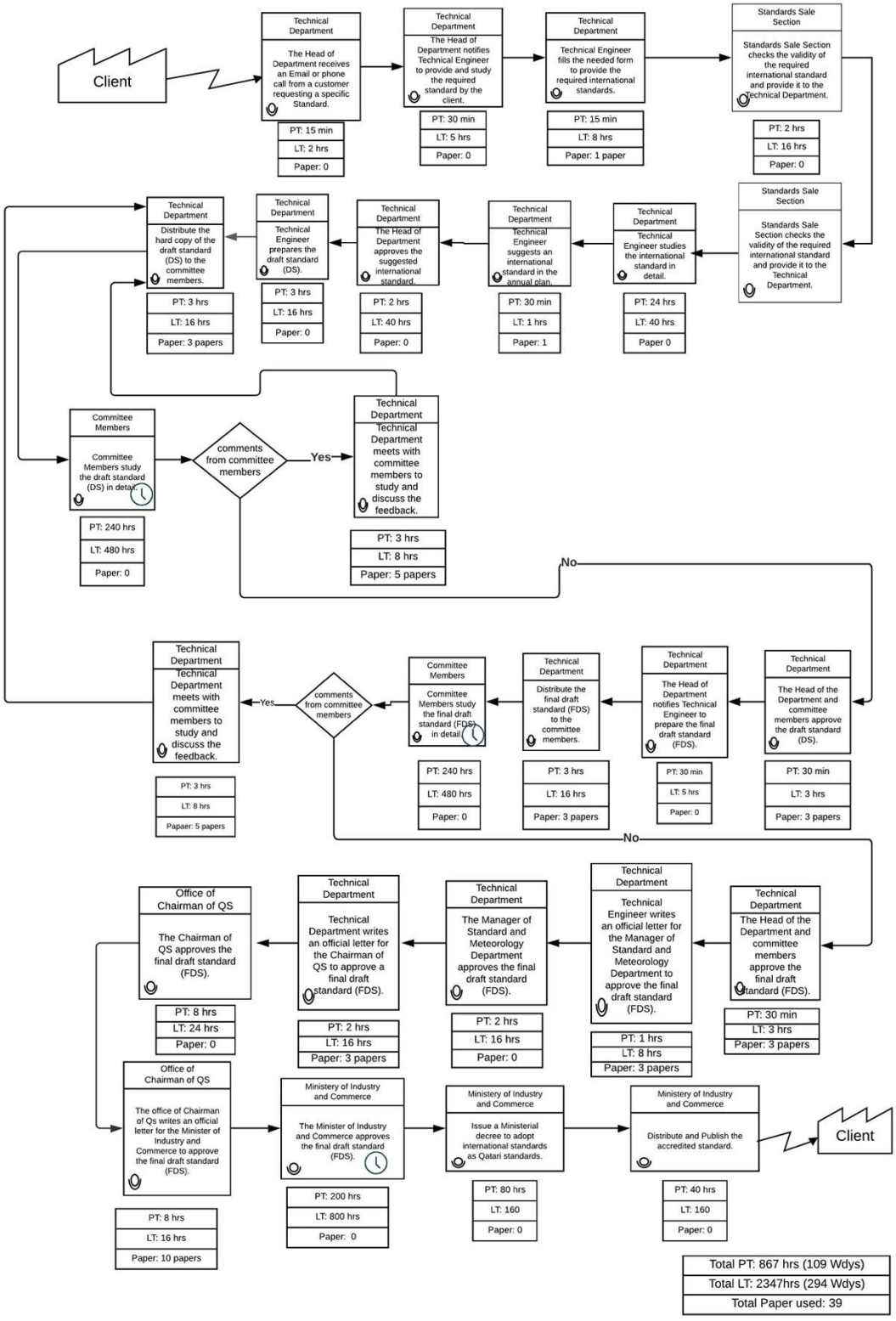


Figure 7. Value Stream Mapping (VSM) Of the Current Process of Adopting Standards

4.3 Fishbone Diagram

Fishbone analysis was applied in this project through a brainstorming session with Qatar Standards (QS) experts' engineers. It involved some questioning technique, such as the 5 Whys or the 4P's (Policies, Procedures, People, and Plant) to continue the discussion and keep focused on identifying the causes based on the experience that could contribute to the problem of the delay in the Adopting Standards Process of Qatar Standards (QS) in order to improve the process by using lean thinking.

Several causes might contribute to the problem identified during the brainstorming session and broken out into significant cause categories as below:

1. People:

- Customer
- Technical Engineer
- Standards Sale Section
- Committee Members

2. Methods:

- Regulations/ Laws
- Procedures/ Policies

3. Environment:

- Weather Impact

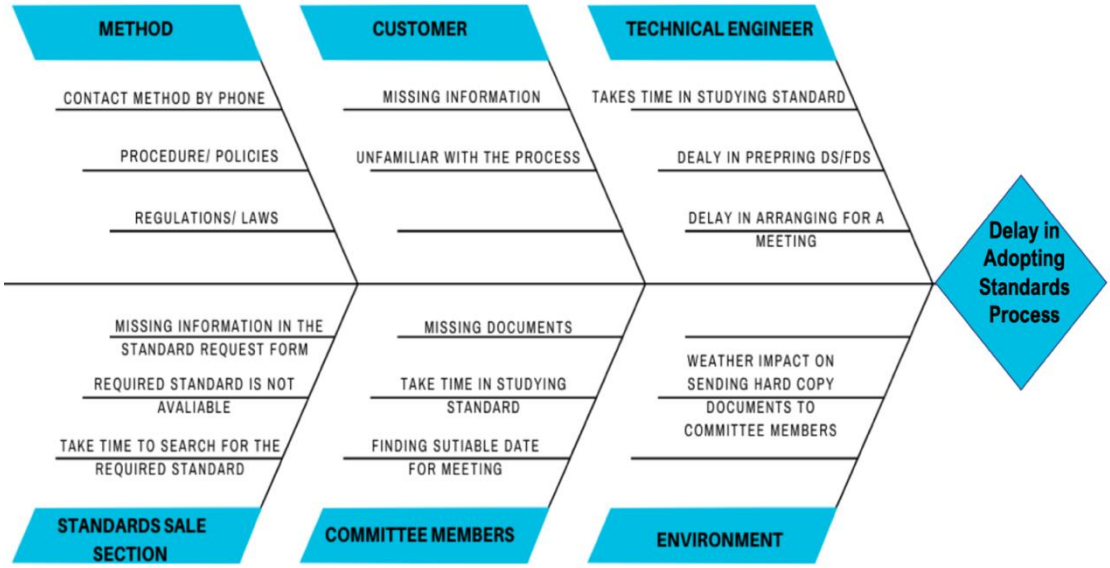


Figure 8. Fishbone Diagram for the Process

4.4 Pareto Analysis

After establishing the fishbone diagram, the next step is to apply Pareto analysis, which helps to identify the top causes that need to be addressed to resolve the majority of the problem and specify the area of process improvements by lean thinking. Based on Fishbone analysis, it was found that several reasons and causes contribute to the delay in the process of Adopting Standards.

The causes of delaying the process:

- Customer
- Technical Engineer
- Standards Sale Section
- Committee Members
- Methods (Procedures/ Regulations)
- Environment

Fishbone analyses identified all causes are scored based on the historical data, and the cumulative percentage is calculated for each cause, as shown in Table 4.

Table 4: Cumulative Percentage of Each Cause

Cause	Count	Cumulative	Cumulative %
Technical Engineer	15	15	28%
Committee Members	12	27	51%
Methods (Procedures/ Regulations)	10	37	70%
Standards Sale Section	8	45	85%
Customer	5	50	94%
Environment	3	53	100%

After identifying the root cause for each problem and score each issue in terms of importance Pareto chart is used as shown in Figure 9 to establish the bar graph. The main benefit of applying the Pareto chart is to classify data and determine the longest bars on the left and the shortest to the right to visualize which situations are more critical.

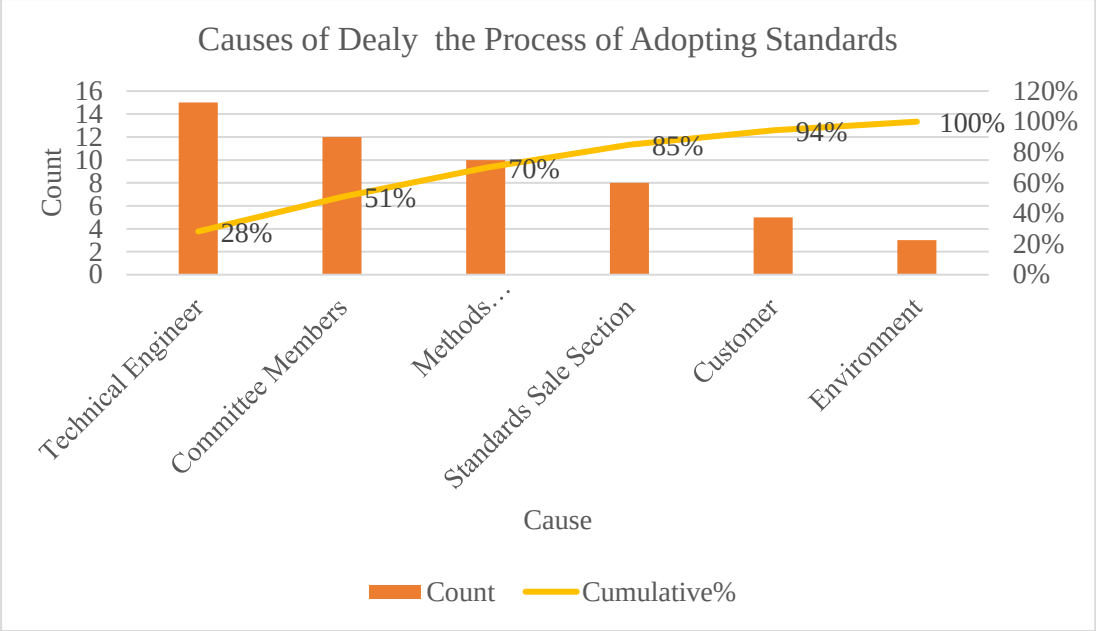


Figure 9. Pareto Chart for The Causes of Delay the Process of Adopting Standard.

4.5 Value Stream Mapping (VSM) Application

The advantage of applying Value Stream Mapping (VSM) is to minimize the time of Adopting Standards, and that will be measured through two factors, processing time and lead time. The additional target is to minimize the number of papers used throughout the process. After that is the discussion of the process using the tool of Value Stream Mapping (VSM) that will enable defining the different types of wastes that might be included in each step of the process. After identifying the problem root causes Figure 10 visualizes the actions taken with the help of the expert engineers in Qatar Standards (QS) to identify the types of wastes found in the process.

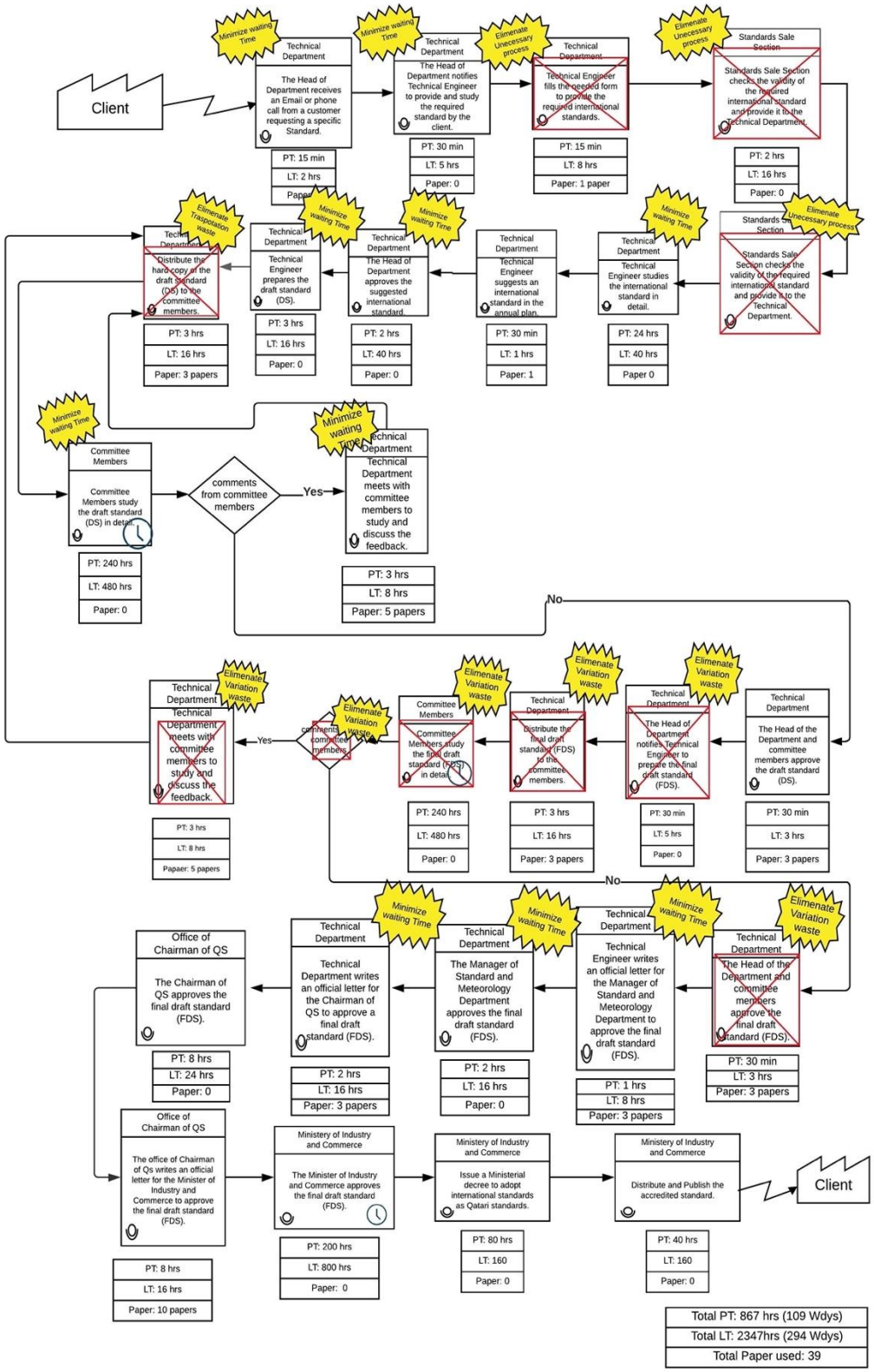


Figure 10. The Steps of Identifying the Waste Using Value Stream Mapping (VSM)

Based on Figure 10, the waste in the following steps will be discussed:

Step (1) Technical Department: In this step, the client has to contact the technical department either by e-mail or phone to request a specific standard.

1. Defects: The client is not providing enough information about the required standard.
2. Waiting: The client is waiting for the employee to reply to the e-mail or answer the phone.

Step (2) Technical Department: In this step, the Department's Head informs the Technical Engineer to provide and study the client's required standard.

1. Defects: The Head of the Department is not providing enough information about the required standard.
2. Waiting: The Head of the Department is waiting for the Technical Engineer to answer the phone.

Step (3) Technical Department: In this step, the Technical Engineer has to fill the needed form to provide the required international standard and send it to the Standards sale Section.

1. Transportation: The Technical Engineer walking to the standards sale section.
2. Waiting: The Technical Engineer is waiting for the employee to be available to process his application.
3. Defects: The Technical Engineer entering incorrect information or missing some documents.

Step (4) Standard Sale Section: In this step, the Standards Sale Section checks the required international Standard's validity by searching in different international standards websites.

1. Waiting: The Standards Sale Section employee is waiting for the webpage to be load.

2. Defects: The Standards Sale Section employee receives incomplete documents.
3. Miss-use of skills: The Standards Sale Section employee is not trained in searching for a standard.

Step (5) Technical Department: In this step, Technical Engineer studies the international standard in detail.

1. Waiting: The Technical Engineer is waiting for the Standards Sale Section to provide the required Standard.
2. Miss-use of skills: The Technical Engineer does not have enough knowledge or skills to study the standard in detail.

Step (7) Technical Department: In this step, the Department's Head approves the suggested international standard.

1. Waiting: The Technical Engineer is waiting for the Head of the Department to be available.
2. Defects: The standard is not capable of being applied in Qatar.

Step (8) Technical Department: In this step, the Technical Engineer prepares the draft standard (DS).

1. Miss-use of skills: The Technical Engineer does not have enough knowledge on how to prepare the draft standard (DS).
2. Defects: The Technical Engineer forgets to write all the required information on the cover page of the draft standard (DS).

Step (9) Technical Department: In this step, the technical department distributes the hard copy of the draft standard (DS) to the committee members.

1. Transportation: The hard copy of the draft standard (DS) must be carried with the delegate.
2. Defects: Some documents get lost during transportation.

3. Waiting: The Technical Department is waiting for the delegate to be available.

Step (10) Committee Members: In this step, the committee members study the draft standards (DS) in detail.

1. Defects: committee members receiving incomplete documents.
2. Miss-use of skills: committee members employee does not have enough knowledge or skills to study the draft standard (DS).
3. Waiting: Technical Department is waiting for 60 working days so that committee members can study the draft standard (DS) in detail.

Step (12) Technical Department: In this step, if there are comments from committee members Technical Department will have a meeting with committee members to study and discuss the feedback.

1. Waiting: Technical Department is waiting for the committee members to confirm the meeting date.
2. Defects: The meeting date is not suitable for all the committee members.
3. Miss-use of skills: The Technical Engineer did not train on how to set the meeting schedule sufficiently.

Step (14) Technical Department: In this step, the Head of the Department notify Technical Engineer to prepare the final draft standard (FDS).

1. Variation: The Technical Engineer is performing the same activity in step 8.

Step (15) Technical Department: In this step, the technical department distributes the hard copy of the final draft standard (FDS) to the committee members.

1. Variation: The Technical Department is performing the same activity in step 9.

Step (16) Committee Members: In this step, the committee members study the final draft standards (FDS) in detail.

1. Variation: Committee Members are performing the same activity in step 10.

Step (17) Decision: In this step, if there are comments from committee members.

1. Variation: The same activity in step 11.

Step (18) Technical Department: In this step, if there are comments from committee members Technical Department will have a meeting with committee members to study and discuss the feedback.

1. Variation: The Technical Department is performing the same activity in step 12.

Step (19) Technical Department: In this step, the Head of the Department and committee members approve the final draft standard (FDS).

1. Variation: The Technical Department is performing the same activity in step 13.

Step (20) Technical Department: In this step, the Technical Engineer writes an official letter for the Standard and Meteorology Department Manager to approve the final draft standard (FDS).

1. Waiting: Technical Engineer is waiting for the official letter to be approved by the Head of the Department before giving it to the Manager.
2. Miss-use of skills: The Technical Engineer does not have enough knowledge on how to write an official letter.

Step (21) Technical Department: In this step, the Standard and Meteorology Department Manager approves the final draft standard (FDS).

1. Waiting: The Technical Engineer is waiting for the Manager of Standard and Meteorology Department to be available.
2. Defects: The Manager of the Standard and Meteorology Department is receiving incomplete documents.

Step (22) Technical Department: In this step, the Technical Department write an official letter for the Chairman of Qatar Standards (QS) to approve a final draft standard (FDS).

1. Waiting: Technical Engineer is waiting for the official letter to be approved by the Head of the Department before giving it to the Chairman of Qatar Standards (QS).
2. Miss-use of skills: The Technical Engineer does not have enough knowledge on how to write an official letter.

Furthermore, some other activities cannot be changed because they are considered one of the main elements of the process and essential to have an accredited standard. Therefore, some activities represent a necessary waste that cannot be eliminated because it is a part of the process and difficult to take action.

In Figure 10, after identifying waste in the process of adopting standards. The waiting time is calculated to a value of 2347hrs (8hrs shift/day) and the processing time to a value of 867hrs (8hr shift/day), and it takes around 109 working days of the process. Besides, there are multiple bottlenecks identified while presenting current processes such as the Minister of Commerce and Industry's approval and the Committee Members' time to study the standard in detail.

4.6 Future Process

After identifying the areas of improvements by eliminating the waste and non-value-adding activity or minimizing, simplifying, or integrating the activities that include the wastes, a new Value Stream Mapping (VSM) developed, which implemented all the changes identified. It represents the proposed future state of the process as it is visualized in Figure 11.

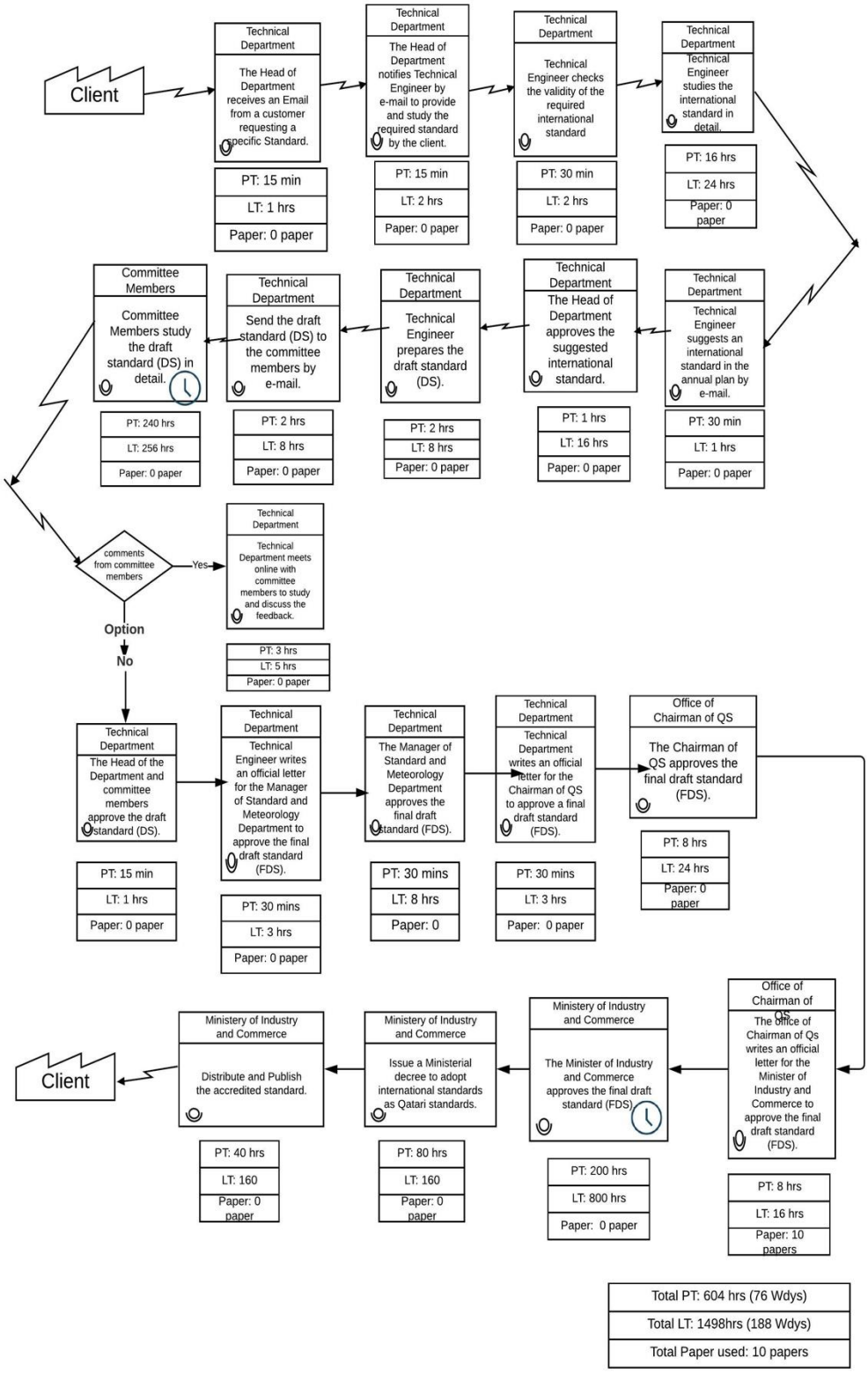


Figure 11: Future Process.

After eliminating all unnecessary activities and wastes, the new process proposes approval electronically using the emails to accelerate evaluating the papers and using electronic signatures. Secondly, the waiting time taken by Committee Members to study the standard still one of the main factors for the waiting times in the proposed process because the standards must not conflict with any of the Committee Members' regulations. However, as the new process shows, the waiting time has been reduced due to electronic communication and approvals. The future process also eliminates all the manual steps taken in the Technical Department and reduces the number of papers used.

4.7 Implementation and Measurement

In this section, different measurements for the current state of the process and the proposed process (future state) will be discussed and compared to check whether improvement and proposed changes are efficient and effective and whether their values are reached. Table 5 shows a comparison between the current and future state's different options and shows improved developments.

Table 5: Measurement of the Current State and Future State

KPI	Current State	Future State	% of improvement
% of used papers	39 papers used	10 papers used	Based on the number of papers used in the process, it can be judged that the level of automation exists in the system. The proposed process achieves 74.4% of automation.
Processing Time (hours)	867 hrs	604 hrs	From processing time, it can notice the vast difference between current and future states. The future process was able to achieve a 30.3% improvement in minimizing the processing time, which means that the goal of minimizing the time of adopting standards achieved.
Lead Time (hours)	2347 hrs	1489 hrs	From this KPI, the percent of improvement achieved in minimizing the lead-time (waiting time). The future state achieved 36.6% of improving (minimizing) the waiting time.

Table 5 concludes that the goal of minimizing the processing and waiting time of adopting standards is achieved. To measure the percent of improvement, the current state of the process was used as a baseline to measure the difference obtained in the future process. The future state achieved a 74.4% improvement in system automation, which means all the wastes related to transportation and motions caused, time, effort, and energy-consuming in non- value-added activity was reduced and eliminated. The proposed process was also able to remove the process's waiting time caused by different activities, mostly from the manual process and the errors that might accrue from the

employee while studying and preparing draft standard (DS). However, to improve the process furthermore and reduce the waiting time, Qatar Standards (QS) should focus on enhancing the underqualified employees. Qatar Standards (QS) can have a program for assessing the employee's qualifications to classify them based on their skills, experience, and qualifications. Based on that, they can provide an intensive program for the employee, which is under the level of accepted skills. Furthermore, re-structure the organization to place a suitable employee with the right skills in the right position to facilitate the success of the organization in different areas and success in achieving a high level of productivity. These critical areas require enhancement so that the organization can compete with others.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Adopting a standard is a process of approving international standards as a national standard based on response to industry or other stakeholders' requests. The current method of adopting standards was studied and reviewed through mapping and analyzing the ongoing process steps through Value Stream Mapping. After developing the Value Stream Mapping (VSM) on the existing process, it was found that the process has many wastes, defects, excessive processes, and non-value-added activities, which increase the processing and lead time. In addition, Fishbone and Pareto analysis applied to identify the waste's root causes in the current process. Then Value Stream Mapping (VSM) tool is implemented on the current method to find improvement areas. After that, the future state obtained after applying Value Stream Mapping (VSM) by minimizing, simplifying, and integrating the waste activities as much as possible to reach the target objective, reducing the processing time of adopting standard processes and meeting customer satisfaction. In conclusion, a 36.6% improvement in minimizing the processing time has been achieved by implementing lean thinking on the current process.

5.2 Recommendations

After applying lean thinking on adopting a standard process, the following recommendations are suggested to Qatar Standards (QS) to improve their processes:

- Apply for the Structured Continuous Improvement Program to improve the overall process efficiencies (including opportunities for process harmonization, customer satisfaction, and integration).

Continuous improvement attempts to enhance every process in the organization by

concentrating on improving the activities that provide the most value for the clients while removing/eliminating as many waste activities as possible. In Lean management, there are different strategies for obtaining continuous improvement, such as Plan-Do-Check-Act (PDCA) method. The planning stage must set goals and processes essential to delivering results per the expected output (the target or goals). The next phase is "Do." It is a straightforward step to perform what has been laid down through the process's planning stage. After completing the objectives, it needs to check what has been achieved and compare it to expected. Finally, gather as much information as possible and consider what can be improved to make more significant results next time.

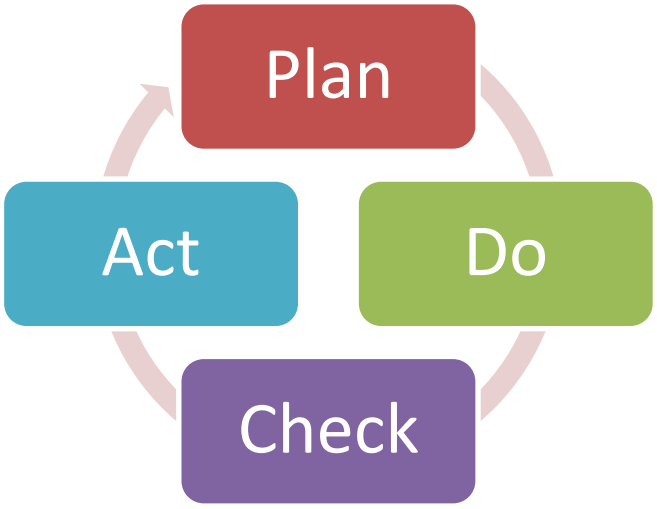


Figure 12. PDCA Continuous Improvement

- Apply Bottom-up improvement principle:

Consider the importance of involving the organization staff and encouraging them to spot opportunities and apply improvements. The continuous improvement

model depends significantly on employees, not only the highest management, to recognize development opportunities. This bottom-up improvement is beneficial because workers are most familiar with the problems and better equipped to solve them.

- Poll everyone:

The people who operate directly within the processes have the best penetration into the root cause of problems and how things could be enhanced. Introduce surveys that go out to the clients and the employees, each with different questions, to understand the consequence's process improvement efforts. Take the information from those studies, done at frequent periods, score how the organization manages, and how previous modifications have (or have not) improved the processes.

- Apply DMAIC strategy:

DMAIC is a data-driven quality approach applied to improve processes. It is an essential part of a Six Sigma initiative, but in general, it can be used as a standalone quality improvement method.

DMAIC is an acronym for the five states that make up the process:

- Define the problem.
- Measure process performance.
- Analyze factors that need to be adjusted or eliminated
- Improve process performance by implementing the best solution to the problems.
- Control the improved process and future process performance.

- Continuous Improvement Software:

Online programs allow companies to capture opinions and feedback from employees immediately. Continuous improvement software also does review and reporting a breeze. Instead of performing multiple spreadsheets or collecting key performance indicators from different departments, reports can be generated

immediately. Continuous improvement software allows the organization to see how to proceed towards its ongoing improvement goals and how productivity, profitability, or qualities are affected.

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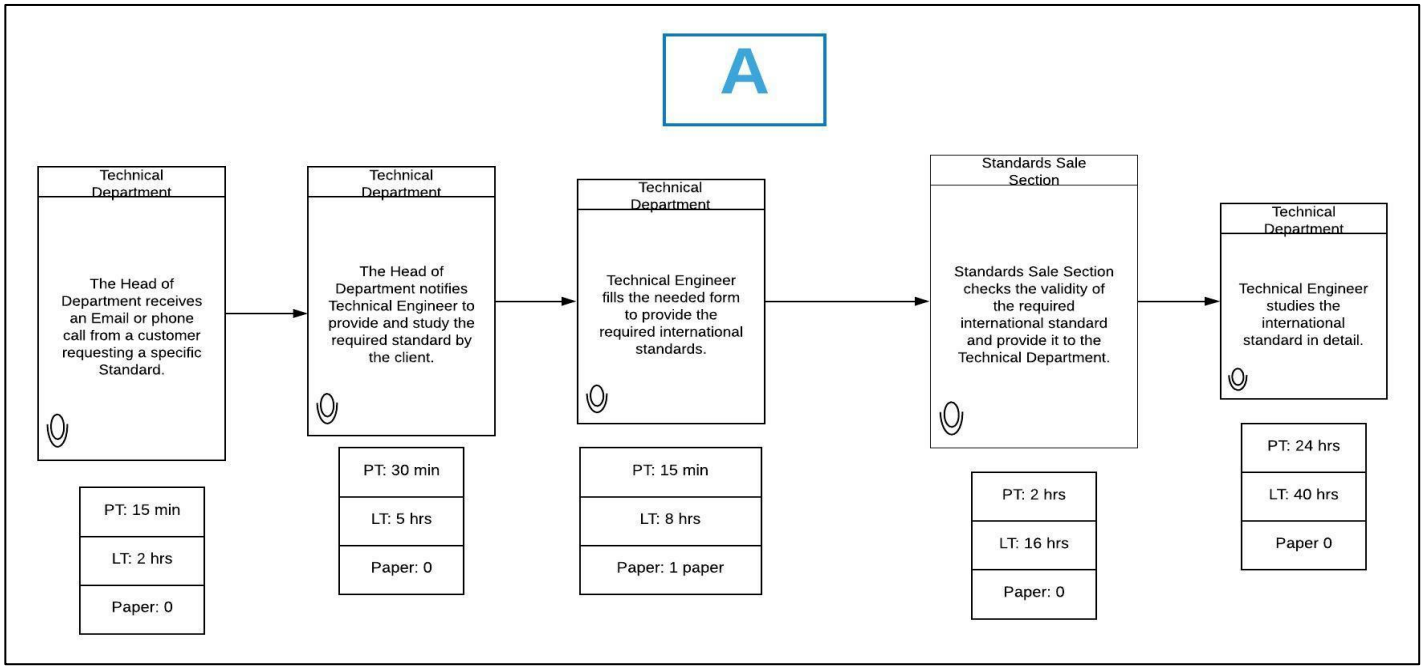
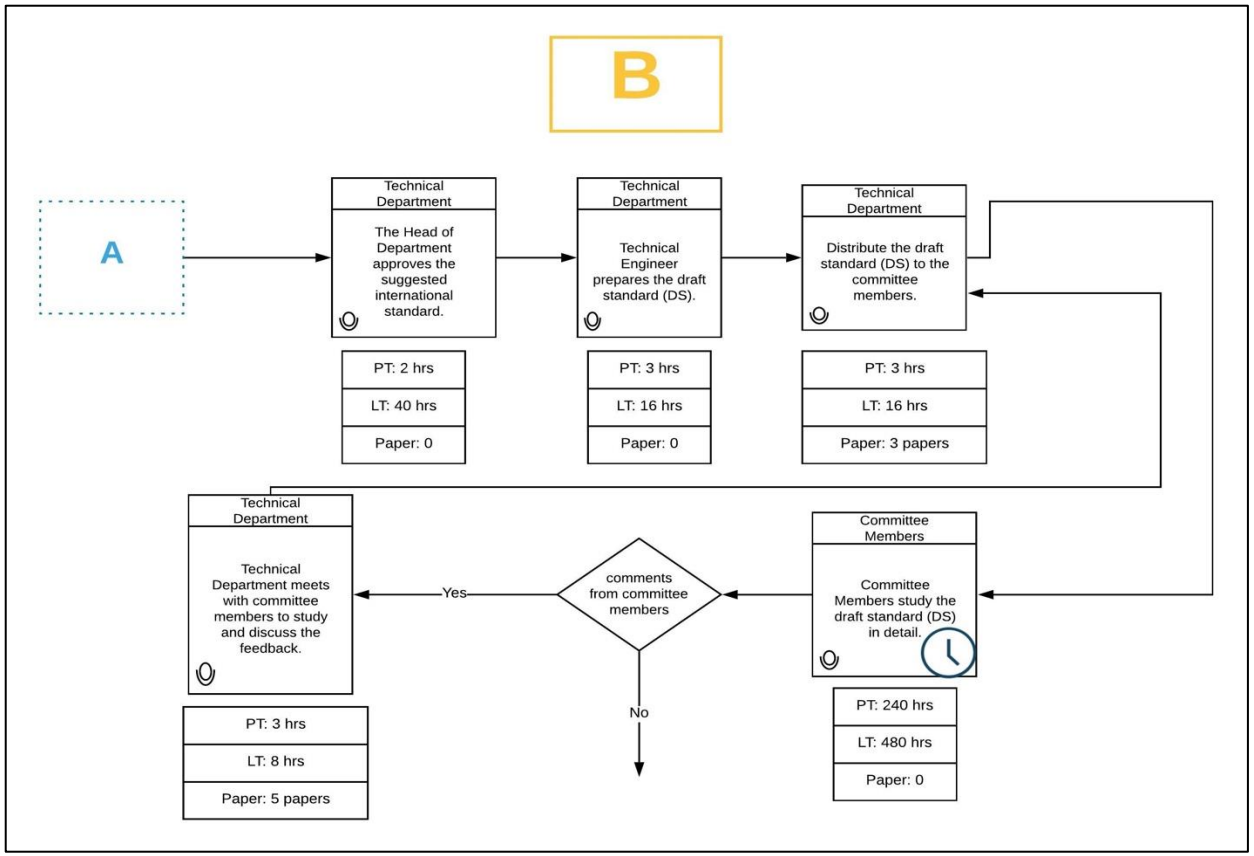
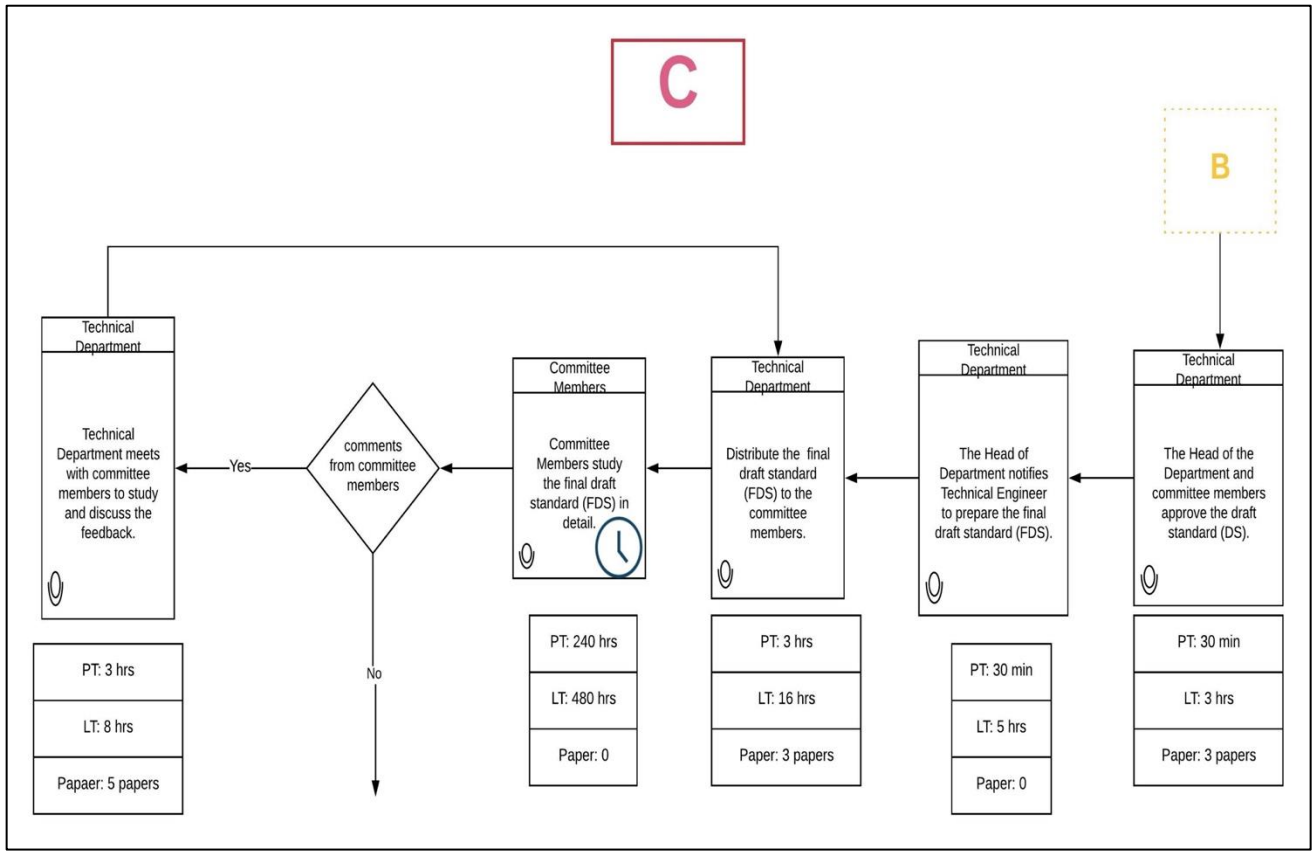
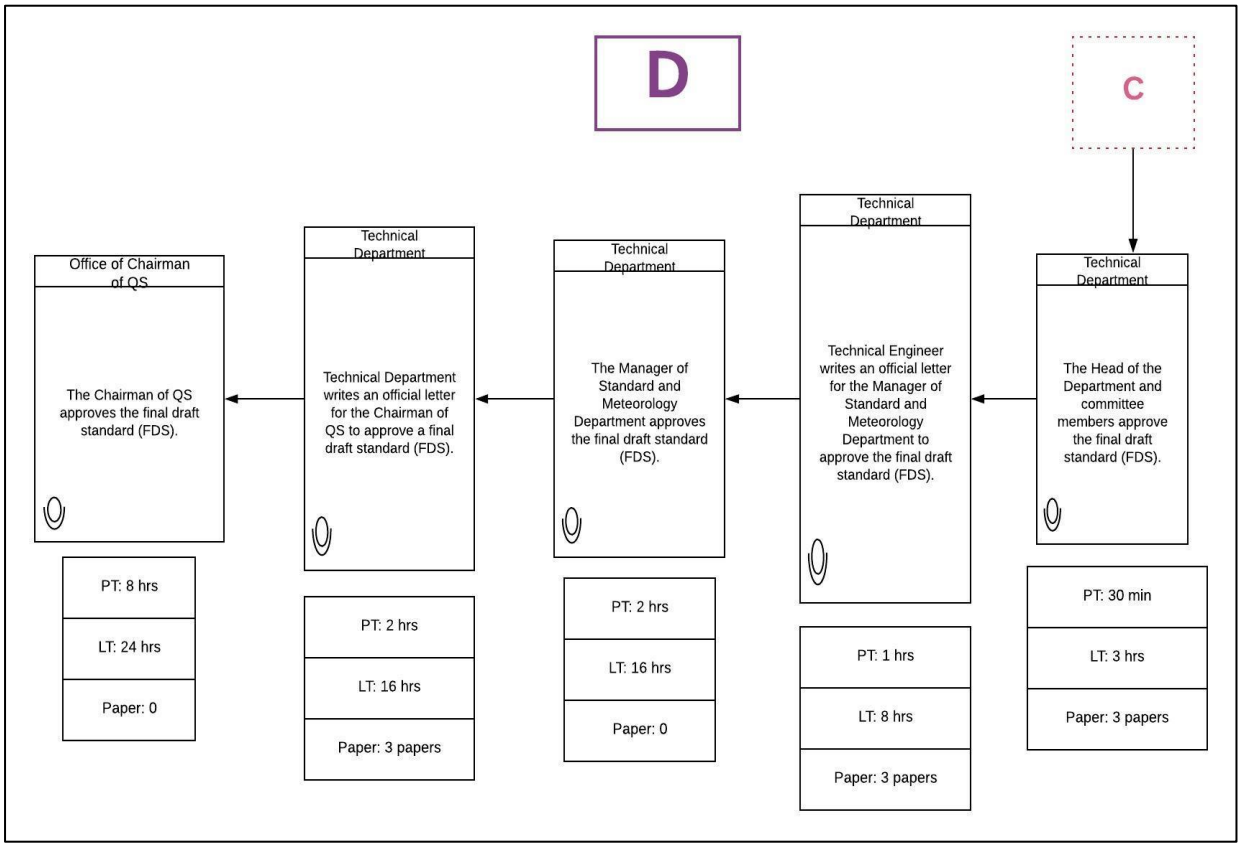
APPENDIX

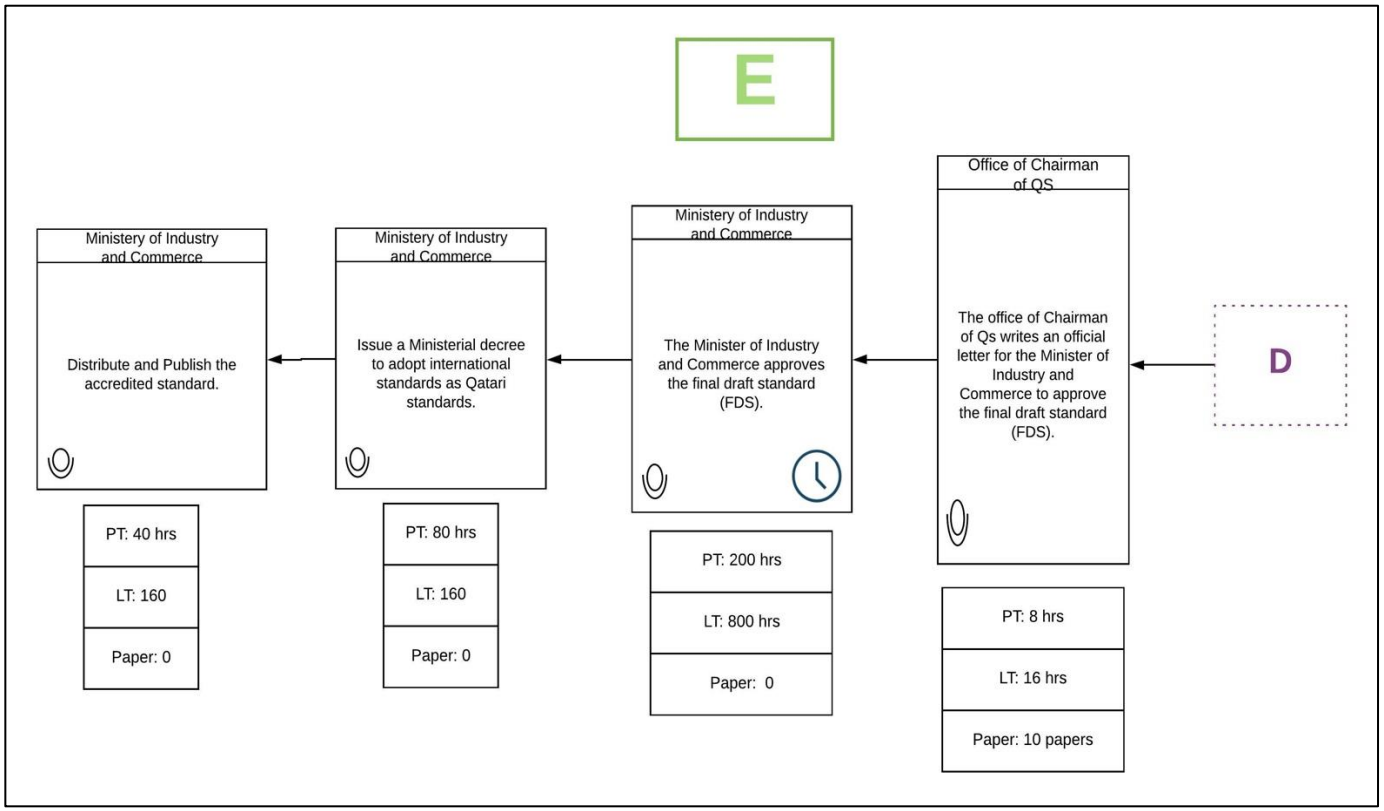
Appendix A: Detailed Value Stream Mapping (VSM) of the current process



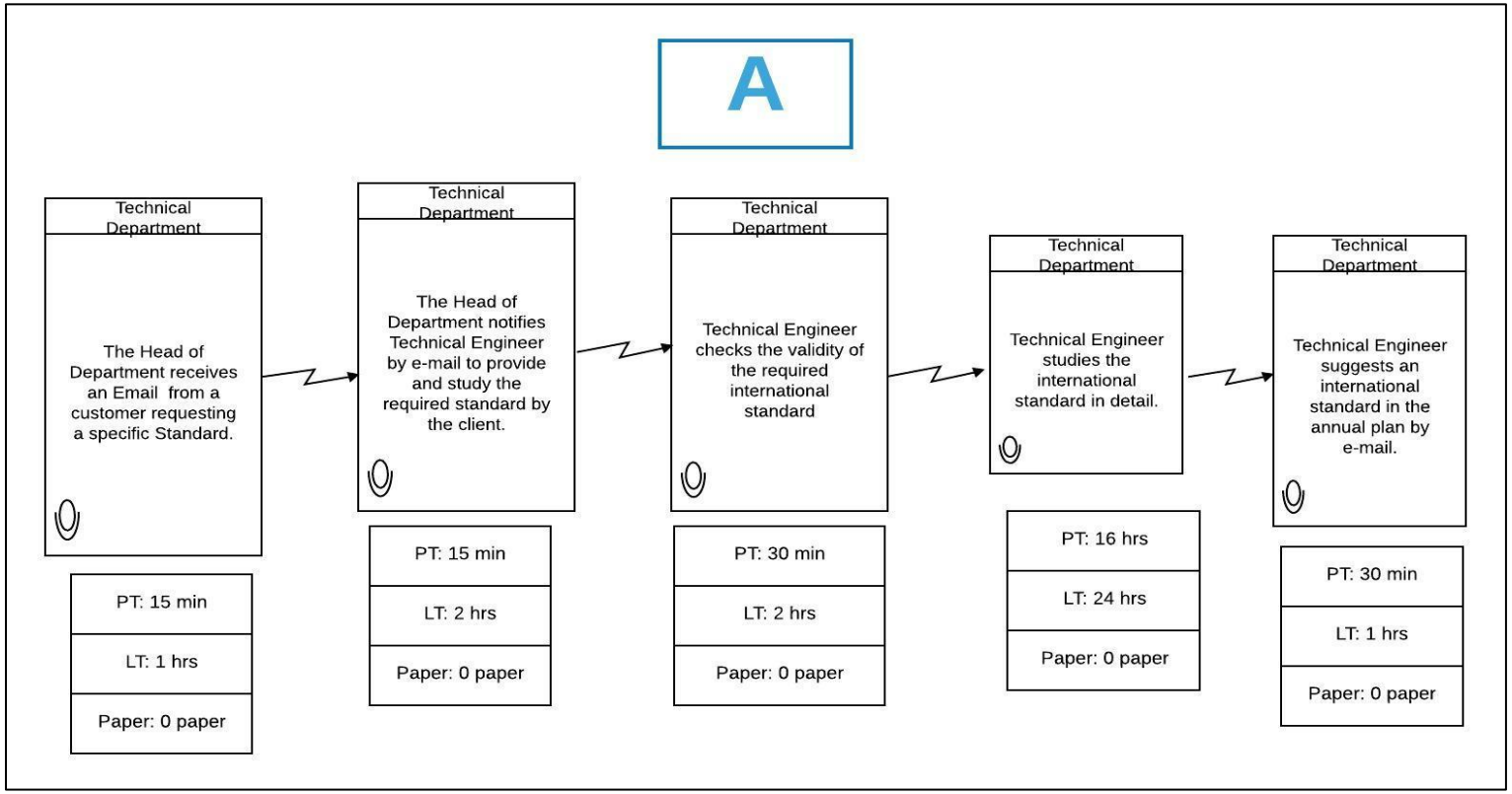

B
A
Technical Department
The Head of Department approves the suggested international standard.
PT: 2 hrs
LT: 40 hrs
Paper: 0
Technical Department
Technical Engineer prepares the draft standard (DS).
PT: 3 hrs
LT: 16 hrs
Paper: 0
Technical Department
Distribute the draft standard (DS) to the committee members.
PT: 3 hrs
LT: 16 hrs
Paper: 3 papers
Committee Members
Committee Members study the draft standard (DS) in detail.
PT: 240 hrs
LT: 480 hrs
Paper: 0
comments from committee members
Yes
No
Technical Department
Technical Department meets with committee members to study and discuss the feedback.
PT: 3 hrs
LT: 8 hrs
Paper: 5 papers

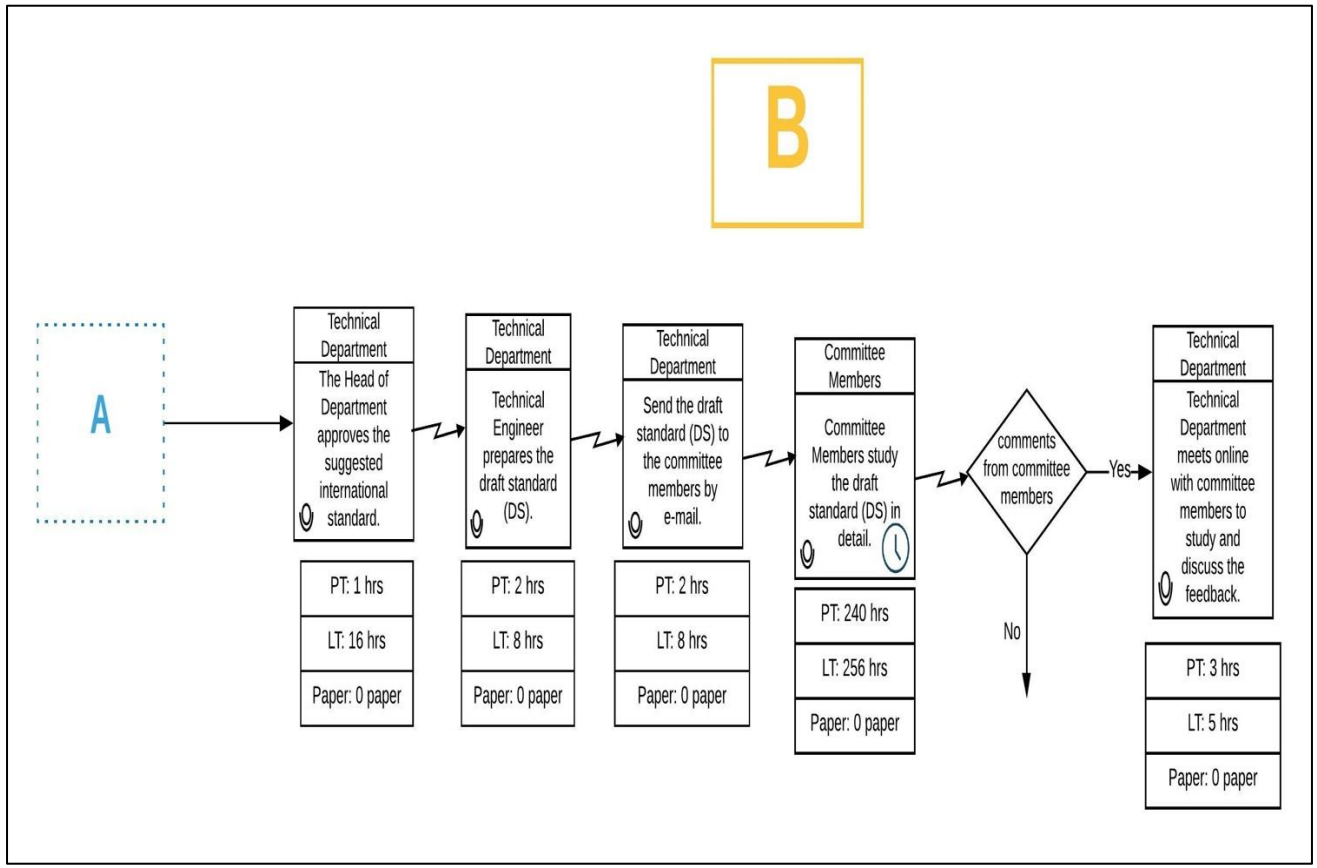

C
B
Technical Department
Technical Department meets with committee members to study and discuss the feedback.
PT: 3 hrs
LT: 8 hrs
Papaer: 5 papers
Yes
comments from committee members
No
Committee Members
Committee Members study the final draft standard (FDS) in detail.
PT: 240 hrs
LT: 480 hrs
Paper: 0
Technical Department
Distribute the final draft standard (FDS) to the committee members.
PT: 3 hrs
LT: 16 hrs
Paper: 3 papers
Technical Department
The Head of Department notifies Technical Engineer to prepare the final draft standard (FDS).
PT: 30 min
LT: 5 hrs
Paper: 0
Technical Department
The Head of the Department and committee members approve the draft standard (DS).
PT: 30 min
LT: 3 hrs
Paper: 3 papers

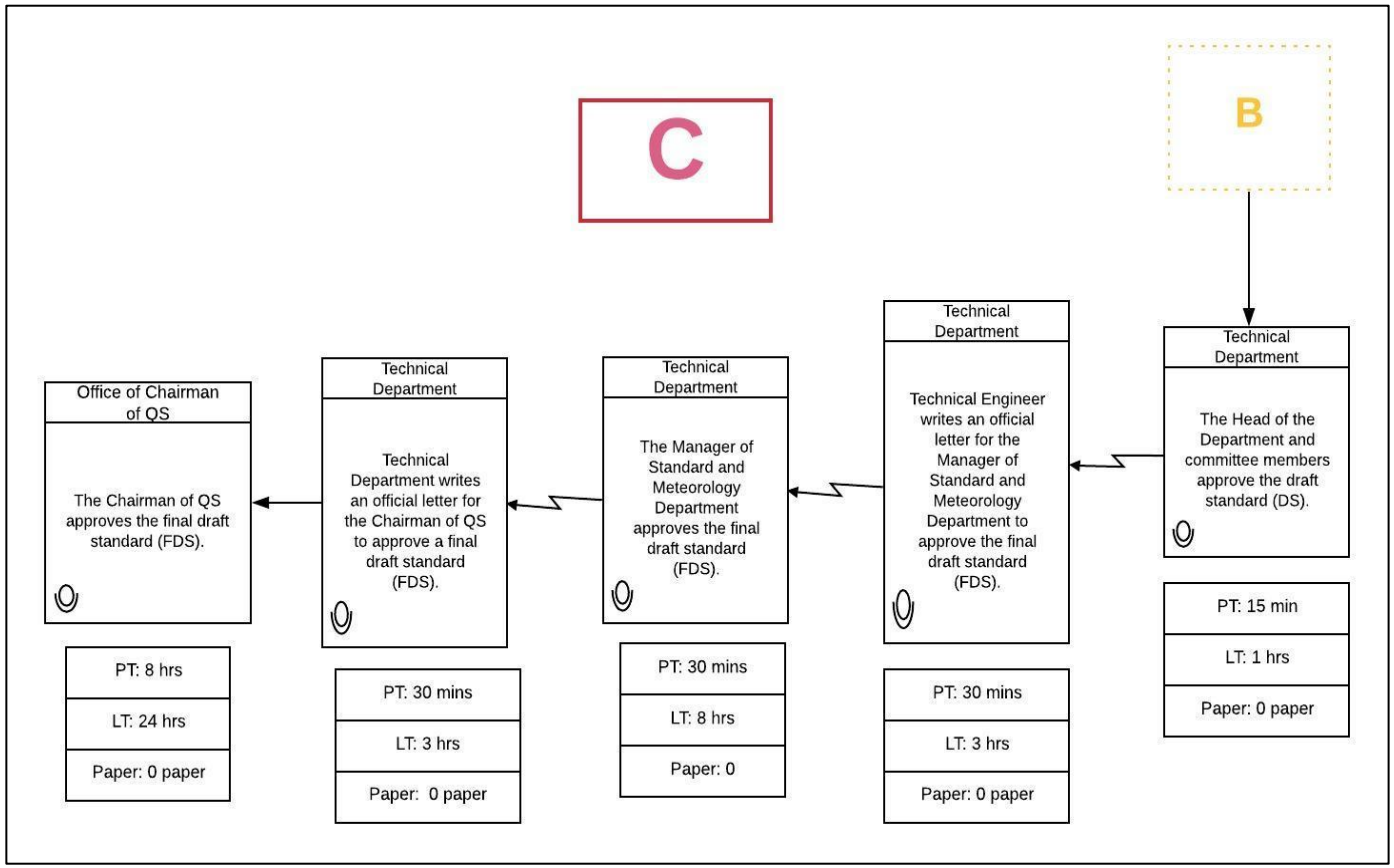

D
C
Technical Department
The Head of the Department and committee members approve the final draft standard (FDS).
PT: 30 min
LT: 3 hrs
Paper: 3 papers
Technical Department
Technical Engineer writes an official letter for the Manager of Standard and Meteorology Department to approve the final draft standard (FDS).
PT: 1 hrs
LT: 8 hrs
Paper: 3 papers
Technical Department
The Manager of Standard and Meteorology Department approves the final draft standard (FDS).
PT: 2 hrs
LT: 16 hrs
Paper: 0
Technical Department
Technical Department writes an official letter for the Chairman of QS to approve a final draft standard (FDS).
PT: 2 hrs
LT: 16 hrs
Paper: 3 papers
Office of Chairman of QS
The Chairman of QS approves the final draft standard (FDS).
PT: 8 hrs
LT: 24 hrs
Paper: 0

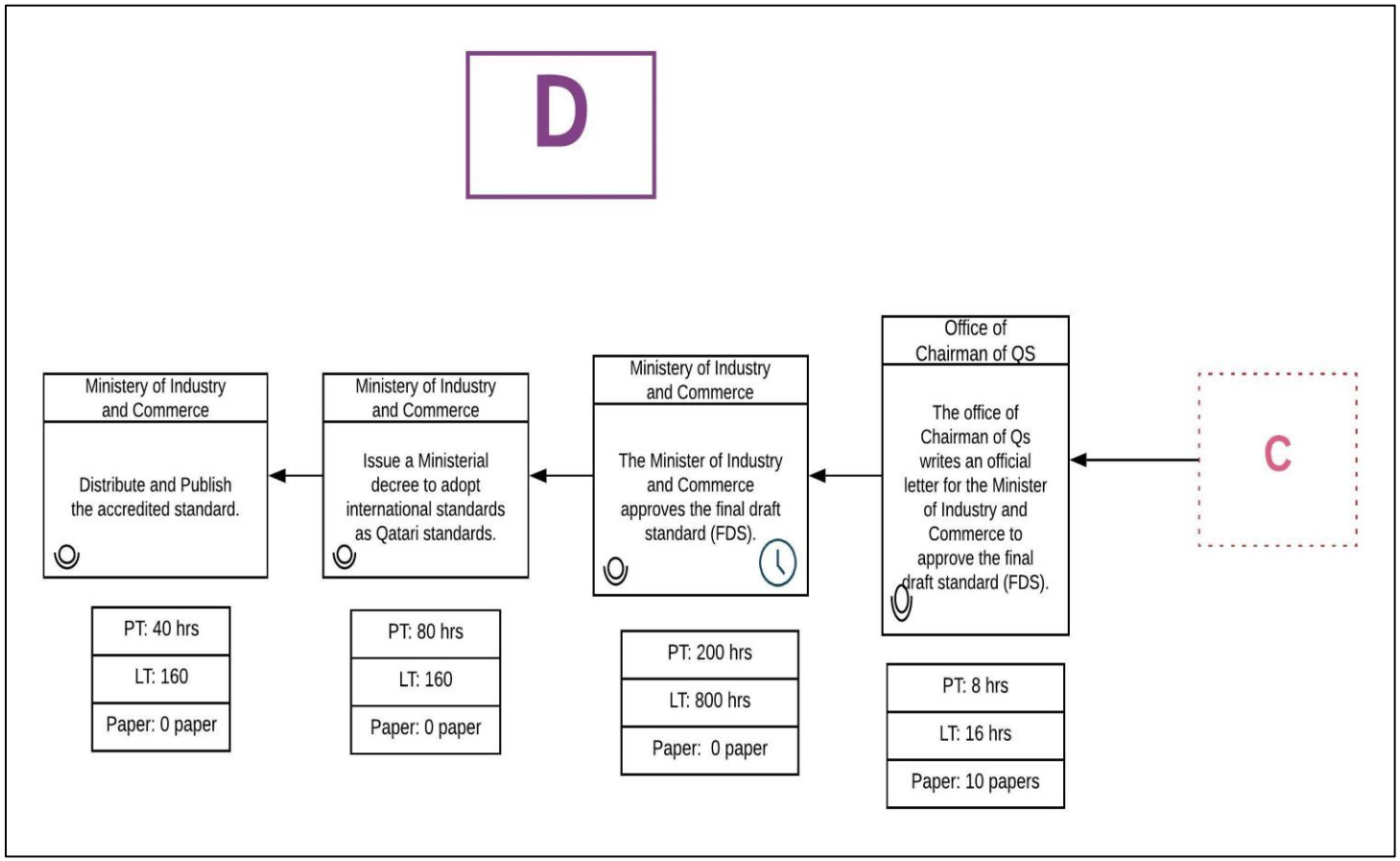

E
Office of Chairman of QS
The office of Chairman of Qs writes an official letter for the Minister of Industry and Commerce to approve the final draft standard (FDS).
PT: 8 hrs
LT: 16 hrs
Paper: 10 papers
D
Ministery of Industry and Commerce
The Minister of Industry and Commerce approves the final draft standard (FDS).
PT: 200 hrs
LT: 800 hrs
Paper: 0
Ministery of Industry and Commerce
Issue a Ministerial decree to adopt international standards as Qatari standards.
PT: 80 hrs
LT: 160
Paper: 0
Ministery of Industry and Commerce
Distribute and Publish the accredited standard.
PT: 40 hrs
LT: 160
Paper: 0

Appendix B: Detailed Value Stream Mapping (VSM) of the future process




B
A
Technical Department
The Head of Department approves the suggested international standard.
PT: 1 hrs
LT: 16 hrs
Paper: 0 paper
Technical Department
Technical Engineer prepares the draft standard (DS).
PT: 2 hrs
LT: 8 hrs
Paper: 0 paper
Technical Department
Send the draft standard (DS) to the committee members by e-mail.
PT: 2 hrs
LT: 8 hrs
Paper: 0 paper
Committee Members
Committee Members study the draft standard (DS) in detail.
PT: 240 hrs
LT: 256 hrs
Paper: 0 paper
comments from committee members
Yes
No
Technical Department
Technical Department meets online with committee members to study and discuss the feedback.
PT: 3 hrs
LT: 5 hrs
Paper: 0 paper


C
B
Technical Department
The Head of the Department and committee members approve the draft standard (DS).
PT: 15 min
LT: 1 hrs
Paper: 0 paper
Technical Department
Technical Engineer writes an official letter for the Manager of Standard and Meteorology Department to approve the final draft standard (FDS).
PT: 30 mins
LT: 3 hrs
Paper: 0 paper
Technical Department
The Manager of Standard and Meteorology Department approves the final draft standard (FDS).
PT: 30 mins
LT: 8 hrs
Paper: 0
Technical Department
Technical Department writes an official letter for the Chairman of QS to approve a final draft standard (FDS).
PT: 30 mins
LT: 3 hrs
Paper: 0 paper
Office of Chairman of QS
The Chairman of QS approves the final draft standard (FDS).
PT: 8 hrs
LT: 24 hrs
Paper: 0 paper


D
Office of Chairman of QS
The office of Chairman of Qs writes an official letter for the Minister of Industry and Commerce to approve the final draft standard (FDS).
PT: 8 hrs
LT: 16 hrs
Paper: 10 papers
C
Ministery of Industry and Commerce
The Minister of Industry and Commerce approves the final draft standard (FDS).
PT: 200 hrs
LT: 800 hrs
Paper: 0 paper
Ministery of Industry and Commerce
Issue a Ministerial decree to adopt international standards as Qatari standards.
PT: 80 hrs
LT: 160
Paper: 0 paper
Ministery of Industry and Commerce
Distribute and Publish the accredited standard.
PT: 40 hrs
LT: 160
Paper: 0 paper