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COLLEGE OF ENGINEERING

LEAN IMPLEMENTATION IN RAWDAT AL-KHAIL HEALTH CENTER

BY

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ABSTRACT

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Title: LEAN IMPLEMENTATION IN RAWDAT AL-KHAIL HEALTH CENTER

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Due to the significant increment of the State of Qatar Population in the Last few years, enormous pressure are puts on the current health care centers across the country. Health care is one of the main pillars of the future vision of Qatar 2030. Therefore, a revision of the current system of the country's health care system is highly appreciated. In this project, one of Qatar's busiest health care centers is studied to enhance the workflow of the patients. The walk-in patients are the most unpredictable, and hence, the project is focusing on improving the current walk-in patients' flow in the health care center. The Lean Thinking approach is utilized to achieve this enhancement to the system. The Value Stream Mapping (VSM) tools are the used tool to accomplish this goal. After mapping the current process of the patients, the non-value-added activities are identified, and improvement ideas are suggested in order to reduce the waiting time of the walk-in patients of Rawdat Al-Khail Health Center. Cost-reduction is also achieved using the recommended approach of organizing the work activities. The improvements in the lead time (LT) and process time (PT) were mainly in the administrative steps of the current workflow since the other actions are not controllable, where a reduction of 8.8% in LT and 9.3% in PT were achieved. Suggestions and recommendations were made to Rawdat Al-Khail Health Center, which are applicable to other health centers in the State of Qatar. Further improvements to the other sectors

of the Health Care are going to be addressed in the future in order to achieve a larger enhancement to the entire system.

DEDICATION

*To my lovely wife for her patient and support, to my family, to my friends, colleagues,
and professors who helped me to succeed in every step of my project.*

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In the loving memory of my Father. Many thanks to my mother, wife, and two kids who were keen supporters and for their invaluable motivation.

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CHAPTER 1: INTRODUCTION

The development of Qatar's health care system sector in the last decade is enormous. The growth of investment in medical technologies, healthcare services, and new healthcare facilities have transformed the health infrastructure in Qatar. This growth aimed to ensure the health needs of the nation's fast-growing population is sufficient. One of the essential pillars of Qatar National Vision 2030 is Human development, which is aiming to achieve Qatar's ambition of developing a mentally and physically healthy population.

The main driver of this research is improving health center patient flow and reduce redundant wastes in the related service either by eliminating, simplifying, or integrating. Due to a challenging present in a population increase of state of Qatar, this research is studying the current walk-in patients' flow practice in Rawdat Al-Khail health center under the auspices of the Primary Health Care Corporation (PHCC). This project aims to introduce a future recommended walk-in patient's workflow in the health center mentioned above based on the Lean Thinking approach using Value Stream Mapping (VSM) tool.

This research proposes the utilization of the VSM tool in order to eliminate wastes. These wastes categorized under the following: Overproduction, Transportation, Movement, Waiting, Processing, Inventory, Defects / Rework, and Miss-use of skills. Practically, obtaining a wastes free system is impossible. Therefore, this research aims to enhance the health care performance regarding Total Process Time (PT), Total Lead Time (LT), and Total Material Used (TM) for the walk-in patients in Rawadt Al Khail health center. This reduction of wastes will lead to cost-saving in terms of TM and

reduce PT/LT. This reduction leads to increased satisfaction from the patients and the Primary Health Care Corporation.

1.1 Problem Statement

Qatar's population has increased in the last few years enormously due to the state's mega-projects in several fields, especially the FIFA world cup 2022, the transportation projects, and the expansion in the existing oil and gas industry. These projects offered a huge number of job opportunities that attracted people from all over the world. These projects and jobs lead to a population surge that overwhelmed the health system and other general public facilities.

According to collected data from Primary health care cooperation in December 2019, the registered patient population of Rawdat Al Khail Health Center is 106,419 patients, which is 40% higher than the population of three years earlier. The total patients' visits to the health center increased by 20%, and total visits during 2019 were 289,026, with a daily average of 800 visits. Mainly, about 45% of the total visits are walk-in visits. In terms of Health Center rankings based on patients' visit volume, among 27 health Centers of PHCC, Rawdat Al Khail Health Center moved from the fourth position in 2018 to the first position in 2019. This position change clearly illustrates the increasing role and demand of the primary care services offered through Rawdat Al Khail Health Center.

The main issue of the patients that they are unpredictable and varying during the year. This variation is due to the summer vacation season, where most of the population travel abroad either for tourism or family visiting. Another reason for the yearly variation is due to seasonal diseases. Another small scope of variation comes during

the week where the patients' number decreases during the weekend, where 92% of patients visit the Rawdat Al Khail Health Center on the weekdays while the remaining 8% attend on the weekend. This variation is due to the closing of some clinics in the Rawdat Al Khail Health Center.

During the conducted site visits, multiple issues had been noticed. The first issue is the absence of clear signs of the waiting areas and other facilities of the Health Center. This absence of signs leads to the queuing of patients in front of the Triage door, the pharmacy windows. The patients are repeatedly asking the employees for the directions for the other facilities. The second issue is the No Show patients from the first call for the service providers; this includes the Registration, Triage Assessment, Doctor Assessment, Laboratory, and Pharmacy. This issue will lead to the interruption of the process flow of other patients. The third problem is the Payment method in service providers such as pharmacy. The patient can pay either in the cashier next to the pharmacy, which always crowded with only one working employee. The second option is the main cashier of the Health Center, which has more working employees but far from the pharmacy. This distance causes inconvenience to the patients to walk to the main cashier. Last but not least, the issue of some of the Receptionists' attitude toward the patients is not cooperative. The attitude causes arguments between the patients and the employees, which means more disturbance to the flow of the system.

1.2 Project Objectives

- To examine the value of the Lean Thinking of the existing patient flow of the walk-in patients on Rawdat Al Khail Health Center.
- To eliminate, simplify, or integrate the possible wastes in services in Rawdat Al Khail Health Center.
- To propose the future recommended patient flow to the management of PHCC

1.3 Research Methodology

This research intended to reduce the waiting time of the patients and materials used for the walking patients' in Rawdat Alkhail Health Center by applying the Lean Thinking approach. The used method in this research is the VSM. This method will propose the recommended future state of walk-in patient flow. Then the introduced recommended future walk-in patient flow will be compared with the current walk-in patient flow.

First of all, an interview conducted with the Rawdat Alkhail Health Center Manager to understand the operating system of the health center. Then, a discussion with several patients and employees at Rawdat Alkhail Health Center had been held to understand the current patients' flow and associate issues. This collected information helped in understanding the issue, then identifying the problem for this research. After identifying the issues of the current system, the Lean Thinking approach used to reduce waiting time. Additionally, a study visit to many health centers and other hospitals in Qatar to understand there practice in patient flow. A general overview of all working health sectors system in Qatar was obtained.

The data used for this research was collected from the Rawdat Alkhail Health Center and with their permission. The data consist of three years of raw data of all patients visited the Rawdat Alkhail Health Center and their spent times in the center in addition to their numbers, nationality, lead time, and other statistical data. The data obtained do not contain any personal data of the patients, such as names and phone numbers or the type of diseases.

Due to the significant number of the gathered data, the project focused on the walk-in patients flow only. These patients are the most unpredicted; due to the reasons mentioned in the introduction section, the objective of this research chosen to improve the patients' flow system in general at Rawdat Alkhail Health Center.

1.4 Report Outline

After the introduction chapter, the project report consists of the following chapters: chapter two is an overview of the resent Literature about Lean Thinking in general and especially for health care waste reduction. Next, chapter 3 explains the utilized Research Methodology, Value Stream Mapping (VSM), in waste reduction. Then, chapter 4, the implementation of VSM for the walk-in patients' of Rawdat Alkhail Health Center. Finally, the Conclusion, summary, recommendations, and future work of the project made in chapter 5.

CHAPTER 2: LITERATURE REVIEW

In this chapter, a recent literature review of the books and research papers related to the field of Lean Thinking in the healthcare sector. Besides, a summary of some of the general applications of the Lean Thinking techniques in several areas made. The main keywords for research were Lean Thinking, Health care sector, waste reduction.

2.1 Introduction to Lean Thinking

Lean Thinking is a structured approach to solve the problems that cause waste in an organizational system. According to Grove, Meredith, Macintyre, et al. (2010), the history of the lean concept traces back to the early 1900s invention of the assembly line by Henry Ford. Henry Ford devised a system of marrying together work processes with interchangeable automobile fitting parts thus effectively creating a system where both labor and time incurred in completing the automotive assembling was significantly reduced. The essence of Henry Ford's assembly line as the primer to the concept of lean Thinking is that it worked towards reducing both time and labor wastage in the automobile production process. The lean Thinking concept first initiated by Henry Ford was further developed under the Toyota production system, which narrowed down lean management focus from the process as the major area of attention to now focusing on eliminating waste in the product itself (Rotter, et al., 2019). The outcome was that lean management was effectively transformed from a purely manufacturing-centered process into a concept that can be adopted in the management of the production of goods and services in other sectors. Effectively, in the hospital context, Lean Thinking has emerged as a set of operating attitudes and methods that support to create maximum

value for patients by reducing waste and waits in the healthcare delivery systems and processes (Lawal, et al., 2014). Thus, in Healthcare, lean Thinking emphasizes paying attention and consideration to the needs of the patient clients, while also ensuring employee involvement and continuous improvement of the systems. Lean Thinking in Healthcare is geared towards listening at what customers want, engaging the customers in what they value most, and ensuring to meet the expectations of customers.

2.2 Lean Thinking Applications

Lean Thinking has found extensive application in diverse sectors of the economy. The fundamental basis of application of lean Thinking has been in both the manufacturing and industrial production sectors. For example, while initially applied in the early 1900s under the Ford assembly line system, the Toyota production system took up the Lean Thinking concept and sought to advance it further. However, the application of the lean concept has varied based on the specific industry or operational area it is being implemented. For example, under the Toyota production system, Lean Thinking is applied to reduce wastage by eliminating unevenness and overburden of the systems (Grove, Meredith, Macintyre, et al., 2010). Accordingly, the Toyota manufacturing processes have focused on smoothing the production and applying the demand-push system where the customers' demand defines the production to be made as opposed to applying the conventional target push. The outcome is that Toyota is able to eliminate wastes through avoiding overproduction of automobiles through making sure that customer demands inform the quantities to be produce instead of producing huge quantities and then pushing to sell all of them.

In addition to the manufacturing and industrial production applications, lean Thinking has also found extensive application in the service and construction sectors.

For example, lean Thinking was applied by the Virginia Mason Center to help address the challenges of unnecessary staff and material movement during construction, with the outcome being to reduce the unnecessary movement by 72% within two years of Lean Thinking implementation (Spagnol, Min & Newbold, 2013). The application of the Toyota lean philosophy has also become adopted significantly in the healthcare sector, with promising outcomes that indicate the lean concept can indeed improve the healthcare service delivery to patients (Boronat, Budia, Broseta, Ruiz-Cerdá, Vivas-Consuelo, 2018). On the other hand, Mofizul (2014) identifies the implementation of lean management in the energy sector, where the energy and power supply companies have in the recent decades been involved in the adoption of lean management through waste removal, increased customer communication, and quick response to the customer complaints. The application of Lean Thinking also extends to other service sectors, where there “are several examples of its applicability in high-tech companies in the software industry and games” (Silva, Calado, Silva & Nascimento, 2013). Therefore, lean management has continued to find widespread application in diverse industries, despite the fact that the outcomes of the implementation of the lean concept for the different industries and sectors have been mixed.

2.3 Lean Thinking in Healthcare

Lean Thinking is of significant value in the healthcare industry. More than any other sector, the healthcare sector offers direct beneficial impact to the society, while any errors in the health sector are also quite negatively impactful on the entire system. Thus, according to Kovacevic, Jovicic, Djapan & Zivanovic-Macuzic (2015), lean Thinking is important for the healthcare sector because it provides the relevant philosophy and tools of applying more effort to benefit both customers and the healthcare facilities,

without creating additional costs. Further, Castaldi, Sugano, Kreps, Cassidy & Kaban (2016) offers that Lean Thinking in Healthcare also extends to the concept of value, where the major focus of Lean Thinking in the healthcare system is to break down the operational processes into individual steps that create value for customer and patients. Consequently, in the health sector, any step, process or service that is not valuable to the clients or customers is considered a waste and efforts must be applied to eliminate it from the system. The aim is to ensure that efficiency in the delivery of health services to patients is realized without creating additional costs to the healthcare facility.

Accordingly, Boronat, Budia, Broseta, Ruiz-Cerdá, Vivas-Consuelo (2018) stipulates that Lean Thinking in the healthcare sector simply entails “to improve the speed and efficiency of the processes through the detection and elimination of any unnecessary step or in which material losses occur”. Thus, to the extent that the speed and efficiency with which patients and customers are served by healthcare facilities and systems is improved, while material losses and unnecessary steps are eliminated, the implementation of Lean Thinking in healthcare services is said to be fruitful. Additionally, lean Thinking in Healthcare also points to the aspect of reducing errors as an important focus for lean implementation in Healthcare. According to Spagnol, Min & Newbold (2013), data from the “Institute of Medicine (IOM) estimates that, on average, hospitalized patients are subject to at least one medication error per day”, necessitating error to attract serious consideration in any intended health services improvement efforts. Therefore, Lean Thinking in healthcare services should mainly focus on the reduction of errors that might impact the health outcomes of patients seeking health services negatively. Thus, Spagnol, Min & Newbold (2013) contends that improvement in value delivery to patients should emphasize the removal of

anything that might hinder efficient cure and pain relief for patients. In this respect, Lean Thinking is a concept that healthcare facilities should focus on adding to their service delivery programs.

2.4 Lean Thinking Applications in Healthcare

There is extensive evidence of the implementation of lean Thinking in Healthcare. For example, Kovacevic, Jovicic, Djapan & Zivanovic-Macuzic (2015) presents the case study of the implementation of lean Thinking at the Royal Bolton NHS Hospital, UK, where the lean concept was implemented to stream the healthcare facility's operations for a period of 18 months. The results of the implementation of lean concept at the healthcare facility reported "42% reduction in paper work, better multidisciplinary team working, and a reduction in length of patient stay by 33% (Kovacevic, Jovicic, Djapan & Zivanovic-Macuzic, 2015). Therefore, there are indications that when implemented effectively, Lean Thinking can create significant benefits for healthcare facilities because it institutes organizational-wide improvements and changes. Further, Spagnol, Min & Newbold (2013) presents a case study of the implementation of lean Thinking in a Canadian health facility, where the findings of the post-lean implementation indicated significant quality improvement in both the reduction of physician assessment wait-times for patients as well as minimization in the material and staff costs requirements. The positive impact of the implementation of Lean Thinking in Healthcare was also identified in ambulatory care, where implementing Lean healthcare principles helped to reduce waiting time and the length of stay of patients in an ambulatory (Tlapa, et al., 2020).

However, the beneficial outcome of the implementation of Lean Thinking in Healthcare has largely been contested. Joosten, Bongers & Janssen (2009) argue that

one challenge facing the evaluation of the impacts of Lean Thinking in the healthcare sector is that “there is a lack of high-quality evidence supporting lean premises”. The fact that evidence regarding the positive impacts of lean management in the healthcare sector could be inconclusive stems from the fact that the healthcare sector is quite a unique and distinctive sector in the manner of its operations as well as the metrics applied to measure the outcomes. While profitability and losses are mainly applied to define the success or failure of most businesses enterprises, the healthcare sector operates under a set of unique metrics that include the rates of patients flow, cost of accessing health services, length of stay (LOS), and the levels of the waiting list for complex treatments (De Souza, 2009). Therefore, it becomes difficult to determine the extent of the success of the implementation of lean Thinking in health services because the metrics to be applied to measure the outcomes are quite unique and unconventional. Further, Joosten, Bongers & Janssen (2009) provides that successfully measuring the outcomes of lean thinking implementation in the healthcare sector can be increasingly difficult because the original lean management tool may find limited application in the healthcare sector. The outcome is that Lean Thinking is implemented in very varied approaches by healthcare facilities and institutions, as informed by the need of each specific healthcare entity.

Accordingly, implementing Lean Thinking in healthcare facilities does not necessarily guarantee success considering that according to Silva, Calado, Silva & Nascimento (2013), “states that success with the Lean Startup approach is less about what kind of organization you're in and more about how you approach the problem is in your hand”. Therefore, it is more of how a healthcare facility is able to utilize the resources available and structure the right team to spearhead the lean concept

implementation that will determine the level of success recorded by a healthcare facility seeking to implement Lean Thinking. Further, according to Castaldi, Sugano, Kreps, Cassidy & Kaban (2016), among the major “limitations for Lean methodology in the health care arena have been the scarcity of financial resources for smaller hospitals and high levels of bureaucracy for large hospitals”. Therefore, it is essential that if lean Thinking is to be implemented successfully in healthcare organizations, resources adequacy accompanied by the removal of strict bureaucracy should be emphasized. Additionally, based on a study of three UK NHS trusts, De Souza & Pidd (2011) established that poor communication, lack of support or ownership of the lean process by management and employees, as well as skepticism attached to lean implementation are major factors contributing to lean implementation failures in healthcare organizations. More importantly, Rossoa & Saurin (2018) provides that the success level of lean thinking implementation in healthcare organizations is mainly determined by the “ability of the healthcare system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required performance under both expected and unexpected conditions”. The implication is that regardless of the availability of resources and appropriateness of bureaucracy-free structure of management, the ability of a healthcare organization to adjust to the disruptive changes created by lean implementation will determine its level of success with lean operations.

2.5 Simulation and Scheduling Applications in Healthcare

There exist other methods to improve the healthcare system in the literature, the use of simulation in Healthcare, and the scheduling. The first method, simulation in Healthcare, is not vastly adopted in the healthcare sector as in the manufacturing, business, and other industries. The use of simulation in the core of these industries leads

to significant improvements. Utilizing the simulation for industries usually consumes a lot of time in building an accurate model for the simulation. Still, the results of the simulation provided huge benefits such as quicker installations and product optimizations. There are plenty of academic papers related to the use of simulation in the field of Healthcare; however, most of these implementations were unsuccessful compare compared to other industries.

Due to the high involvement of human factors in the Healthcare and the deep-rooted cultures of a hospital thought to be the reason for the low success rate. Therefore, additional awareness must be given to trialing, and safety model simulations result become less realistic. Still, airport complex models are focused on human entities that consider reactions, feelings, and the corresponding uncertainty. Likewise, notably in military models Brailsford (2007), the “clinical hierarchy,” including silo effect between departments and professional boundaries are just as dominant in other settings.

The second approach is Healthcare is scheduling. The optimizations of the utilization of the healthcare sector resources such as physicians, personnel, nurses, surgeons, and the facility is the main aim of scheduling. Therefore, the flow of the patient is optimized without increasing the cost of the system.

Defining timetables by setting appointments for scheduling the flow of the patients. The duration of the patient’s visit and type of treatment, types of equipment, nurses, and physicians expected, need to be considered for the scheduling method. A thorough study performed by Ho (1992) on the techniques for outpatient scheduling. The authors considered different rules for scheduling the patients and studied their ability to minimize the cost.

Determining the resources required by each patient and their availability are essential for the scheduling of the patients. The authors in Beliën (2008) developed systems for scheduling to improve the flow of the patients within hospitals. The type of requirements for the patients and uncertainties in the time of arrival makes scheduling the emergency rooms is very complicated. The usage of patients flow simulations have been implemented for scheduling the emergency departments. The authors in Hung (2007), have utilized the simulation models to apply scheduling of the resources in the departments of emergency.

2.6 Summary

Lean management is a structured approach to solve the problems that cause waste in an organizational system that dates back to the early 1900s invention of the assembly line by Henry Ford. The subsequent development of the concept under the Toyota production system made it possible for lean Thinking to be adopted and implemented across diverse sectors and industries. While largely implemented in the manufacturing and industrial production sector, lean Thinking has also been implemented in the health, construction, hospitality, as well as in gaming and computing service sector industries. However, the beneficial outcome of the implementation of Lean Thinking in Healthcare has largely been contested. The positive impacts of lean management in the healthcare sector could be inconclusive stems from the fact that the healthcare sector is quite a unique and distinctive sector in the manner of its operations as well as the metrics applied to measure the outcomes. Finally, a literature review on two other applications for the healthcare sector represented by simulations and scheduling have been conducted.

CHAPTER 3: RESEARCH METHODOLOGY

Initially, in this chapter, the research objective of this project stated. Afterward, the used data acquisition strategy for the waste reduction research project of the patient at Rawdat Al-Khail health center expressed. Finally, the waste reduction methodology of the current patients' system using Lean Thinking techniques (VSM) revealed.

3.1 Current Walk-In-Patient System

In this section, an explanation of the workflow of the current walk-in patients of Rawdat Al-Khail health center is explained in detail, based on the policies of PHCC in addition to several site visits and staff interviews. Initially, Upon entering the Health Center, all Patients will be directed to the triage area by the greeting staff who are stationed on the front triage desk. Any patients who are identified by the greeting staff as a potential emergency will be transferred directly to the Treatment/Observation Room for stabilization and/or transfer to the Hamad Hospital Emergency Department if required. The remaining patients, who are not deemed to be an emergency, through the initial assessment, will be directed to the Waiting Triage area, with a Q-Matic ticket, where they will wait to be seen by the Triage Nurse. Then, when the Triage Nurse assesses the patient, the triage documentation, i.e., the Cerner triage fields (as shown in Figure 1) will be fully completed. Where the Cerner is the health care database program. Based on the Nurse Triage assessment, patients will be managed according to the following categories, as below:

- 1) Emergency
- 2) Priority
- 3) Routine

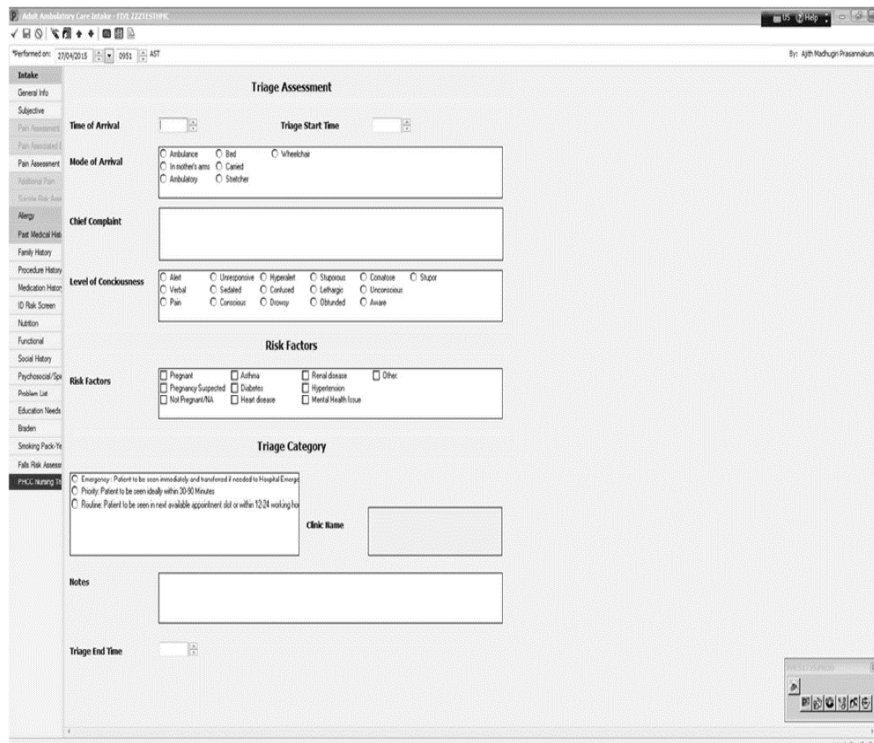


Figure 1. Cerner Triage Field Screenshot- obtained from PHCC

Each of the above patients' categories has a specific definition expressed in Appendix A. the PHCC's Triage Patient Flow Diagram illustrated in

Figure 2.

The first category is the Emergency Case (assessed by a physician within 3-5 minutes), which defined as a Patient with one or more medical Acute and posed an immediate risk to the Patient's life or long term health. These Emergency cases will be managed as follows: initially, a qualified nurse and/or physician should start assessment

and life support. The nurse/clinical greeter should Summon the assigned Physician on duty/in charge. An immediate transfer should be Arranged As directed by the physician after assessment for urgent cases to Hamad Hospital via Emergency Medical Services (EMS). All attempts to stabilize the patient is to be made before the emergency transfer.

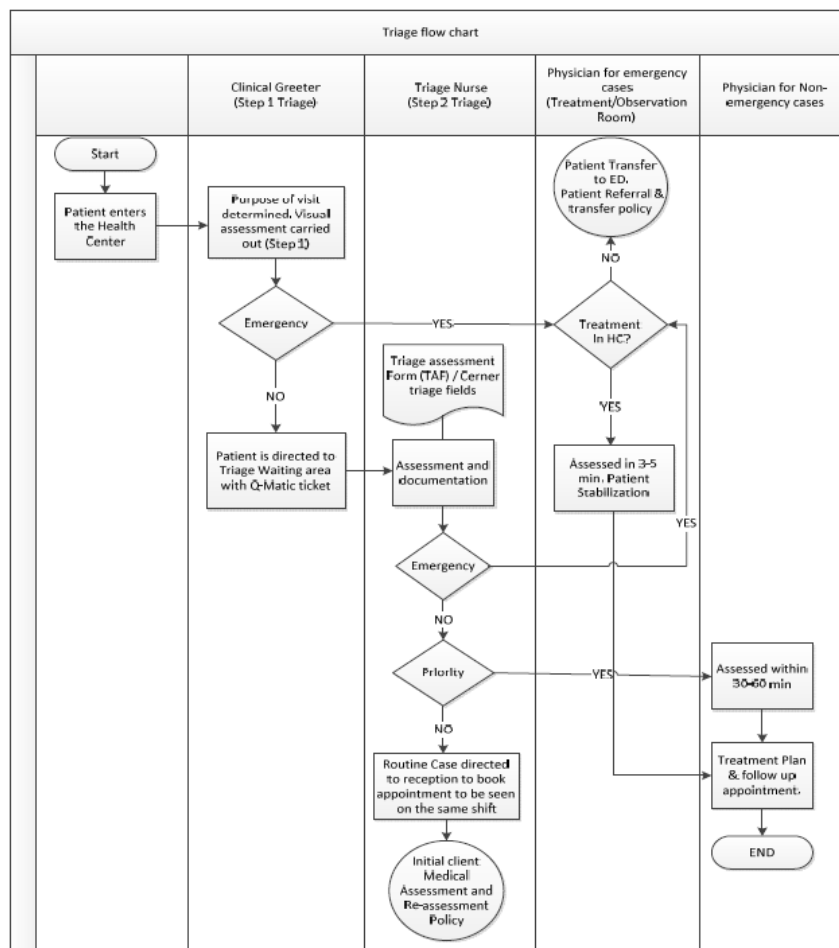


Figure 2. Triage Patient Workflow Diagram- obtained from PHCC

The second category of the walk-in patient is the Priority (assessed by a physician within 30-60 minutes). A 'Priority' case can be described as a Patient with one or more medical condition(s) that:

- 1) Are prone to deteriorate if not consulted as soon as possible
 - 2) Are not life-threatening
 - 3) Can be managed by a PHCC Physician and/or trained Nurse
 - 4) Can be managed without referral to Hospital ED
- For children under 5 years of age, pregnant women or elderly (65 and over) with complaints (are considered priority), extra care must be taken to rule out any serious underlying condition. In case of doubt, the Triage Nurse must contact the assigned Physician.
 - Fever & Diarrhea can have severe underlying conditions and must be assessed with caution. In case of uncertainty, these patients must be treated as a priority, and Physician advice sought as a matter of urgency.
 - The Triage Nurse will fully complete the Cerner triage fields. Patients that are assigned the 'Priority' category should be seen by a physician, ideally within 30-60 minutes of their presentation at the Health Center.
 - All 'Special Needs' patients (with a mental, emotional or physical disability) should be allowed to access the Waiting Triage area upon arrival and be seen by the Triage Nurse without delay.
 - Patients waiting in the reception or triage waiting area to be seen by the nurse or physician must be visually checked regularly (every 30 minutes) by the Pivot

Nurse. Patients should be taken from the waiting area straight into the Treatment/Observation room if their condition deteriorates.

The last category of the walk-in patient is the Routine Cases where a physician assesses them on the same shift. The Routine case can be described as a Patient with one or more medical conditions, that:

- Are not life-threatening
- Can be managed by a PHCC Physician or nurse
- Clinically safe to carry out the investigation, intervention and/or treatment of the Patient's condition, on the same shift.

Maximizing patient safety, including those who are considered routine, should be seen by a physician on the same shift is the PHCC Golden rule. Only patients who request it should be offered an appointment at a later shift/date. The Triage Nurse shall fully complete the triage field on Cerner and then direct the patient to reception to be booked into an available space in the general appointment clinic (GAC), or to be seen in the Multidisciplinary (MD) room in larger HCs, on the same shift.

As monitoring outcomes from the patients visit the following measures taken in:

- The Key Performance Indicators (KPIs) that reported for this service are as follows:
 - 1) Average waiting time for emergency cases to seen by a physician.
 - 2) Average waiting time from triage to physician consultation for priority cases
 - 3) Average waiting time from triage to physician consultation for routine cases
 - 4) Average waiting time from the pharmacy and Laboratory service for all cases
 - 5) Percentage of appointments booked in advance

3.2 Current System Issue and Limitation

Review the current system is a sound system; however, in practice, there are few issues noticed. The first issue of the current system is the lack of guidance signs in Rawdat Al-Khael health center. Some patients are waiting and queuing in front of the Triage door, physicians' doors, and the pharmacy windows. The waiting areas of the Triage, physicians, and pharmacy, are not cleared specified, which creates confusion for the patients, especially the first visiting patients. The created confusion affects the lead time of the patients. Also, the patients are repeatedly asking the employees for the directions for the other facilities.

The average waiting time calculation for all cases is not accurate, because of the waiting time between the receiving of the Q-Matic ticket and the desired service not included in the average waiting time. For instance, when a patient wants to collect medicine from the pharmacy. Initially, he takes a Q-Matic ticket then he waits to be called by the pharmacist. After the patients called, the time starts for the calculations. This is a technical issue caused by the absence of a link between the Cerner and Q-Matic system.

The payment method in the current system leads some time to increase the LT of the patient. For example, if the patient wants to pay for the medicine. Two options are available either in the cashier next to the pharmacy, which always crowded with only one working employee. The second option is the main cashier of the Health Center, which has more working employees but far from the pharmacy. This distance causes inconvenience to the patients to walk to the main cashier.

3.3 Lean Thinking (Value Stream Mapping Tool)

In a process, the lean Thinking approach espouses elimination, integration, and simplification sources of waste. Therefore, the value-added activities which satisfy the customer should be applied. Upon its success in organizing manufacturing processes and elimination of wastes sources, Lean Thinking has been applied in the healthcare sectors. One of the applying tools of Lean Thinking is VSM. The VSM tool can be utilized to improve many parameters in the health care sectors such as our Rawdat AlKheel Health center. These parameters are summarized by the following:

- Material used
- Process time
- Lead time

Which improves the patient flow in the health center and leads to patients and PHCC satisfaction.

The are six-steps to perform waste elimination using VSM. in the Rawdat AlKheel Health center. These steps are as follow:

- 1) To understand the current process (flow of the patient)- (Process Mapping)
- 2) Identify the waste of the current flow of the patient- (VSM)
- 3) Elimination, integration, and simplification of waste of the process stages - (Eliminate Wastes)
- 4) Draw the future enhanced flow of patient - (Future State)
- 5) Implement and evaluate the recommended process flow (Apply & Measure)
- 6) Do the same procedure all over again – (Repeat)

These steps demonstrated in Figure 3.

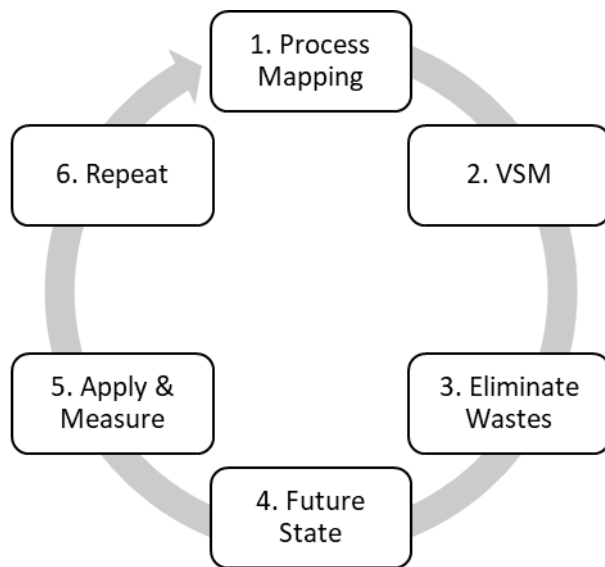


Figure 3. The Six-Steps to Perform Waste Elimination Using VSM.

CHAPTER 4: LEAN THINKING IMPLEMENTATION

4.1 Required data and strategy of data acquisition

An essential step of implementing Lean Thinking using the VSM tool to identify the data necessary to be collocated. The collection of the data will be used in the process mapping of the current walk-in patient's flow system of Rawdat Al- Khell health center. Also, the data will be used in the fifth step to evaluate the recommended method.

The required data to map the process of the current walk-in patient at Rawdat Al-Khail health are as follows:

- Rawdat Al-Khail catchment area
- Rawdat Al-Khail health center services
- Rawdat Al-Khail health center policies and procedures for a walk-in patient
- The number of patients per day/week/year
- The patient profile includes Gender, Age at visit data, etc
- The category of the patient (Walk-in or Appointment)
- Average start and end time for triage service
- Average start and end time for treatment
- Pharmacy Q-Matic: Average Queuing Time (AQT), Average Preparation Time (APT), and Average Service Time (AST)
- Interviews with the workers and patients in the Rawdat Al-Khail health center

The above data are sufficient to map the current procedure of the walk-in patient at Rawdat Al-Khail health center. Some of the collected data are not accurate due to the following reasons. The first reason presented in the existing two separate systems at the health center (Cerner and QMatic). The second reason is that the patients recorded a

time of registering is noted after they been registered not since they have arrived at the registration.

The data acquisition strategy for the walk-in patient at Rawdat Al-Khail health center was performed using the following five steps. The first step was to acquire an official letter from Qatar University addressed to the president of PHCC to collect the data for research purposes only. In the second step, an interview was conducted with the Manager of the Rawdat Al-Khail health center to understand the existing operating system of patients. The third step of data collection was discussions with several patients and employees at Rawdat Al-Khail Health Center to understand the associate issues with patient flow. This collected information helped in understanding the Value-added activities, and non-value added activities for patients. The fourth step was conducting several study visits to other health centers in the state of Qatar. The final stage of the data collection was obtaining the raw data from different departments of the PHCC.

Due to the significant number of the collected data, the project focused on the walk-in patients flow only. The most unpredictable patients are walk-in patients. The objective of this research chosen to improve the patients' flow system in general at Rawdat Alkhail Health Center. The above data are sufficient to map the current procedure of the walk-in patient at Rawdat Al-Khail health center. Some of the collected data are not accurate due to the following reasons. The first reason presented in the existing two separate systems at the health center (Cerner and QMatic). The second reason is that the patients' registered time of the services recorded after the end of the service.

4.2 Data Analysis

After obtaining the raw data, insight analysis was performed to understand the distribution of patients at Rawdat Al- Khail health. Initially, the Rawdat Al-Khail health center’s information was collected to realize the circimctences related to the health center deeply. First of all, the catchment area of Rawdat Al Khail Health center now covers 18 districts which include major zones such as Mushaireb, Al Bidda, Doha Jadeeda, Najma, Mansoura, Rawdat Al Khail and Bin Mahmood (as shown in Figure 4). To meet the needs of the catchment crowded areas, Rawdat Al-Khail health center was built as a TYPE C class, where this class considers as the highest category in PHCC.

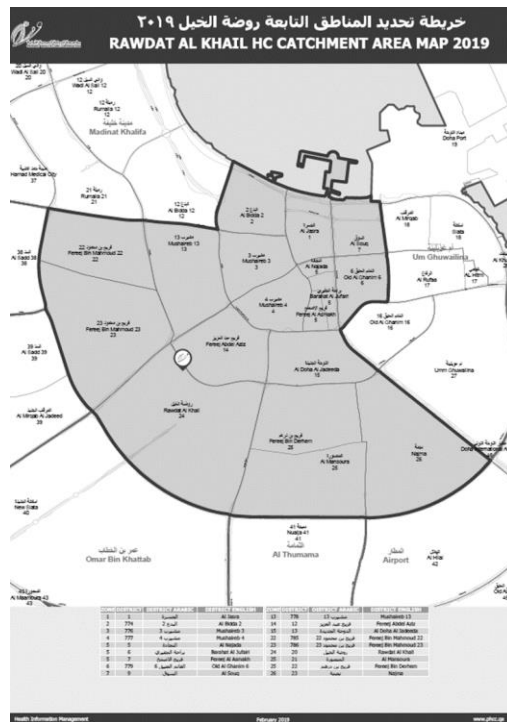


Figure 4. Rawdat Al Khail HC Catchment area May 2019- obtained from PHCC

The health center covers expanded range of Family Medicine Clinics, Dental Clinics and Allied Health Services including Physiotherapy and ancillary services such as Pharmacy, Radiology and Laboratory Services (Appendix B); and in early 2019, the health center was further classified as RSC (Regional Specialty Center) with specialty services encompassing primary care services to Ophthalmology, Dermatology, and ENT, etc. further, the health center launched Urgent care services during the same year.

As of December 2019, the registered patient population of Rawdat Al-Khail Health Center is 106,419 patients, which is 40% higher than the population of two years earlier. as shown in Table 1:

Table 1. Rawdat Al-Khail health center Registered patients for the last three years

Year	Registered Patients
2017	77,954
2018	90,504
2019	106,419

The total patients' visits to the health center increased by 20%, and total visits during 2019 were 289,026 with a daily average of 800 visits, and, notably, about 45% of the total visits are walk-in visits as shown in Table 2. According to the interview

conducted with PHCC management, in terms of Health Center rankings based on patient visit volume among 27 health Centers of PHCC. Rawdat Al-Khail Health Center moved from its fourth position to position one in 2019.

Table 2. Rawdat Al-Khail Health Center Visited by Month in 2019

Month	Walk-In Visits	Appt Visits	Total Visits
Jan-19	10373	15397	25770
Feb-19	9310	13632	22942
Mar-19	11131	15005	26136
Apr-19	10414	14831	25245
May-19	9642	12053	21695
Jun-19	8190	8808	16998
Jul-19	9401	13351	22752
Aug-19	8730	8787	17517
Sep-19	12649	14834	27483
Oct-19	13730	16185	29915
Nov-19	12680	14334	27014
Dec-19	11267	14292	25559
Grand Total	127517	161509	289026

In terms of week distribution of the patients of Rawdat Al-Khail Health Center visits from July to December 2019, it can be noticed that 92% of patients visit the Rawdat Al-Khail Health Center on the weekdays while the remaining 8% attend on the weekend as shown in Table 2. This variation is due to the closing of some clinics at Rawdat Al-Khail Health Center.

Table 3. Rawdat Al-Khail Health Center Week Day Distribution-Visits July-Dec 19

APPT DAY	Weekday	Grand Total
Week Day	Sunday	24,583
	Monday	25,037
	Tuesday	24,852
	Wednesday	23,165
	Thursday	22,604
Weekend	Friday	2,731
	Saturday	8,167
Grand Total		131,139

Table 4 illustrated patient distribution per shift. The data is shown (Morning Shift and Evening Shift) from July to December 2019. The morning shift has most demanded of about 72,492 visits to the Rawdat Al-Khail Health Center. During the night shift, 58,647 patients visited the health center at the Evening shift. In other words,

moring shift patients are 55 % of the total patients' distribution, while evening shift patients form about 44 % at Rawdat Al Khail Health Center.

Table 4. Rawdat Al-Khail Health Center Shift Distribution-Visits July-Dec 19

SHIFT	Weekday	Grand Total
Morning Shift	Sunday	12,880
	Monday	13,501
	Tuesday	13,915
	Wednesday	13,053
	Thursday	13,321
	Friday	847
	Saturday	4,975
Evening Shift	Sunday	11,703
	Monday	11,536
	Tuesday	10,937
	Wednesday	10,112
	Thursday	9,283
	Friday	1,884
	Saturday	3,192
Grand Total		131,139

From the hourly distribution of the patients at Rawdat Al- Khail health center is demonstrated in Table 5. The highest number of patients is about 10 am.

Table 5. Rawdat Al-Khail Health Center Shift Distribution Hourly Distribution-Visits
July-December 19

Hours	Total Visits
0	147
1	83
2	47
3	39
4	37
5	39
6	255
7	10,967
8	12,718
9	12,063
10	12,121
11	11,356
12	9,036
13	3,560
14	595
15	709
16	11,459
17	11,263
18	10,381
19	10,157
20	8,911
21	3,794
22	1,019
23	383
Grand Total	131,139

The monthly distribution of the no-show patients illustrated in Table 6. The data are shown for no-show patients from July to December 2019, where the highest month with no show is in December. This percentage is due to the lack of patients' commitment and to the patients' dissatisfaction from long waiting times.

Table 6. Rawdat Al-Khali health center Monthly Distribution-No Show July-Dec 19

Month	Total No Show
Jul-19	3,849
Aug-19	2,607
Sep-19	4,143
Oct-19	4,645
Nov-19	4,518
Dec-19	4,715
Grand Total	24,477

The average waiting time (in minutes) of Triage service (From Ticket to be called by Triage Nurse) per month is shown in Table 7. This excludes emergency patients. Where ATQ = Average Queuing Time (Waiting before being called by Triage)

Table 7. Average Queuing Time ATQ (Waiting before being called by Triage)

Month	ATQ
July	15
August	16
September	16
October	22
November	26
December	27
Ave	20.3

Rawdat Al-Khail Health Center average consultation time for walk-in patients and appointment patients from July to December 2019 is shown in Table 8. Where Consultation Time: Duration of Patient-Doctor encounter. In average walk-in patient take more time in consultation comparing to appointment patients

Table 8. Rawdat Al-Khail Health Cente -Average consultation Time from July to December 2019

Month	Walk-In	Appointment	Overall
Jul-19	14.1	12.9	13.5
Aug-19	14.1	12.6	13.3
Sep-19	15.2	13.9	14.5
Oct-19	14.5	13.6	14.1
Nov-19	13.8	12.6	13.2
Dec-19	14.3	11.9	13.1
Average	14.3	12.9	13.6

In Table 9 illustrated the average waiting time for the patient in the pharmacy of Rawdat Al-Khail Health Center. ATQ represent the average queuing time (waiting before being called by Pharmacist), ATD is the average preparation time (waiting to get medicines prepared). Finally, ATS is the average service time (overall waiting ATQ + ATD). This excludes the time spent on making payments and queuing.

Table 9. Rawdat Al-Khail Health Center Pharmacy QMatic Report 2019

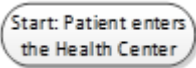
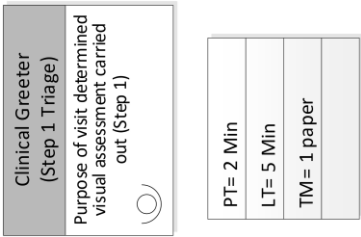

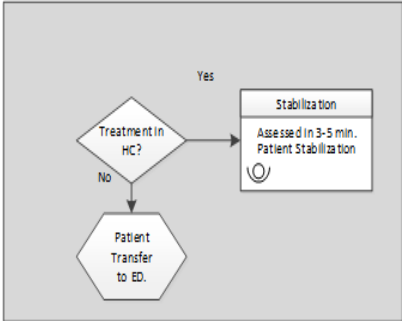
Month	ATQ	ATD	ATS
July	6	10	17
August	8	11	19
September	5	11	16
October	4	11	15
November	10	10	19
December	7	8	15
average	6.67	10.17	16.83

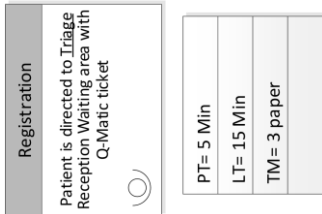




4.3 VSM Implementation


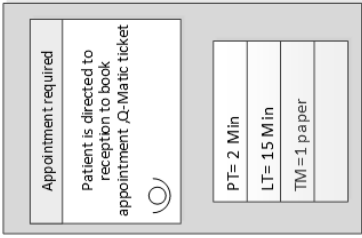
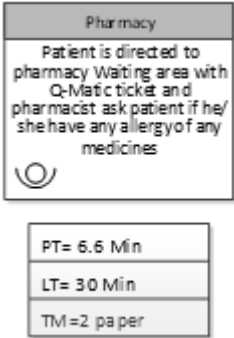
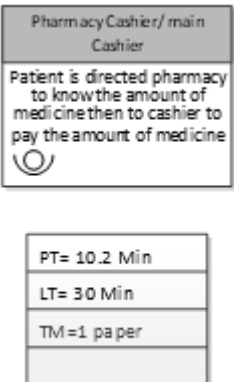
In this section, the implementation of VSM for walk-in patients at Rawdat Al-Khail Health Center explained. The first step of the VSM application is To understand the current process (flow of the patient)- (Process Mapping), as shown in Figure 2. Then, identify the waste of the current procedure of walk-in patients. After that, the

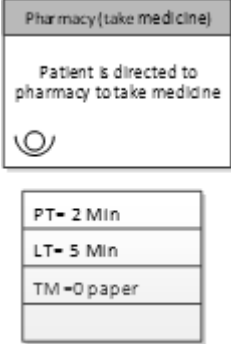
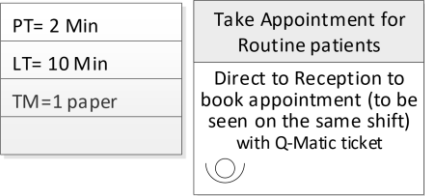
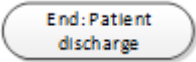
VSM map is made for the current system, as demonstrated in Table 10. The details of the walk-in patient are described in this section. The total current process workflow can be found in Figure 5.

Table 10. VSM map of the current system of the Rawdat Al-Khail Health Center.

Step no	Activity	Activity Description
1.		<p>The Start of the process when the walk-in patient enter Rawdat Al-Khail Health Center</p>
2.		<p>When the Walk-in patient enters to Rawdat Al-Khail Health Center, the patient will be greeted by the nurse, then ask the patient of the aim of the visit. A7 paper ticket from Q-Matic required for waiting in reception</p>
3.		<p>In case if this patient has Emergency (Appendix A) he/she transfer to step 4</p>
4.		<p>In Emergency cases, if the patient can be treated in the Rawdat Al-Khail Health Center, the patient should be assessed within 3-5 minutes otherwise transfer to the Emergency department in Hamad Hospital</p>

Step no	Activity	Activity Description			
5.	 <p>Registration Patient is directed to Triage Reception Waiting area with Q-Matic ticket</p> <table border="1"> <tr><td>PT= 5 Min</td></tr> <tr><td>LT= 15 Min</td></tr> <tr><td>TM= 3 paper</td></tr> </table>	PT= 5 Min	LT= 15 Min	TM= 3 paper	<p>If the patient does not have an Emergency case, then the patient goes to the registration's waiting area until his number shows on the screen. Next, after the patient gives his valid health card to the registration, the patient will receive two A7 papers in addition to patient will have one A4 with multiple stickers include his/here information for Rawdat Al-Khail Health Center services.</p>
PT= 5 Min					
LT= 15 Min					
TM= 3 paper					
6.	 <p>Triage Assessment Form/ Cerner triage fields Assessment and documentation</p> <table border="1"> <tr><td>PT= 3 Min</td></tr> <tr><td>LT= 20.3 Min</td></tr> <tr><td>TM= 0 pa per</td></tr> </table>	PT= 3 Min	LT= 20.3 Min	TM= 0 pa per	<p>An Initial assessment such as weight, height, temperature, blood pressure and document in Cerner</p>
PT= 3 Min					
LT= 20.3 Min					
TM= 0 pa per					
7.	 <p>Emergency</p>	<p>From step no. 6, in case the Nurse assesses an Emergency case (Appendix A), then go to step no. 4</p>			
8.	 <p>Priority</p>	<p>From step no. 6, in case the Nurse assesses a Priority case (Appendix A), then go to step no. 9 for Doctor assessment</p>			
9.	 <p>Seeing Doctor Assessment Patient is directed to Doctor</p> <table border="1"> <tr><td>PT= 14.3 Min</td></tr> <tr><td>LT= 45 Min</td></tr> <tr><td>TM= 0 pa per</td></tr> </table>	PT= 14.3 Min	LT= 45 Min	TM= 0 pa per	<p>The doctor assessment or physician assessment</p>
PT= 14.3 Min					
LT= 45 Min					
TM= 0 pa per					

Step no	Activity	Activity Description
10.		<p>From step no. 9, in case the Doctor requested an appointment for the patient at a different clinic. Patients need to be processed to step no. 11</p>
11.		<p>The patient goes to the reception to book an appointment with an A7 paper ticket from Q-Matic.</p>
12.		<p>After completing the assessment from the doctor, the patient may be asked to go to the pharmacy. The patient is directed to the pharmacy waiting area with two A7 paper tickets from Q-Matic. The pharmacist will call the patient by the number showing on the screen. The pharmacist asks if the patient has an allergy to any medicines. Afterward, the patient waits for a second call.</p>
13.		<p>After the second call, the pharmacist confirms the availability of the medicine then asks the patient to pay the expense of the medication at the pharmacy's cashier or the main cashier of Rawdat Al-Khail Health Center by credit card only</p>

Step no	Activity	Activity Description
14.		After the payment, the patient is directed to the pharmacy window and receive his medicines
15.		In the case of Routine case (Appendix A), the patient is directed to book an appointment (to be seen by a doctor on the same shift), then he receives an A7 paper ticket from Q-Matic. The patient should follow the procedure of step no. 9
16.		The patient is discharged

As can be seen in Table 10, the total steps in the walk-in patient workflow are 16 steps. The process and lead times in each step are described in Table 11, along with the aggregate materials used.

Table 11. Current Analysis Description with Total Timings and Resources Used

Step	Activity description	PT (Min)	LT (Min)	TM (paper)
Clinical Greeter (Step 1 Triage)	Purpose of visit determined visual assessment carried out (Step 1)	2	5	1
Registration	The patient is directed to Triage Reception Waiting area with Q-Matic ticket	5	15	3
Triage Assessment Form/ Cerner triage fields	Assessment and documentation	3	20.3	0
Seeing Doctor Assessment	The patient is directed to Doctor	14.3	45	0
Pharmacy	The patient is directed to the pharmacy Waiting area with Q-Matic ticket and pharmacist ask the patient if he/she has an allergy of any medicines	6.6	30	2
Pharmacy Cashier or Main Cashier	The patient is directed pharmacy to know the amount of medicine, then to cashier to pay the amount of medicine	10.2	30	1
Pharmacy (take medicine)	The patient is directed to the pharmacy to take medicine	2	5	0
Take Appointment for Routine	Direct to Reception to book an appointment (to be seen on the same shift) with Q- Matic ticket	2	10	1
Total		45.1	160.3	8

The total process time in the walk-in patient workflow is 45.1 Minutes, the total lead time identified was 160.3 Minutes, the complete resources used in the process was 8 (one paper A4 sticker and remaining papers A7 from Q-Matic ticket).

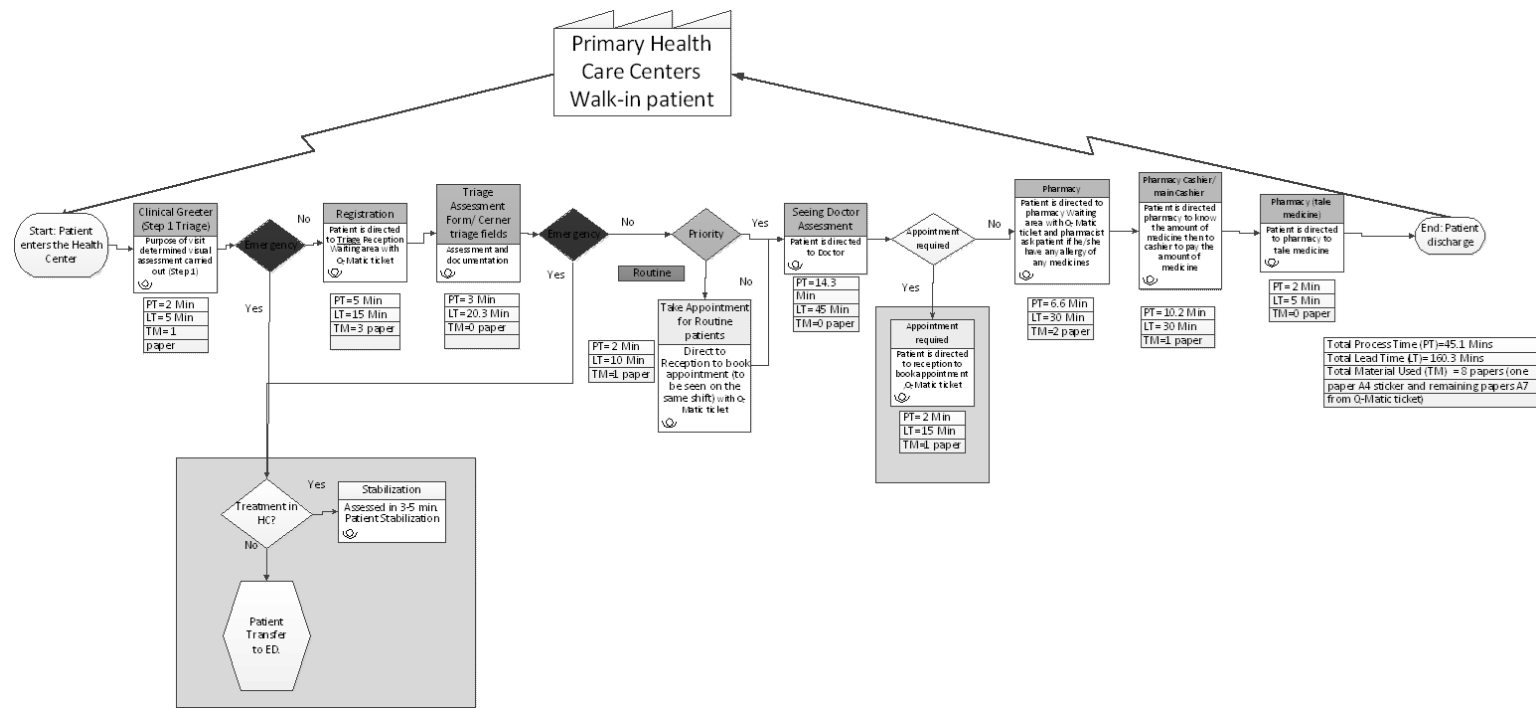




Figure 5. VSM map of the current system of the Rawdat Al-Khail Health Center

The third step of VSM is to eliminate, integrate, and simply the current procedure of Rawdat Al-Khail health center to reduce Wastes. The lean process will be used to identify wastes in the walk-in patient process and will be described in Table 12.

Table 12. The third step in VSM eliminated the waste

Step no.	Activity	Activity Description
5	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; background-color: #cccccc;">Registration</p> <p>Patient is directed to Triage Reception Waiting area with Q-Matic ticket</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p>PT= 5 Min</p> <p>LT= 15 Min</p> <p>TM= 3 paper</p> </div>	<p>Reduce the A4 stickers paper into A5 stickers paper.</p>
13 and 14	<div style="text-align: center; margin-bottom: 10px;">  <p>Integrate</p> </div> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 45%; text-align: center;"> <p style="background-color: #cccccc; font-weight: bold; font-size: small;">Pharmacy Cashier/ main Cashier</p> <p style="font-size: x-small;">Patient is directed pharmacy to know the amount of medicine then to cashier to pay the amount of medicine</p> </div> <div style="font-size: 2em; margin: 0 10px;">→</div> <div style="border: 1px solid black; padding: 5px; width: 45%; text-align: center;"> <p style="background-color: #cccccc; font-weight: bold; font-size: small;">Pharmacy (take medicine)</p> <p style="font-size: x-small;">Patient is directed to pharmacy to take medicine</p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>PT= 10.2 Min</p> <p>LT= 30 Min</p> <p>TM=1 paper</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>PT= 2 Min</p> <p>LT= 5 Min</p> <p>TM=0 paper</p> </div> </div>	<p>Steps 13 and 14 are proposed to be integrated into one step. It not essential for patients to go for cashier and to queue to pay.</p>
	15.	<div style="text-align: center; margin-bottom: 10px;">  <p>Eliminate</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>PT= 2 Min</p> <p>LT= 10 Min</p> <p>TM=1 paper</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%; text-align: center; margin-top: 10px;"> <p style="background-color: #cccccc; font-weight: bold; font-size: small;">Take Appointment</p> <p style="font-size: x-small;">Direct to Reception to book appointment (to be seen on the same shift) with Q-Matic ticket</p> </div>

As can be seen in Table 12, the total steps identified as wastes and could be eliminated or integrated are three steps. The process and lead times of each eliminated step are illustrated in Table 13, along with total materials used/eliminated. These steps are eliminated or integrated. However, a few steps were enhanced, and a reduction in cost and time is proposed.

Table 13. Eliminated and Integrated Activities Description with Total Timings and Resources Used

Step	Activity description	PT (Min)	LT (Min)	TM (paper)
Registration	The patient is directed to Triage Reception Waiting area with Q-Matic ticket	5	15	3
Pharmacy Cashier or Main Cashier	The patient is directed pharmacy to know the amount of medicine, then to cashier to pay the amount of medicine	10.2	30	1
Pharmacy (take medicine)	The patient is directed to the pharmacy to take medicine	2	5	0
Take Appointment for Routine	Direct to Reception to book an appointment (to be seen on the same shift) with Q-Matic ticket	2	10	1
Total Reduction		4	15	2

The first step of Table 13 can be enhanced in terms of the materials used. The enhancement is proposed by changing the A4 stickers paper with an A5 stickers paper. The second and third steps of Table 13 are integrated into one step. The patients will make the payments for the medicine at the pharmacy window. By doing so, the processing time will be reduced, and the material used will decrease since the papers do not have to be printed at the pharmacy for the medicine cost. The third step can be eliminated in the suggested process. The appointment is not necessary since the routine patient is already taking the appointment. The total reduction process time in the walk-in patients' workflow process is 4 minutes, and the total reduction lead time is 15 minutes. The total resources used in the process were two.

The total eliminated and integrated process workflow can be found in Figure 6.

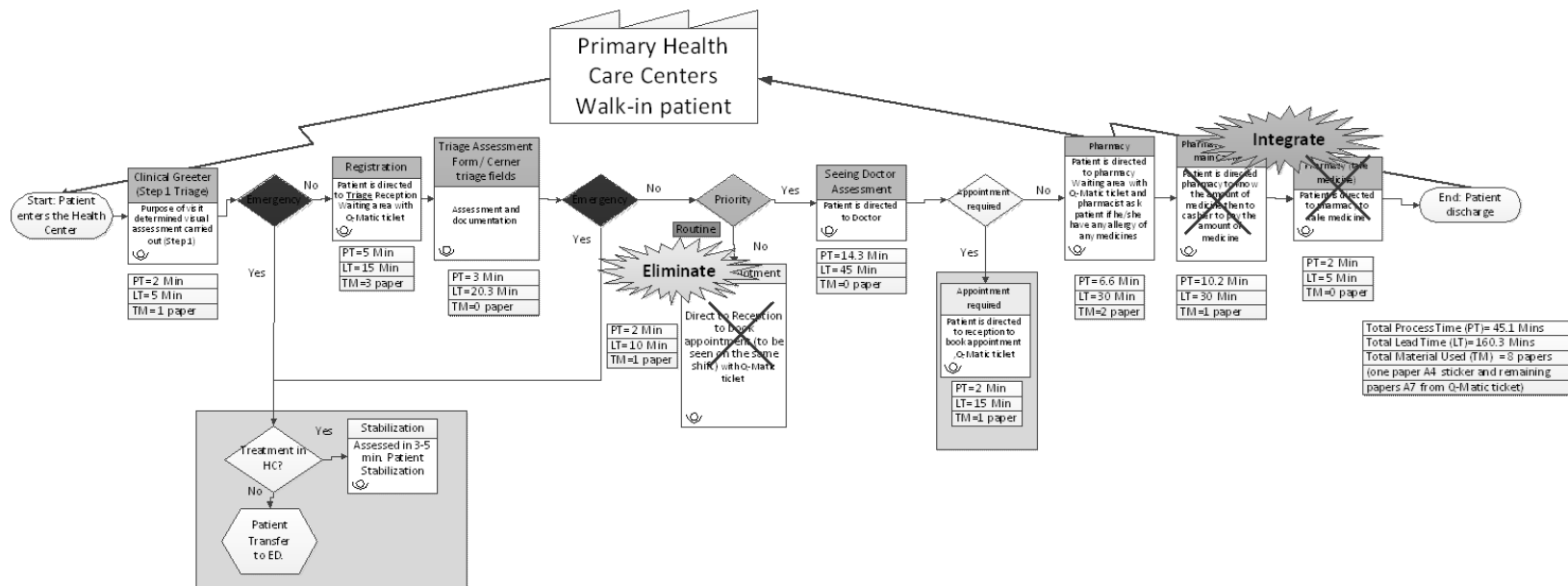
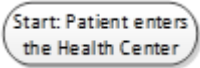
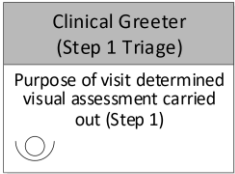
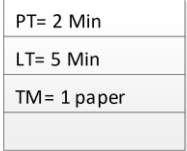

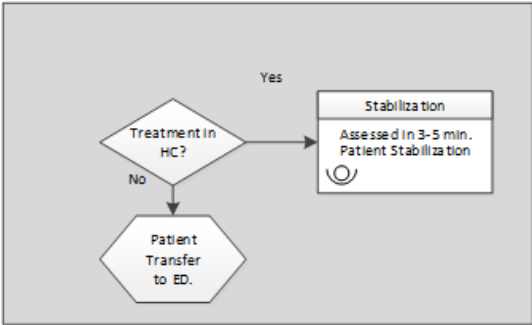








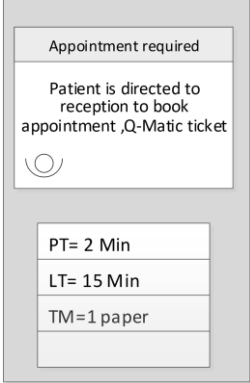
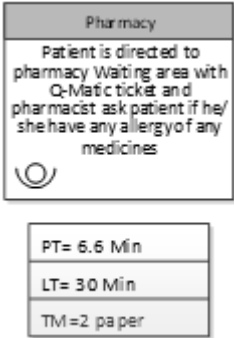
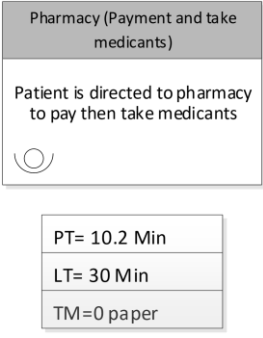
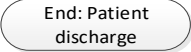
Figure 6. The third step in VSM eliminated the waste

The new proposed workflow process will be described in Table 14.

Table 14. Proposed VSM of the future system of Rawdat Al-Khail Health Center.

Step no	Activity	Activity Description
1.		The Start of the process when the walk-in patient enter Rawdat Al-Khail Health Center
2.	 	When the Walk-in patient enters to Rawdat Al-Khail Health Center, the patient will be greeted by the nurse, then ask the patient of the aim of the visit. A7 paper ticket from Q-Matic required for waiting in reception
3.		In case if this patient has Emergency (Appendix A) he/she transfer to step 4
4.		In Emergency cases, if the patient can be treated in the Rawdat Al-Khail Health Center, the patient should be assessed within 3-5 minutes otherwise transfer to the Emergency department in Hamad Hospital

Step no	Activity	Activity Description
5.	<div data-bbox="536 461 767 633"> <p>Registration</p> <p>Patient is directed to Triage Reception Waiting area with Q-Matic ticket</p>  </div> <div data-bbox="560 651 756 808"> <p>PT= 5 Min</p> <p>LT= 15 Min</p> <p>TM= 3 paper</p> </div>	<p>If the patient does not have an Emergency case, then the patient goes to the registration's waiting area until his number shows on the screen. Next, after the patient gives his valid health card to the registration, the patient will receive two A7 papers in addition the patient will have one A5 with multiple stickers include his/here information for Rawdat Al-Khail Health Center services.</p>
6.	<div data-bbox="536 920 767 1099"> <p>Triage Assessment Form/ Cerner triage fields</p> <p>Assessment and documentation</p>  </div> <div data-bbox="560 1117 743 1267"> <p>PT= 3 Min</p> <p>LT= 20.3 Min</p> <p>TM= 0 paper</p> </div>	<p>An Initial assessment such as weight, height, temperature, blood pressure and document in Cerner</p>
7.		<p>From step no. 6, in case the Nurse assesses an Emergency case (Appendix A), then go to step no. 4</p>
8.		<p>From step no. 6, in case the Nurse assesses a Priority case (Appendix A), then go to step no. 9 for Doctor assessment</p>
9.	<div data-bbox="536 1682 767 1816"> <p>Seeing Doctor Assessment</p> <p>Patient is directed to Doctor</p>  </div> <div data-bbox="560 1834 743 1939"> <p>PT= 14.3 Min</p> <p>LT= 45 Min</p> <p>TM= 0 paper</p> </div>	<p>The doctor assessment or physician assessment</p>

Step no	Activity	Activity Description
10.		From step no. 9, in case the Doctor requested an appointment for the patient at a different clinic. Patients need to be processed to step no. 11
11.		The patient goes to the reception to book an appointment with an A7 paper ticket from Q-Matic.
12.		After completing the assessment from the doctor, the patient may be asked to go to the pharmacy. The patient is directed to the pharmacy waiting area with two A7 paper tickets from Q-Matic. The pharmacist will call the patient by the number showing on the screen. The pharmacist asks if the patient has an allergy to any medicines. Afterward, the patient waits for a second call.
13.		The payment is made in the same pharmacy window, the patient is directed to the pharmacy window and receives his medicines
14.		The patient is discharged

As can be seen in Table 14, the total steps identified as lean and proposed to be in the future state are 14 steps. The process and lead times of each Lean step are described in Table 15, along with total materials used.

Table 15. Future State Description with Total Timings and Resources Used

Step	Activity description	PT (Min)	LT (Min)	TM (paper)
Clinical Greeter (Step 1 Triage)	Purpose of visit determined visual assessment carried out (Step 1)	2	5	0
Registration	The patient is directed to Triage Reception Waiting area with Q-Matic ticket	5	15	3
Triage Assessment Form/ Cerner triage fields	Assessment and documentation	3	20.3	0
Seeing Doctor Assessment	The patient is directed to Doctor	14.3	45	0
Pharmacy	The patient is directed to the pharmacy Waiting area with Q-Matic ticket and pharmacist ask the patient if he/she has an allergy of any medicines	6.6	30	2
Pharmacy (Payment and take medicine)	The payment is made in the same pharmacy window, the patient is directed to the pharmacy window and receives his medicines	10.2	30	1
Total		41.1	145.3	6

The total proposed process workflow can be found in Figure 7

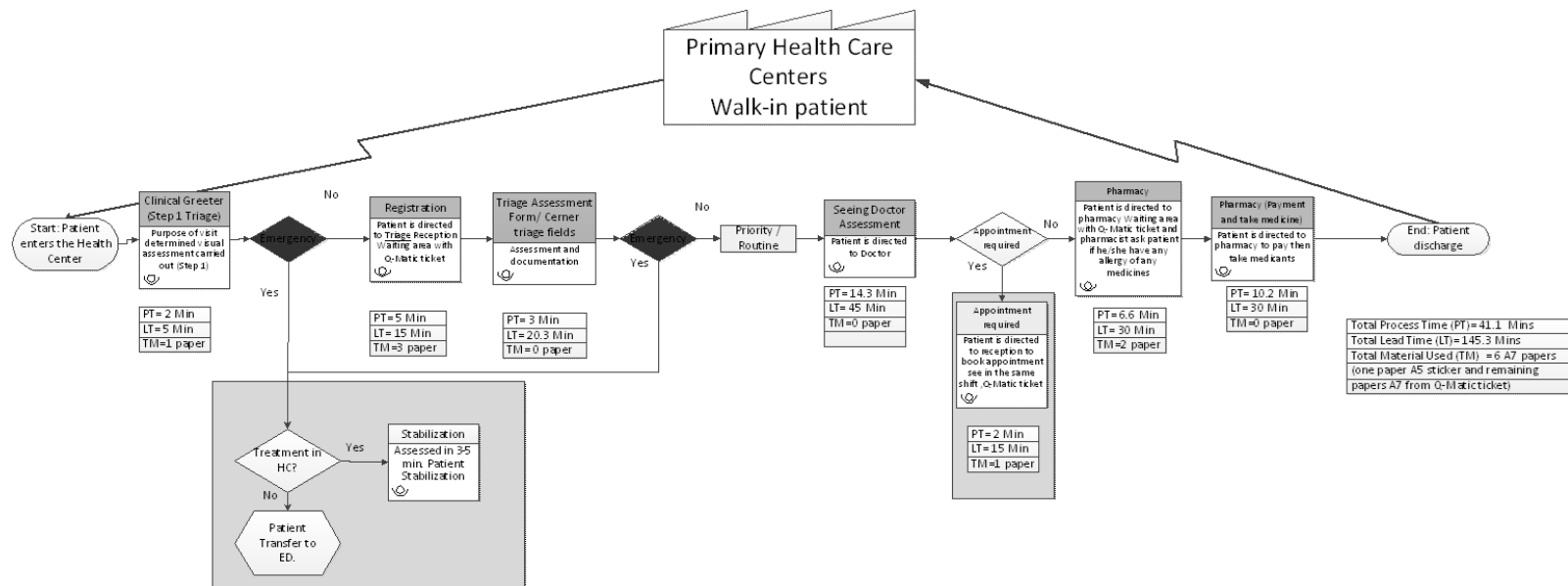


Figure 7. The proposed VSM map of the future system of the Rawdat Al-Khail Health Centre

Implementation and evaluation of the recommended process flow (Apply & Measure) shown in Figure 7, to be shared with PHCC and Rawdat Al-Khail health center. If the process is applied, then an evaluation of the proposed workflow will be made, and further improvements will be suggested.

4.4 Evaluation Results and summary

Table 16. Summary of current vs. The future workflow at Rawdat Al-Khail Health Center

Metric	Current State	Future State	% of improvement
Process Time (mins)	45.1	41.1	8.8
Lead Time (mins)	160.3	145.3	9.3
Material Used (papers)	8	6	25

After applying the lean thinking into the walk-in patient in the Rawdat Al-Khail workflow process, a total of 3 steps were found to waste and were eliminated or integrated. For total process time, only 4 minutes could be reduced, creating an 8.8% improvement in the overall process. For the lead time, a total of 15 minutes could be enhanced, amounting to a 9.3% improvement in the overall process. The improvement

percentages were comparably low because most of the time is being utilized in steps: 5,6,9,12 and 13 (around 95% of total process time and 96% of whole lead time). Those steps are essential to the patients' treatment. Usually, those activities take a huge amount of time, depending on the available information and the complexity of cases. The improvements and wastes identified were in the remaining steps were administrative activities could be improved and integrated into one person to collect and handle (pharmacist and cashier) instead of distributing the load to multiple people.

CHAPTER 5: CONCLUSION & RECOMMENDATIONS

5.1 Summary

In this project, Lean Thinking has been used to enhance the walk-in patients at Rawdat Al-Khail Health Center workflow. The used tool to accomplish this goal was the Value Steam Mapping (VSM) approach. Six-steps utilized to implement the improvements to the process. An improvement to the process times and lead time of the walk-in patients was achieved of about 8.8% and 9.3%, respectively. A reduction of 25% made in terms of the materials used for the walk-in patients at Rawdat Al-Khail Health Center. This will lead to a decrease in the cost to the PHCC since there is more than 800 patients visit the health center daily. The cost-saving per year could be around 50% of the cost of the A4 stickers' papers due to the reduction of the stickers from A4 to A5 papers. Most of the steps lead, and process time could not be improved since it is not controllable. Therefore, most of the improvements happened in the administrative steps.

The data and process flow collected from the primary health care center (PHCC) of the state of Qatar. Several site visits and interviews were conducted to achieve this project, and three years of raw data for Rawdat al-Khail health center were analyzed. The proposed VSM for the future system of the walk-in patients will be suggested to the PHCC for implementation. Upon the application of the proposed method, further improvements may be recommended.

5.2 Recommendations

The following recommendations are made to the current workflow of the walk-in patients:

- 1) Add more and clear signs for the services to the Rawdat Al-Khail Health Center to eliminate queuing and misdirected patients.
- 2) Add guidelines on the health center's floor to guide the patients to the services
- 3) Train and motivate the receptionists to improve their attitude toward the customers
- 4) Apply restrictions on the no-show from the first call patients to return to reception and take a new number to avoid interruption of the to the patient's flow
- 5) Use mobile application or SMS to produce the tickets for the patients
- 6) Make a database of the currents employees spoken languages and put the flags of the languages on their names' badges to improve the communication between the patients and the employees.
- 7) Use different methods of payments such as applications or top-up card
- 8) Create a database of the highest demand for all health centers and distribute the employees accordingly
- 9) Encourage the employees' data entry skills in order to improve data accuracy and consumed time
- 10) Integrate all systems (QMatic and Cerner) into one system to improve the tracking system of the services

5.3 Future work

To achieve the goals of lean thinking (elimination of as much waste as possible) and properly increase the efficiency of the healthcare facilities in Qatar, Lean Thinking should be applied in all the other departments of the healthcare facility (e.g. Rawdat Al-Khail Health center). These department and sections include Dental, Radiology, Laboratory, and Physiotherapy. Additionally, using the smart hospital applications provided by PHCC in the state of Qatar has the potential of eliminating many of the existing wastes in the system. This is viable due to the current utilization of smart applications by PHCC in the Qatari healthcare sector.

REFERENCES

- Beliën, J., Demeulemeester, E., “A branch-and-price approach for integrating nurse and surgery scheduling”, *European Journal of Operational Research*, vol. 189, no.3, pp. 652-668, 2008.
- Boronat F, Budia A, Broseta E, Ruiz-Cerdá JL, Vivas-Consuelo D. (2018). Application of Lean Healthcare methodology in a urology department of a tertiary hospital as a tool for improving efficiency. *Actas Urol Esp*.42, 42---48.
- Brailsford, S.C. 2007, "Tutorial: advances and challenges in healthcare simulation modeling", 2007 Winter Simulation Conference IEEE, Washington, DC, USA, 9-12 Dec. 2007, pp. 1436.
- Castaldi, M., Sugano, D., Kreps, K., Cassidy, A. & Kaban, J. (2016). Lean philosophy and the public hospital. *Perioperative Care and Operating Room Management* 3, 25–28.
- De Souza, B. L. (2009). Trends and approaches in lean Healthcare. *Leadership in Health Services*, 22(2), 121–139. doi:10.1108/17511870910953788
- De Souza, L. B., & Pidd, M. (2011). Exploring the barriers to lean health care implementation. *Public Money & Management*, 31(1), 59–66. doi:10.1080/09540962.2011.545548
- Grove AL, Meredith JO, Macintyre M, et al. (2010). Lean implementation in primary care health visiting services in National Health Service UK. *Quality and Safety in Health Care*, 19:e43.
- Ho, C. J., Lau, H. S., “Minimizing Total Cost in Scheduling Outpatient Appointments”, *Management Science*, vol. 38, no. 12, pp. 1750-1764, 1992.

- Hung, G. R., Sandra R., O'Neill, C. B., Gray, A. P., Kissoon, N., "Computer Modeling of Patient Flow in a Pediatric Emergency Department Using Discrete Event Simulation", *Pediatric Emergency Care*, vol. 23, pp. 5-10, 2007.
- Joosten, T., Bongers, I. & Janssen, R. (2009). Application of lean Thinking to health care: issues and observations. *International Journal for Quality in Health Care* 2009; Volume 21(5), 341–347.
- Kovacevic, M., Jovicic, M., Djapan, M. & Zivanovic-Macuzic, I. (2015). Lean Thinking in Healthcare: Review of implementation results. *International Journal for Quality Research* 10(1) 219–230.
- Lawal, A. K., Rotter, T., Kinsman, L., Sari, N., Harrison, L., Jeffery, C., Kutz, M., Khan, M. F., & Flynn, R. (2014). Lean management in health care: definition, concepts, methodology and effects reported (systematic review protocol). *Systematic reviews*, 3, 103. <https://doi.org/10.1186/2046-4053-3-103>
- Mofizul, I. (2014). Breaking the Barrier of Service Hostility: A Lean Approach to Achieve Operational Excellence. *International Journal of Business and Economics Research* 3(6-1), 65-73.
- Rossoa, C.B. & Saurin, T.A. (2018). The joint use of resilience engineering and lean production for work system design: A study in Healthcare. *Applied Ergonomics* 71, 45–56.
- Rotter, T. et Al. (2019). What Is Lean Management in Health Care? Development of an Operational Definition for a Cochrane Systematic Review. *Evaluation & the Health Professions* 42(3) 366-390.

Silva, S.E. P., Calado, R. D., Silva, M. B. & Nascimento, M. A. (2013). Lean Startup applied in Healthcare: A viable methodology for continuous improvement in the development of new products and services. *International Federation of Automatic Control*, 295-299

Spagnol, G., Min, L. & Newbold, D. (2013). Lean principles in Healthcare: an overview of challenges and improvements. *International Federation of Automatic Control*, 229-234.

Tlapa, D. et al. (2020). Effects of Lean Healthcare on Patient Flow: A Systematic Review. *Value in Health*, 2-14.

APPENDICES

Appendix A

1) Emergency cases include, but are not limited to:

1	Major / multiple system trauma *
2	Penetrating / blunt instrument trauma *
3	Massive uncontrollable hemorrhage/bleeding *
4	Cardiopulmonary arrest *
5	Ingestion/inhalation of rapidly acting/unknown poison or drug overdose *
6	Anaphylactic shock *
7	Acute neurovascular impairment * eg. Stroke
8	Chest Pain
9	Hyperglycemia RBS/FBS above or equal 14mmol/L(250mg/dl) with symptoms of Diabetic Ketoacidosis (DKA) and/or Hyperglycemic Hyperosmolar (HHS) RBS/FBS value above or equal to 25mmol/L(> 500mg/dl)
10	Hypoglycemia RBS/FBS lower than or equal to 3.9 mmol/L(70 mg/dl)
11	Acute urinary retention
12	Acute abdomen and acute abdominal pain
13	Head injury
14	All Superficial Partial Thickness and Full Thickness Burns, except the minor Superficial (Erythema +/- minimal Blistering) Burns
15	Any acute retained foreign body/substance injuries
16	Any fracture or dislocation
17	Psychiatric crisis +/- deliberate self-harm (suspected suicide attempt)
18	Acute severe asthma
19	Acute shortness of breath – severe respiratory distress
20	Convulsion / Seizure
21	Fever greater than or equal to (temp 39.4°C/103°F) with unstable vital signs and presentation
22	Heat stroke
23	Severe Dehydration and/or lethargy
24	Hypothermia (temperature below 35°C)
25	Altered level of consciousness (Glasgow Coma Score <15/15)
26	Sudden onset severe headache
27	Acute visual disturbances
28	Pregnancy with vaginal bleeding and/or any of : leaking amniotic fluid, high blood pressure, high blood sugar, acute onset pain, decreased fetal movements, persistent vomiting, abdominal pains (refer to antenatal policy)
29	Hypertensive emergency with BP greater than or equal to 180/120 mmHg
30	Hypotension less than or equal to 90/60 mmHg
31	Syncope
32	Central Cyanosis
33	Suspected communicable disease (as per PHCC Policy)
34	Fever with non-blanching rash and Suspicion of Septicemia
35	Suspected labor including pain
36	Active epistaxis
37	Active vomiting
38	Eye trauma

2) Priority cases include, but are not limited to:

1.	Minor Burns – first degree burn less than 1%, NOT covering neck, hands, feet, groin, face, and NOT inhalation burns or electrical burns
2.	Fever with temperature above or equal 37.8C- 39C axillary or tympanic
3.	Mild to moderate dehydration and/or lethargy
4.	Acute dizziness
5.	Mild to moderate heat related illnesses e.g. heat exhaustion
6.	Painful red eye not caused by trauma
7.	Mild shortness of breath without respiratory distress - SaO2 90-95%
8.	Moderate hypertension - Diastolic 100 - 115 mmHg
9.	Recent sprain with history of trauma
10.	Acute skin infections e.g. abscess
11.	Acute onset skin rash with or without associated symptoms
12.	Medication not initiated by PHCC (where the administration is time dependent)
13.	Acute or chronic onset moderate pain – any cause eg sore throat, earache, dysmenorrhea, dysuria, headache
14.	Any other condition not listed that the nurse is concerned about

3) Routine Case includes, but are not limited to, the following (provided there are no systemic signs or symptoms):

1.	Acute or chronic onset mild pain – any cause eg sore throat, earache, dysmenorrhea, dysuria, headache
2.	Mild, acute or chronic cough
3.	Mild dermatological conditions
4.	Mild ENT problems without discharge
5.	Mild Respiratory problems
6.	Mild gastro-intestinal problems
7.	Mild genito-urinary problems
8.	Chronic diseases and in stable condition, e.g.: Diabetes Mellitus, Hypertension etc.
9.	Mild surgical problems (varicose veins, etc.)
10.	Ante natal booking
11.	Mild insect and animal bites, with stable vital signs
12.	Minor superficial abrasions and contusions without excessive bleeding or potential neurovascular impairment

Appendix B

This appendix shows all Clinics and Services of Rawdat Al Khail Health Center

CLINCS

- ❖ Antenatal
- ❖ Audiology (Adult)
- ❖ Communicable Diseases & Travel Vaccine
- ❖ Dental
- ❖ Dental Beautiful Smile
- ❖ Dental School Health
- ❖ Dermatology
- ❖ Dietitian
- ❖ Ear, Nose, Throat - ENT
- ❖ Family Medicine
- ❖ Healthy Life Style
- ❖ Non Communicable Diseases
- ❖ Smoking Cessation
- ❖ Ophthalmology
- ❖ Optometry
- ❖ Physiotherapy
- ❖ Postnatal clinic
- ❖ Well Baby
- ❖ Well Woman
- ❖ General pediatrics
- ❖ Walk-in clinic

SERVICES

- ❖ Breast & bowel Cancer Screening
- ❖ Health Card (soon)
- ❖ Geriatric Service Clinic
- ❖ Cardiology Service Clinic
- ❖ Health Education
- ❖ Home Health Care
- ❖ Laboratory
- ❖ Maternal & Child Health Counsellor
- ❖ Medical Commission
- ❖ Mental Health
- ❖ Pharmacy
- ❖ Radiology
- ❖ School Health
- ❖ Smart Health Check-Up
- ❖ Social Worker
- ❖ Ultrasound
- ❖ Wellness