QATAR UNIVERSITY

COLLEGE OF ENGINEERING

APPLICATION OF LEAN THINKING IN MAIN SERVICE CENTER OF TOYOTA QATAR

BY

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A Project Submitted to

the Faculty of the College of

Engineering

in Partial Fulfillment

of the Requirements

for the Degree of

[Master of Science in Engineering Management]

June 2018

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ABSTRACT

BADER, IHSAN, A., Masters: June: 2018, Master of Science in Engineering Management

Title: Application of Lean Thinking in The Service Center on Toyota Qatar

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Lean thinking is one of the well-known techniques that aims to create more value to customers with minimum used resources via minimizing or eliminating wastes. While the lean concepts are traditionally applied in the manufacturing industry, they can be implemented in service industry too.

This report introduces the lean thinking using the value stream mapping tool in the service department of Toyota Qatar – Abdullah Abdulghani & Brothers (AAB) in order to validate the approach of lean methods in the service industry and to improve customer satisfaction by reducing the service time through eliminating the non-value-added activities of the process.

DEDICATION

I dedicate this work to my loving parents for their greatest motivation and continuous support, it will always be remembered.

I dedicate this work also to my beloved wife and son for their endless support and patience, couldn't achieve this work without it.

ACKNOWLEDGMENTS

I would like to thank my family and friends who supported me to reach to the end of the Master's degree. I owe my deep gratitude to Dr. Tarek Y. El Mekkawy, my project supervisor, for his continuous guidance, assistance and support until the completion of the project work.

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LIST OF ABBREVIATIONS

QU	Qatar University
SA	Service Advisor
TA	Technical Advisor
JC	Job Controller
TQ	Technician
QC	Quality Check
RT	Road Tester
RO	Repair Order / Job Card
TMC	Toyota Motor Corporation
VSM	Value Stream Map
PT	Process Time
LT	Lead-Time
TM	Total Material
CSI	Customer Satisfaction Ind

CHAPTER1: INTRODUCTION

1.1.Background

A well-known technique which concentrates on the manufacturing industry and its applications is called Lean Thinking. It aims to get rid of waste in order to provide customers with more value. Waste refers to any activity that does not add value to consumers and hence it should be removed or reduced. In Toyota production system, this management philosophy was invented, then a lot of manufacturing industrial companies follow, not only in the industrial field but also in-service organizations like offices, healthcare, and financial institutions.

The marketplace nowadays is wide and flexible place where the most important mission to be done is pleasing the customer. In addition, service industry desires to minimize the service cost and provides excellent quality at the same time. Although there is a rapid improvement in information technology and automation, the quality of services is decreasing intensively. As a result, Lean Thinking is considered a good choice that has to be adopted and applied by many service and industrial companies so that they could provide an excellent service with least amount of waste.

Abdulla Abdughani & brothers group is the Toyota distributor in Qatar, and one of its key performance areas is to provide effective and efficient service after sales to support sales missions. Applying the lean thinking principles to these processes is necessary in order to increase Toyota customer satisfaction by reducing the service lead time.

1.2.Problem Statement

Automotive service industry facing a huge increase in demand and customer requirement, continuous improvement is required to overcome this demand and requirement, Toyota Qatar service center took this opportunity to introduce the lean thinking to reach its goals. This project will help in understanding the lean thinking and the value stream mapping method that leads to enhancing processes by reducing the service time for customers in order to increase customer satisfaction.

1.3.Objectives of The Study

The project aims to:

1- Study the application of lean thinking in the service industry.
2- Provide an overview of lean thinking principles in the automotive service industry
3- Apply the lean thinking principles in the main service department on Toyota Qatar.
4- Study a current service main service center on Toyota Qatar that needs to apply the lean thinking method.
5- Study the effectiveness of the future results.

1.4.Scope and Limitations

Toyota main service center offers Toyota customer various services like periodic maintenance and general repair; diagnoses complain, engine and transmission overhauling and electrical system repair of Toyota vehicles. appendix F shows the type of service performed on Main service center

The scope of this project is limited to periodic maintenance and general repair to study the system for all process from the entry of the customer to service center through all the processes till the customer leave the system by receiving the vehicle back

The reasons for this limitation:

1- All kinds of services provided by Toyota Qatar pass through similar processes so reducing the waste from periodic maintenance and general repair will reduce waste from other services too.
2- 60% of repair order in main cervices center is periodic maintenance.
3- There is a huge impact of periodic maintenance on the customer satisfaction.

1.5. Report Overview

This report consists of six chapters including this chapter. The second chapter is about literature review of topics related to this project. The research methodology used in this project will be illustrated in chapter three. Chapter four will discuss the implementation of lean principle in main service center at Toyota Qatar. Chapter five

is about discussing the results and analyzing them. Chapter six provides the project conclusion, recommendation, and future research work.

CHAPTER 2: LITERATURE REVIEW

2.1. Lean Philosophy

Lean Philosophy is a point of view that has severely transform the superiority of delivery with minimizing the cost and it also becomes widely known applicable method in the manufacturing area. It requires developing the agenda and work timeline that must reach the point where the largest amount of waste is reduced in order to meet the needs in the marketplace (Higor & Guilherme, 2015). Waste is one of the most effective factors that have an effect on the products and services quality because it's an essential procedure in goods and services making. In Toyota's motor vehicle production procedures there was an adaptive flexibility which leads the Lean perspective to occur after suffering from a headache caused by the chaos made by the post-world-war-II that especially and badly effects the financial view in many ways. According to (Higor & Guilherme, 2015) and (Shingo, 1996) The popular vehicle company, Toyota, had suffered from an enormous lack of incomes which reduced its productivity and therefore it was hard for the institution to keep going and improve itself with the old classical production system. So, the company decided to correct and reboot its financial system to the post-world-war-II and apply the Lean philosophy. Because of the lack of incomes, supplies, and bad economic controls it was important to decrease waste. Meanwhile, the institution wants to stay on the global market track and produce high quality vehicles that the international market demands in spite of their financial problems. (Caldera et all. 2017) collected many articles that indicates the connection between lean thinking and supportable business actions. Supportive business examples were built by the study depending on the application of Lean principles, so it can

decrease waste and cost, and increase the products proficiency in production procedures.

(Dennis, 2008) according to him, waste is categorized as any procedure or an action that does not enriches the product or the service in the line of production. Waste wasn't given much importance in the old classical example it was identifies as an ordinary part of the line of production. The most essential characteristic in Lean thinking is the elimination of unimportant actions. Yet (Womark et al, 1992) indicates that was has to be classified into two clusters, waste that the company is capable of removing it, and waste that the company can't. the first type of waste contains those objects which use a lot of time and energy that are not important on the employee's part. Careful Value Stream Mapping techniques could simply remove over-processing waste. There are unnecessary stages in the line of production development that are considered as waste which should be reduced such as waiting and work in progress , work in progress are those products that the company haven't done with yet , it are still working on them while waiting is the pauses and postponements such as waiting for supplies or ingredients , coordination, data and staff or workers. Another type of waste are faults and errors, it's considered as waste because it consumes a lot of money and effort particularly if the service or the product is not as perfect as the customer expects, in that case, the company will be costed an extra effort and money in order to re-do the production process to reach the perfect product or service. There is another type of waste where needless activities are made. Lastly, Variation it's when a company uses various techniques or tools for the same duty.

Lean thinking is a collection of thoughts approval which leads to keep producing or providing a service and minimizing faults or waste at the same time. As (Womack & John, 2003) recommends that the service or the product should reflect two aspects, the international and the personal one. By fulfilling the customer's personal taste besides attracting the universal taste as well in order to receive a bigger group of customers. Plus, success in getting valuable products in constant procedures using minimum recruits.

2.2. Acceptance of New Technologies and Theories.

The world that we live in is rapidly and enormously developing, one of the significant changes or developments is the technological one. technology nowadays is exploding which affects human beings and their attitudes towards new discoveries. For example; especially in Egypt the discover of wheel that has a great effect on the agricultural revolution. And the most important invention that has improved the technological section is the invention of the Computer and its supplementary tools which also has an effect on the industrial section. The world now is facing a great technological change that's why companies and industrial institutions are forced to accept this change to keep following the stream and it's also important to change their executive system.

Kurt Lewin had developed Lewin's model in 1940's which is still able to be applied in the current time. According to this model, institutions should react to the change in three distinguishing phases; unfreeze, change, and then refreeze. First, the unfreezing phase requires an institution improving a flexible acceptance ready to accept and handle the change. It is frequently complemented by a state of hesitation in the investors

(Thomas & Christopher, 2014). second, the change phase demands the investors progressively deciding their doubt to accept change. The Last phase, is the refreezing phase needs recruiting new guidelines, operative structure and administrative structure to introduce instructions in the organization. Executive changing is significant perception that can be practical in lean philosophy application. Occasionally, frequent development in the recent century needs frequent adoption of new technologies to provide better services and/or products.

2.3. Lean Thinking in the Service Sector

Lean Philosophy was perfectly applied in manufacturing zone, but it wasn't really supported in the services zone. This is because the Lean thinking method beginning was in the industrialization period. Technological development affects the service zone positively by adding an extra importance in the 21st century. almost Approximately 58% of the world's Gross Domestic Product (GDP) refers to the service zone (Higor & Guilherme, 2015). Moreover 79% of experts in the US belong to the service zone. It's true that the service section is the leading section at this time because using improved technology indicates that it's important to apply Lean Philosophy's principles in delivery service to improve it.

There are five ethics of lean philosophy by (Womark & Jones, 2003) which as well can find use in the service area. First of all, a service organization should meet the value it needs in order to reach the level of satisfying its customers. Second, Value Stream Mapping is also necessary so as to provide a wider image to the organization an image of the procedures, stages, operations, and how much does it cost, in order to realize the

definite price. Flow optimization comes in hand the moment the service company requests to decrease waste. Waste in the service industry is essentially established through knowledgeable waste (lack of employee empowerment) (Higor & Guilherme, 2015), mistakes and errors in the delivered service or the service delivery systems, plus postponements and pauses in service delivery. In the service zone, the most essential element is the employee (as compared to materials in lean manufacturing). The employee is the core of intellectual stuff as well as a mean of service creation and also the main factor in the process of creating and delivering. The service area depends on To-Be-In-Time idea as the service must be delivered meeting the customers' needs and in the exact time. This is as well appropriate in the manufacturing zone where it helps the company to avoid waste and overproduction. Unlike the manufacturing zone, Overproduction is not applicable in the service sector since services are delivered on customers' request, whereas in the manufacturing area goods are factory-made and deposited, in consequence, revealing the industrial secure to risks of waste and overproduction. Finally, the standards of excellence and frequent development is valid in the service area. A progress in the services offered good service delivery systems by which the company offers its services is crucial for value creation and superb business presentation. Harmonized with this, customer's opinion is significant. Nevertheless, there must be direct connection with the final customer in order to increase probabilities of earning trustworthy feedback. (Higor & Guilherme, 2015) indicate new additional principles in the lean service zone. First, a lean service institution must focus on the customer. The institution must make sure to completely fulfill the customer's desires, to choose the perfect timing, and the right circumstance with negligible budgets. Second, the service must be presented in a way that exceeds the customer's expectations. The customer's mood could be influenced by their attitude during

consumption of the entire service and, therefore, the need to buy the same service again. (Bozena et al, 2016) demonstrates in their article, the application of lean methods in healthcare that lean thinking reveals valuables effects of time and effectiveness to the procedure in the healthcare; however, the influence of patient pleasure is low. As a result, it was suggested that patient's participation while recognizing the cost and the entire application procedure.

2.4. Services That Used Lean Thinking Philosophy

Although the majority of service productions have applied lean philosophy in their delivery service, literature on lean application in the service area containing success situation studies is still uncommon (Piercing & Rich, 2008). This is the result of lean philosophy is still a new method to service delivery hence a slight number of conveyed successful cases. Yet, a rare successful case of lean applications in the service industry are defined below;

Food Service Sector: Taco Bell Fast Foods Company

Taco Bell is a fast-food institution located in the United States. Taco Bell was the first company that applies lean philosophy in its service delivery (Bowen & Youngdahl, 1998). The company has accomplished many positive aspects after applying Lean such as in trades proficiency, economic performance, flexibility, and minimal cost service delivery. To begin with, the company appreciates its customers and employees. Next, it follows and applies the be-In-Time theory, presenting services depending on customers request. The company has been flexible enough to start an operation centers

in many places to reach out to a majority of customers in order to expand their services. Taco Bell accomplishes low-cost procedure and superiority in food service delivery at the same time, plus an inexpensive cost to its customers.

Transport Service Sector: South-West Airlines.

South-West Airlines has effectively applied lean service delivery. It is a representative sample of services in the transportation area which get benefited by lean philosophy.

The company had recorded the highest number of tourists in 2012 almost (88 million) at minimum 72 cities and towns in almost 37 countries around the globe (Stanley & Reahm, 2012). Firstly, the company predicted the type of price that people can afford. As a result, it introduced the "Fly Bags Free" policy to meet the customers' needs. Separately from not getting payed for customers' bags, the company reacts to customers' requests and criticizes in an appropriate attitude and also accomplishes suitable flight departures and landings. The company also decreased wastes by reducing cases of employee turnover. The company seldom retires its employees because this is an intellectual waste. It appreciates its customers and employees, therefore creating importance at low costs with minimal wastage.

Lifecare Hospital: Healthcare sector.

Lifecare Hospital applied lean philosophy which helped it to deliver quality services to its patients by the removal of pollutions, infections and deaths resulted by transfusion mistakes. Before the application of lean philosophy, the hospital records about 15

million victims of medication faults since its beginning. What makes it worse is that the death rate caused from these mistakes was extremely high. Roughly 40% of the victim's died from medication's flows. The hospital applied lean philosophy by development of its medical test tools (replacement where necessary), rejection of uncertainty by acceptance of medicine technology such as Computerized Physician Order Entry (CPOE), and employee training. Lean Philosophy's application results were extraordinary because the hospital decreased the number of contagion cases to almost 87%. While other hospitals such as Park Nicollet Health Service, and Monongahela Valley Hospital accomplishes an improvement in patient care by lean practice (Higor et al, 2015).

Banking and Insurance: Jefferson Pilot Financial Company.

Jefferson Pilot Financial Company is a life and insurance company that has successfully applied lean philosophy. At first, this company started in lean practice through the creation of a model-cell simulation set-up (Value Creation and VSM). This model represented as a guide on how to make price at low costs. Directed by the VSM, the company achieved time reduce that was spent on procedure applications as well as mistake introduced throughout processing. Waiting waste was removed successfully. It accomplished a 70% decrease of the time of processing a request and 40% of mistakes.

The company also sited linked procedures near each other in order to improve proficiency. Through harmonizing of amount of work and salary, employee pleasure was accomplished. It effects into 26% decrease of the cost of employment. Finally, the company keeps going of its presentation and performs frequent enhancement.

2.7. Value Stream Mapping

Lean philosophy has five main principles; value identification, value streaming, flow, pull, and perfection. Value talks about what the customer is exactly searching for. For the company, in order to deliver the customer with what they are looking for, a procedure of steps, practices, and operations is necessary. Value stream is the series of steps, practices, and operations is essential to provide the customer what they want.

Value stream mapping is then a meditation procedure which inclines to support the organization to build a completed image of needed procedures and actions in order to deliver services to the customer at minimum cost. While value steam mapping has established most applications in the manufacturing area, it is as well able to apply in the service area.

In general, there are four main steps in VSM; mapping recent state, identification of opportunities and implementation challenges, mapping future state, and finally implementation of the future state. In the service area, (Andrea et al, 2011) indicates that VSM should start by selecting the value the consumer needs. To successfully decide the type of service a customer wants, a company ought to carry out Service Quantity (SQ) examination and apply data mining techniques. Once the service is identified and classified as the cost that the customer needs, the expert should board on mapping the recent status of the company's service delivery system. Mapping obliges construction of an observable stream-diagram of procedures and methods to be affected by accomplishment of the directed service. Approved from the manufacturing area,

Figure 1 demonstrations the basic icons that are able to apply in VSM. Nonetheless, if they want to find application in the service industry, (Andrea et al, 2011) recommends some extra changes because there are essential differences between the manufacturing area and the service area.

(Andrea & Gionata, 2011) recommends adding supplies and information icons to identify the type of material/data that are necessary for a successful service. Also, should be included lens on the procedure box icon to show further steps rather than a single step procedure because several services can be provided in an illustration by a single human being. Afterwards; showing a current state map, a future state map is shown, followed by fully service application.

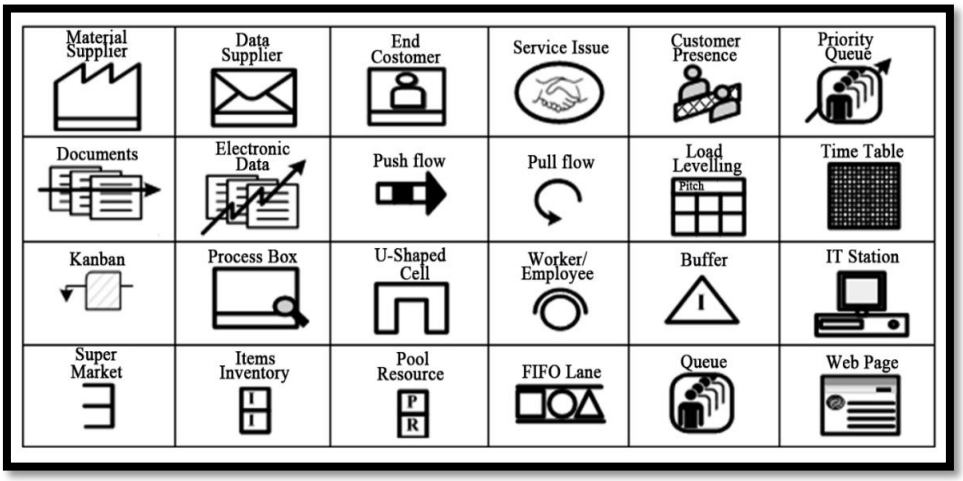


Figure 1 Value Stream Mapping Tools

The VSM instrument could be used anytime at any measurements even if it's a humble administrative procedure or a complicated one. Figure 2 shows the progress in VSM by time. The chief time is the time from starting the request to the delivery time of the request. The black covered zones symbolize the addition time that significances the procedure. The light covered area represents the essential non-additional cost procedure time, on the other hand, the middle darkness colored area shows the unimportant non-additional cost procedure time, which is the waste that must be reduced from the procedure. The white areas represent where the work is inactive.

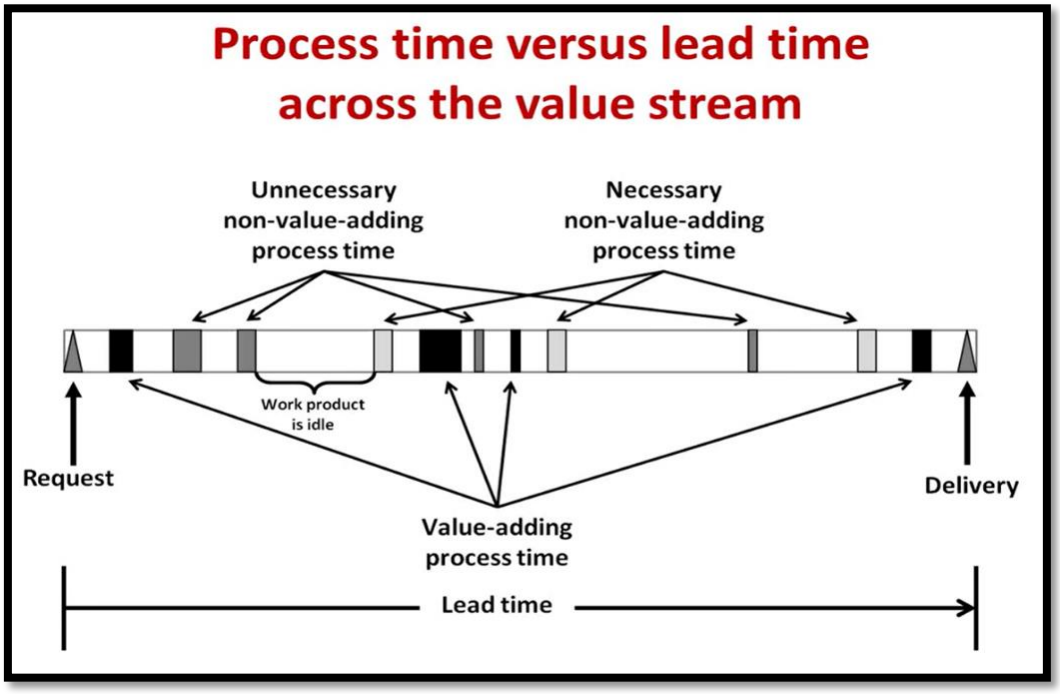


Figure 2: Timeline Types In VSM

In order to measure current work procedures or any commercial to organizations of all levels, The VSM is an essential instrument to use, for example:

- To provide suggestions of the customer's viewpoint.
- Providing a mutual language in order to notice and calculate the cost stream.
- Contributing full observation of the needed procedure to produce a product to a customer.
- Distinguishing disorganizations in the procedure.
- Improve the employees' sympathetic of work.
- Influential and modest instruments to boost manufacturing workflows.

Eight Essential Value Stream Mapping Templates:

There are some beneficial professionally designed value stream mapping patterns was made by using the typical signs available in the Creately value stream mapping tool library. Creately is a specialized website for graphic partnership instruments. There are eight existing molds that you can use easily by clicking once and selecting the pattern in the mold then open it in the Creately editor. These molds are:

- Production Control Value Stream Map

It's used to show the stream of supplies and data through a product's production track from dealer to the consumer.

- Current State Value Stream Map

The current state value stream map example as in Toyota model production system. It is recent state map that is used to categorize disorganizations of the recent system. It is the basis for the upcoming state map.

- Software Development Process Value Stream Map

In software improvement procedures, the procedure should be funded to the product's price via the use of the VSM instrument. This mapping example is helpful to develop the price from the basic required supplies to the final product or service used by the consumer.

- Funnel Shaped Value Stream Model

This type is suitable when there are quick first processing and enormous received amounts of tools or materials.

- Supply Chain Management Value Stream Map

. To see supply sequence management procedure, this pattern is a good choice.

- Pyramid Shaped Value Stream Map

The one is convenient when the final productions are large and the received material or orders is slow, so it's the opposite of funnel-shaped model.

2.8. Root Cause Analysis

Root Cause Analysis is the applicable form of inferential investigation methods that has to decide the reason of a difficulty and then provide a possible resolution. In companies which are applying lean, RCA has to be part of their frequent development methodology. There is a variation of RCA methods. (James et al, 2004) indicates that a good RCA technique must first undoubtedly describe the problem and its effects. Future influences if the problem continues should also be revealed. The technique

should start a fundamental relationship of factors and issues that combined influences to cause the recent condition. While classifying a fundamental connection of influences, the technique should provide proof to support inclusion of specific elements. To conclude, a good RCA technique must offer the most possible explanation to the problem at hand. A multiplicity of techniques and models for RCA is an existent.

Table 1:

Root Cause Analysis Methods

METHOD	BRIEF PROCEDURE
Events and causal chart method	Finds out events related to the problem and arranges them to establish a causal relationship.
Change analysis	It initially defines a problem, then defines a situation without the problem to find differences.
Barrier Analysis	Identifies whether a barrier that prevents occurrence of a certain problem was compromised with or failed.
Tree Diagram	It is the establishment of causal relationships between factors then narrowing down to a single problem.
5 Whys	It is a series of five "Why' questions in which each question leads to an answer. The fifth question gives the most probable cause of a problem.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Research Method:

Two techniques were used in this research project. The first technique was documentary analysis method and the second technique was observation method. The next step after completion of the first two techniques is to implement the value stream mapping tool in the periodic maintenance process in Toyota Qatar.

3.1.1. Documentary Analysis Method

Facts and ideas are recorded in documents, which considered as tangible materials that can be used to extract useful data for the research. Several documents and articles were studied as illustrated in the literature review part that talks about lean thinking in service areas which implemented lean. The gathered knowledge from literature will be the used to implement the lean thinking methods in Toyota Qatar service center process.

3.1.2. Observation

The most straightforward method to obtain data is by observing the different processes. Thus, the second method was observing the process of the services that are the aim of this research project.

3.2.Value Stream Mapping Tool

After gathering all the necessary data and facts, the next stage is to apply the VSM tool to the procedures. In order to comprehend the map, there are three central sections of any value stream map presented by (Karen, 2013):

- Production or Work Flow

The procedure flow from left to right just like the traditional process flow chart, the equivalent and matching responsibilities or the subtasks streams also from left to right but underneath the leading flow. This method is representing a mutual language so that any customer can comprehend the stream. This flow as presented in the middle portion of the map in Figure 3.

- Information or Communication Flow

At the highest area on the top of the map all formal and informal communication that appears throughout the procedure is presented. Because there is no regular communication stream, the communication stream can happen at any way.

- Timelines and Travel Distances

The bottom area of the map demonstrates the timelines of the procedure. It is a very significant key of evaluating services development. The process time are the chief time kinds measured in VSM, lead time, value added process time, non-value-added process time. yet, the process time, lead time or cycle time is used in most of the maps. The other line that is exposed in the map at the bottom is the travel distance of the work, or people or the product throughout the whole procedure if any figure 3

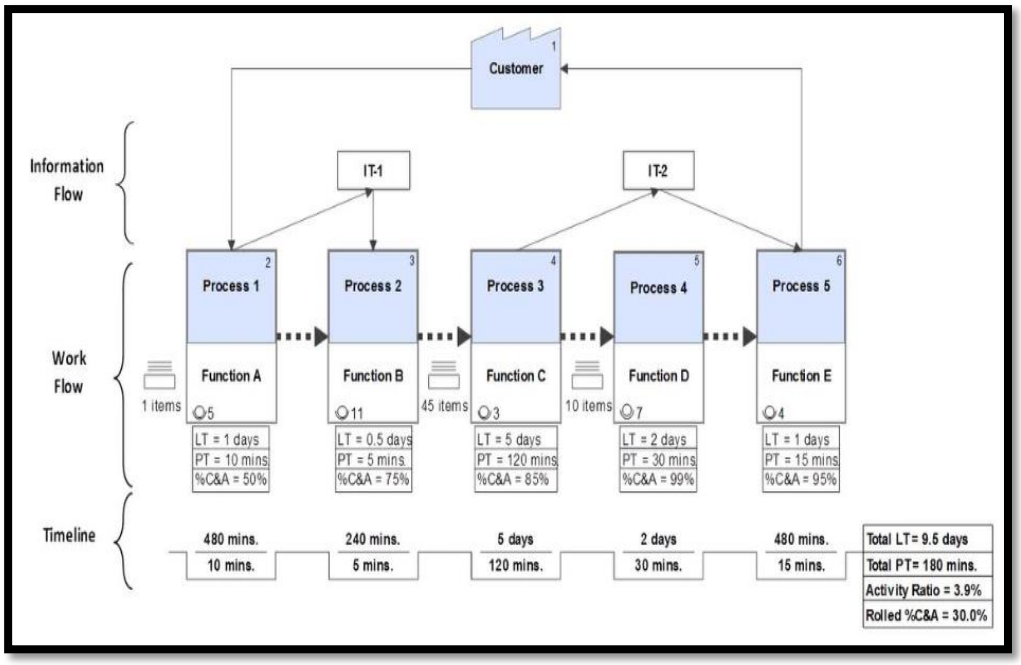


Figure 3: The Three Main Segments of Value Stream Mapping

CHAPTER 4: APPLYING LEAN THINKING IN TOYOTA MAIN SERVICE CENTER

4.1. Toyota Qatar:

Abdullah Abdulghani & Brothers' group is the Toyota dealer in the State of Qatar. Toyota automobiles are famous and widely used in the State as sales which represents 55% of the share market. Depending on surveys conducted by AAB Company, Toyota and AAB Company cars and services are purchased due to reliability of brand, reasonable price and high resale value. In addition, other parameters like variation in models, availability of parts at relatively low costs, and various service centers lead to make Toyota the most popular brand in Qatar.

AAB has one main service center in the industrial area in Qatar, and seven quick service centers providing various services to customers. main service center is one of the busiest centers, and the service center is analyzed in this report. It serves customers by doing all kinds of mechanical repair such as periodic maintenance, brake job, suspension, electrical job, even engine and transmission repair.

The main service located at the industrial area in Qatar, street no.6, with huge workshop that has 52 working pay to cover the huge demand. Such huge workshop requires large parking area, specially that must of the vehicle spend more than one day specially for major repairs, the parking can accommodate 500 vehicles, with distance 80,000 m^2. Main service works for 2 shifts with 8 hours for each, with more than 135 staff.

4.2. The Goal of Applying Lean Thinking:

As per customers' service and feedback reports, only 35% of Toyota owners use Toyota service centers. These reports highlight that 70% of the customers' complaints are about long delivery time (throughput time), and as a reason, many customers use non-Toyota service centers.

As AAB Company aims to have greater participation in the Qatari market, the company has to be capable of serving more clients in a faster rate. Given that, the objective of the process analysis is to identify the problems and bottleneck of the current main service center's process and provide a redesigned process and suggestions to increase the capacity in order to allow more cars to be served, and for more clients to come for services rather than using other non-Toyota centers.

AAB Company provides appointment system in addition to the regular common used walk-in system. This report and analysis cover, the walk-in system as it represents 80% of the service request cases.

4.3. Value Steam Mapping:

The value stream mapping is a preferred way to plan and implement the necessary improvement that is required to achieve truly lean institution. Stream mapping technique, which is a tool of lean methods, inquires a complete preparation for the targeted process by agreeing on what process/service to study, how to map it, collecting necessary data, and choosing the team who will work on the selected process. The second step is to draw the current state of the targeted process

including all steps, adding value and non-adding value steps, in the current state all data should be highlighted on the map. The future state is the next step; it should give a clear vision about where the process should be after minimizing or removing the waste or non-adding value steps from the process. The last step is planning for implementing the changes in order to achieve the future state vision. According to Locher (2016), the above four explained steps are general steps that are used to insure achieving a good implementation of VSM. The chart below summaries the mentioned steps.

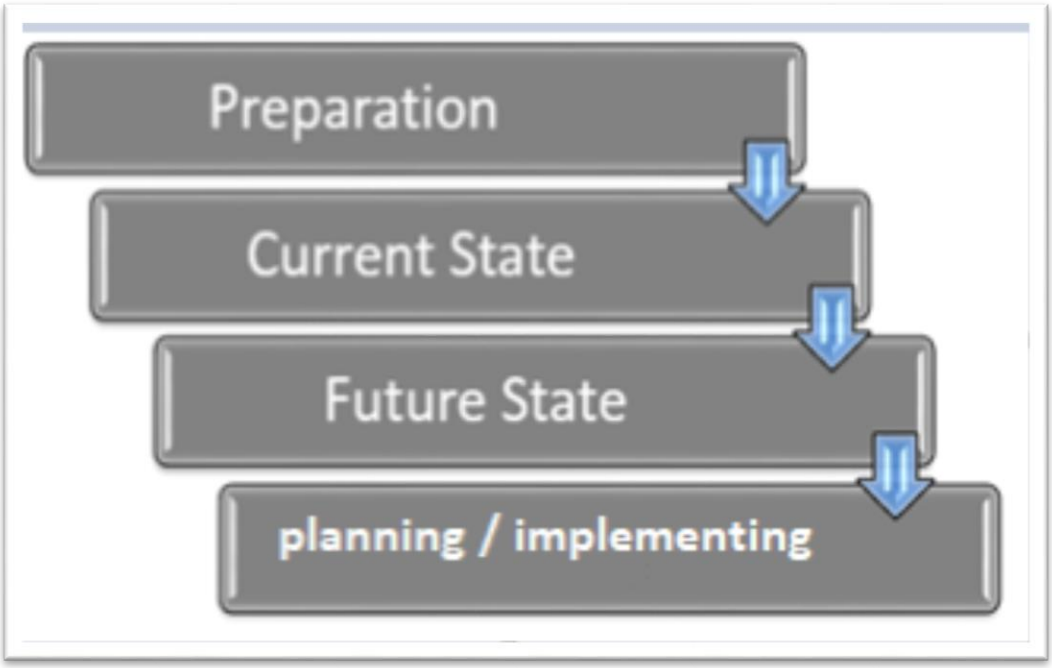


Figure 4: General Steps of Achieving Good VSM

4.2.1. Step 1: Preparation

As explained above the first step of implementing VSM is to understand our targeted process.

4.2.1.1 Understand the Process

To understand the proceed flow, the work stages must be defined, since vehicle inter the service center till delivering it to customer. The work stages can be described as the following:

- Opening a Job Card:

This part of the process takes place at the reception area. An advisor asks the customer about the type of service he/she needs, and if a wash should be included, along with the details of the car and its owner. This service request, regardless of the service type, is referred to as Job Card (JC).
Number of service advisors: 16.
Task time: 15 minutes.

- Initial Road Test Technical Advisor:

If a customer complains about sound or vibration or smell that requires Road test to confirm the problem, in that case, a qualified Road technical advisor has to join the customer to road and test the vehicle then recommend the necessary repair to workshop to do.

Number of technical advisor: 4

Task time: 30 min

- Control Room (Buffer):

All opened Job Cards are passed to the control room by the advisors. The control room is a buffer where a controller assigns the Job Card to the next available technician. Also, the controller monitors the flow of a Job Card through the process as it moves from stage to another. The Job Cards are assigned and controlled in first served basis. A board called "Job Process Control board" hosts the Job Cards and is sectioned as per the process steps. The next Job Card is placed waiting for the next available technician to come, take it, and start the "Fixing" stage.

- Fixing:

This step represents the actual implementation of the service requested by the customer. The next available technician takes the Job Card with the details needed. He goes to the parking to bring the car, arranges the spare parts needed depending on the type of the service, and then starts the actual fixing.

Number of technicians: 100.

Task time: each task has different time, TMC call it flat rate for example replace oil and filter take 0.3 hour. Appendix E shows the time required for each service.

On average fixing process takes 60 minute

- Road Test and Re-fixing:

For safety and quality assurance purposes, most of the vehicles have to be road tested specially the vehicle with safety related job. If the road test fails, the car goes through additional fixing in a "re-fixing" stage made by the same road tester. On average, only 5% of the tested Job Cards fail and all of them pass the second road test.

Number or road tester: 2.

Task time for road testing: 30 minutes.

Task time for re-fixing: 0.5 hour.

- Optional Car Wash:

This service is optional and offered by Toyota service centers at cost of 30 QAR. The car was being attractive to customers because it is cheaper compared to prices abroad, as the price in other car wash centers is about 35 QAR. In addition, it feels easier for customers to receive their cars washed rather than having to wash it in another place at different time.

Number of car wash team: 6

Task time: 0.5 hour.

- Billing:

When the Job Card is done and ready for payment, the controller notifies the advisor. The advisor then notifies the customer to do the payments at billing clerk window. After the payment, the customer is handed a receipt confirming that all financial aspects are cleared.

Number of clerk: 2.

Task time: 6 minutes

- Delivery to Customer:

The customer meets the advisor again at the reception. The advisor confirms closure of Job Card and gives a summary of the implemented Job Card to the customer. The advisor arranges delivery of car to customer by guiding him to the parking location.

Number of advisors:16.

Task time: 15 minutes.

The Job Card travel through the process step by step through having its new position on the "Job Process Control board" at the control room. After fixing, the controller makes sure that the responsible employee for the next stage in the process is aware about the Job Card by notifying the road tester if the Job Card needed safety and quality assurance testing, and notify washing team if the customer requested a wash, or notify advisor if the Job Card is ready for payment by moving the job card on the position on Job Process Control board.

The car will be kept inside the service center premises during the process implementation to assure easier flow from task to task.

4.2.1.2. Process Mapping (SER)

In order to understand the workflow of main service process and where the targeted weak points are located throughout the process, this section gives a clear visual map of the workflow process.

Figure 5 shows the mega process workflow for the all process and also the interact between the parties which connected to the five working stages that are reception, problem verification, fixing, quality check, cleaning and delivery.

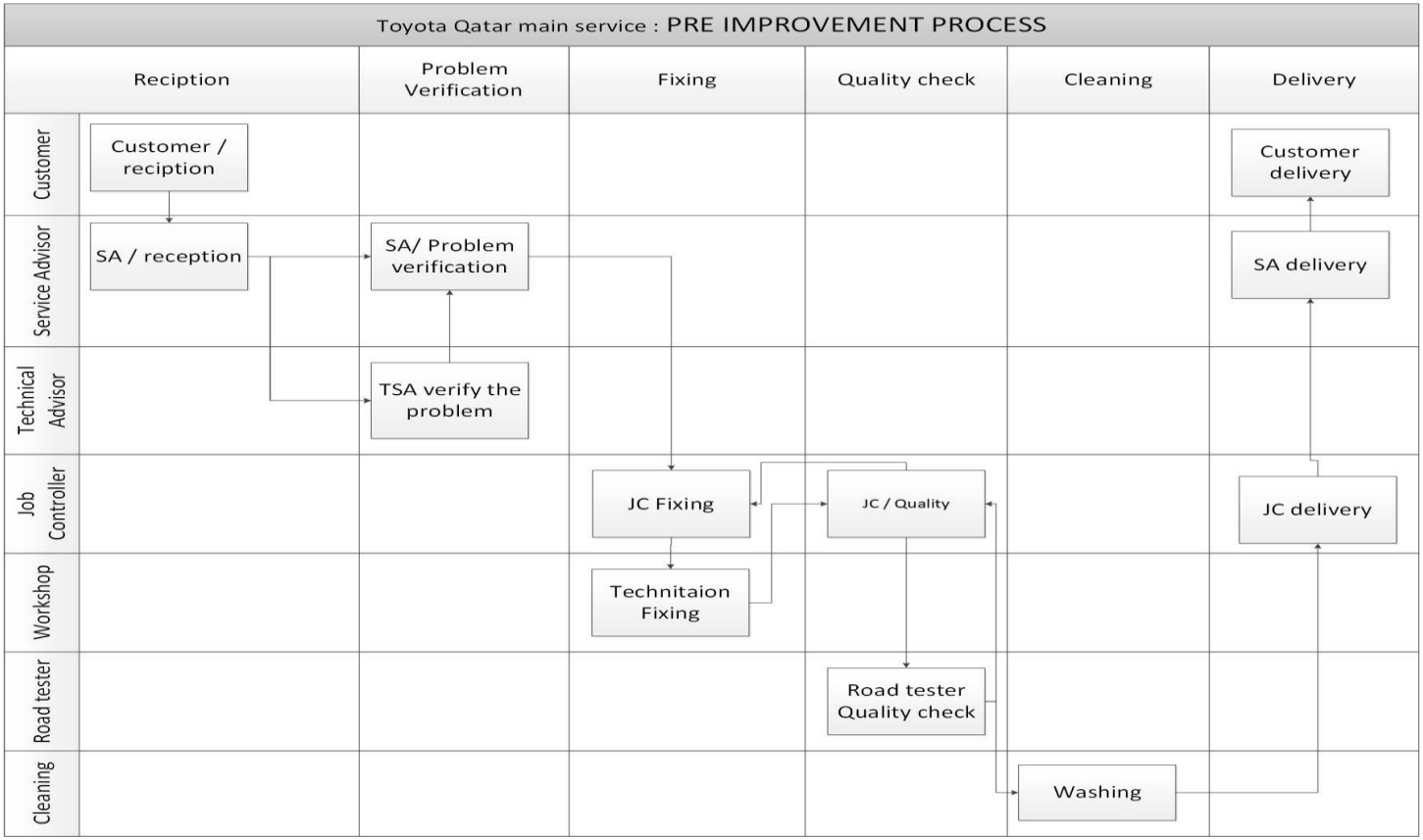


Figure 5: Main Service Process Flow Chart.

To understand the exact situation, each work stage needs to be expanded in order to see what has acutely done.

Figure 5.1 shows customer that action on reception process is noticeable that customer has to wait his/her turn to meet the SA. It's important that the waiting time for customer to meet the varies from 5 minutes to 45 minutes on rush time.

Figure 5.1: Customer/ Reception Flow Chart.

Then SA meets the customer and asks him/her about the reason of the visit and enter customer and vehicle data in the system and open job card to him/her as shown in Figure5.2

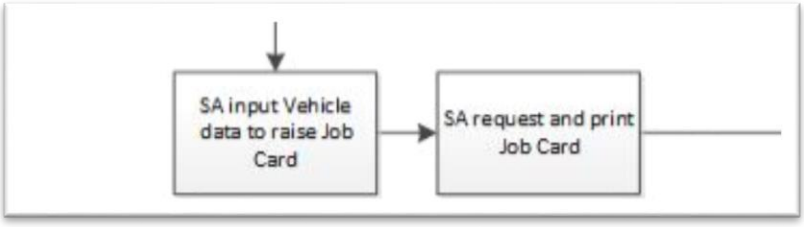


Figure 5.2: Service Advisor/ Reception Flow Chart

Customer and SA walk to the car to verify the problem on it. In case the customer complains about noise or vibration appear while driving, SA requests technical service advisor (TSA) to join customer to road test. Figure 5.3.

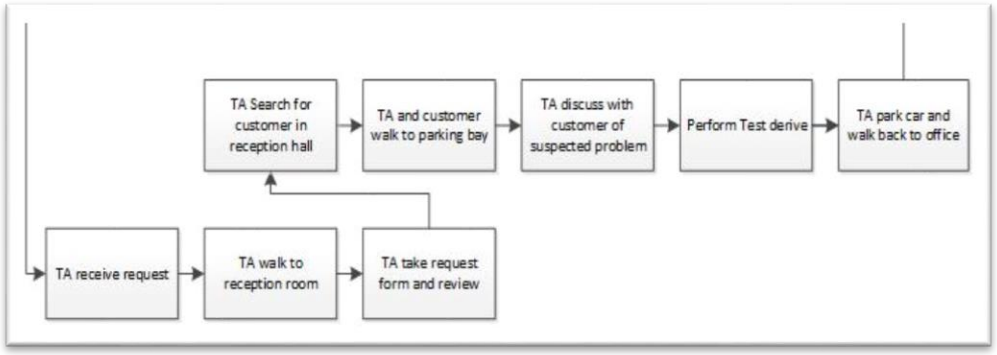


Figure 5.3: Technical Advisor/ Problem Verification

After verifying the problem, SA takes the customer approval to do the necessary job and inform him about the estimation time and cost. Then SA passes the job card to Control room, in their job card stay on Job process control board till schedule time arrives to start fixing stage. In that time car will move to parking. see Figure 5.4.

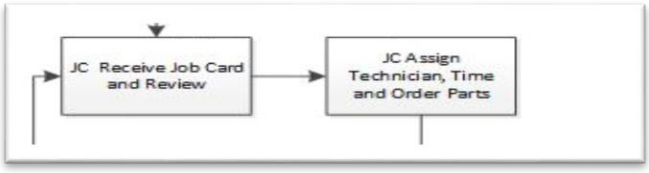


Figure 5.4: Job Controller / Fixing

The technician receives the Job card from the JC, go to the parking to search the job card and paring it to workshop then he moves to the part store that located at the corner of the workshop to collect the part and processed the job. After fixing completed, technician write the job has done on the back of the job card and sign it, and take signature from his Forman. Then pass the job card to Job control again, Figure 5.5 shows the process flow, then technician drive the car to the parking, and search for the next vehicle.

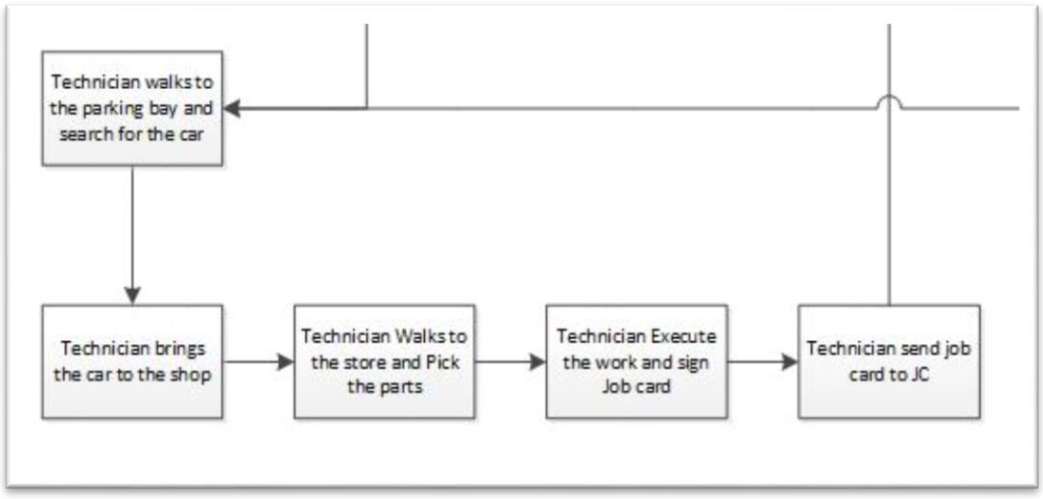


Figure 5.5: Technician / Fixing

After workshop fixes the vehicle, Job controller review the job card and confirm that all customer's complaints had been resolved, if not reschedule the job card to the next technician , it's important to notice that in some cases the car moved to many technicians with different skills, JC decide if the vehicle needs to be Road tested or not, if so, JC pass the job card to Road tester for Quality check (QC). Car pass quality check controller move the job card to Wash Board see figuer5.6.

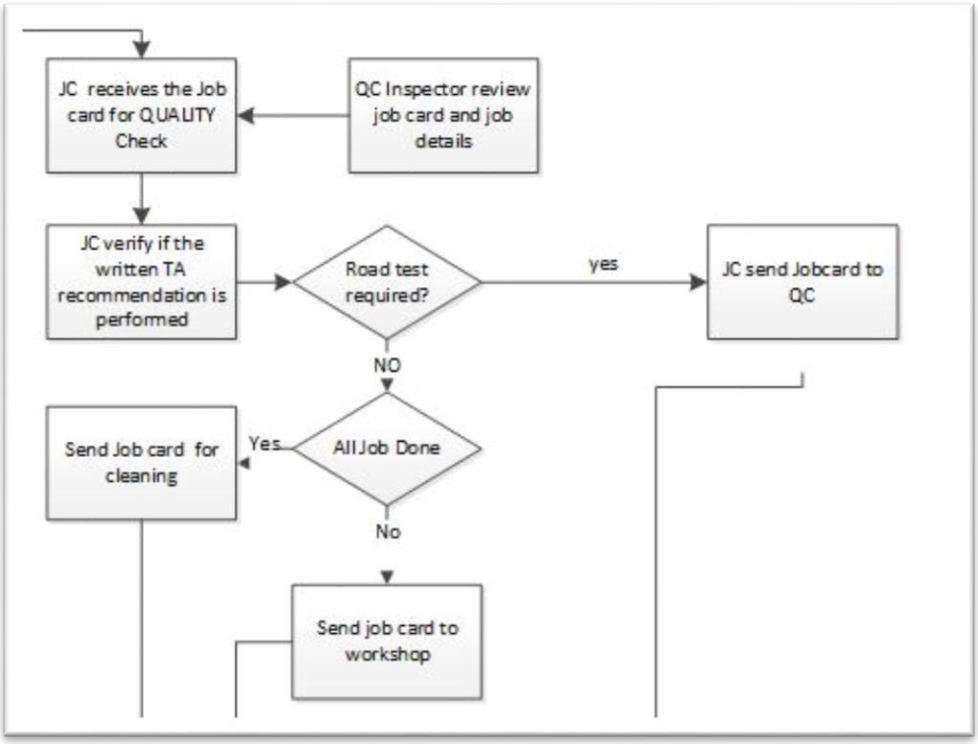


Figure 5.6: Job Controller / Quality Check

Road tester read customer's complaints then move to Parking area to search for the car, then conform that customer issues will not appear anymore. Then stamp QT pass stamp on it and return the job card to JC. In case some issue still appearing in the car QC writes the new recommendation on the job card and send it again to JC.

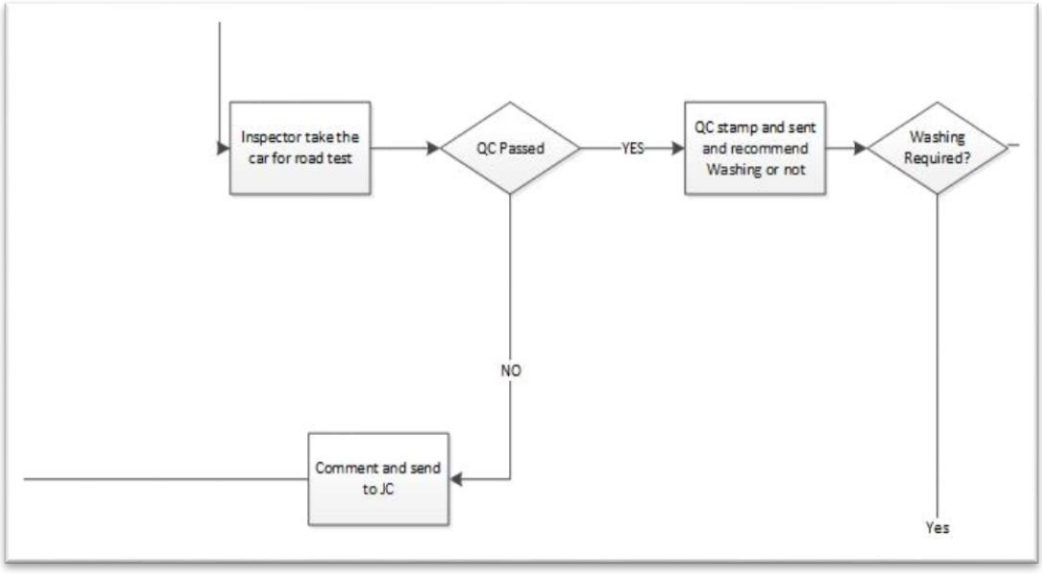


Figure 5.7: Road Tester / Quality Check

Driver bring the car from parking to wash, after washing task is done, Wash Forman stamp the date of the wash and sign, then return the job card to JC. JC finalize the bill by calculation all the tasks that are done, and parts issued on the car. Then notify the SA of compilation of work.

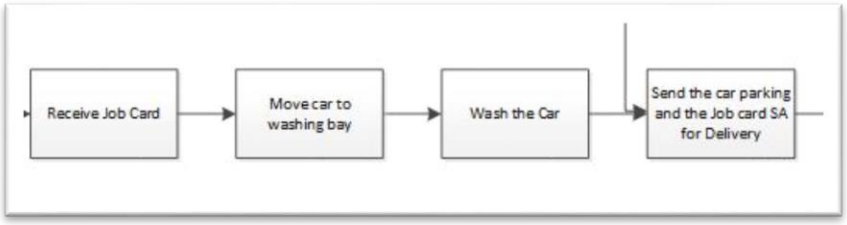


Figure 5.8: Washing Process

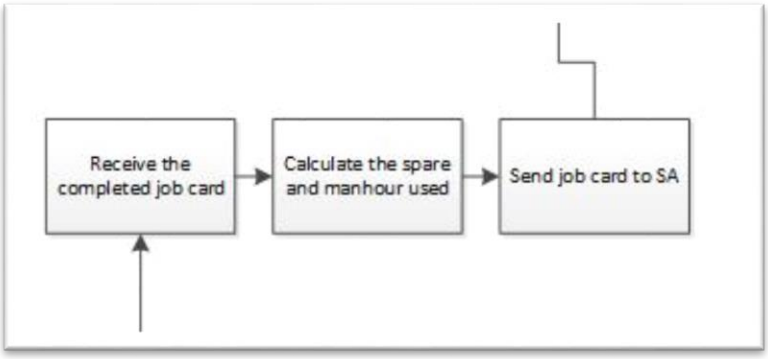


Figure 5.9: Job Controller / Billing

The final step of the service is delivery. SA will meet the customer and explain the tasks done to him/her and explain the charges and amount, guide him to casher then give him the gate pass, a driver will bring the car to customer.

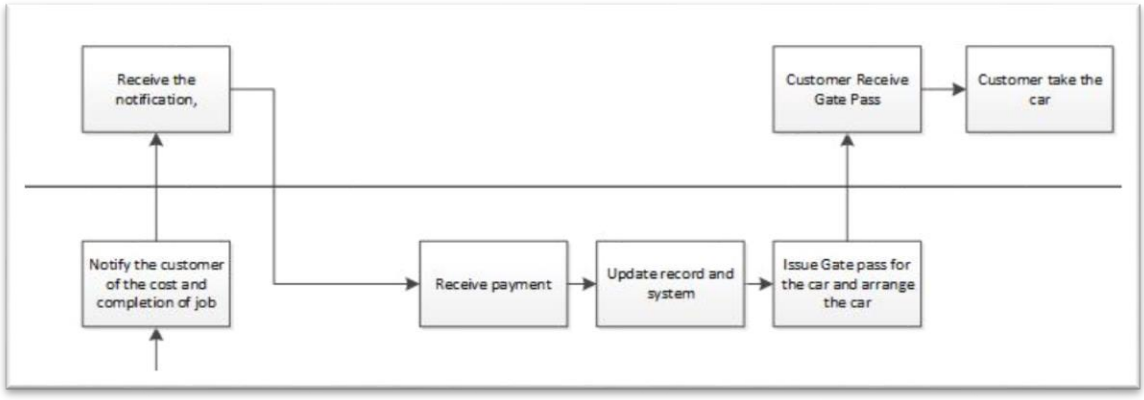


Figure 5.10: Delivery Follow Chart

Easily we can notice on the detailed Process flow chart the delay and movement that effects the throughput time, which make the important improvement, we notice also that moving the car through the work stages is necessary but consuming a lot of time as well.

4.2.1.4. Data and Resources

Data of this project were gathered via observations of the existing service system in Toyota Qatar. In addition, setting meetings with service management team and parties who are involved in the service department. Extracting reports from the current operation system was the method used to have detailed information regarding the number of customer arrive and requests entered per term.

- Observing the service department took four months of focusing and following up the time and effort needed from different stockholders to finish one vehicle in different days to understand the current situation. Service order differ in time and effort depending on the cause of the service order and the employee availability and potentials, even the different demand on that day. The method used was track a specific service order from entry time till delivery time recording all the movement and time that each stage requires, different types of service order and writing up the time and effort required to accomplish one job.
- Several meetings were arranged with the different parties involved in the system, and those are the customer (one employee vehicle), service advisor, reception driver, job controller, technician, road tester and even car washer, there are the stakeholder in system. Each different stakeholder was represented by a focal point. The overall number of meetings held is five meetings. The goal of these meeting was to gather all data and information from the different stakeholder, and to identify current defaults and difficulties facing each stakeholder.

Table 2

Statistics of Service Report of First Quarter of 2017

month	average daily service order	monthly service order	average daily sold hour	monthly sold hour	technician productivity
Jan-17	107	2772	290	7633	73%
Feb-17	152	3230	345	7633	71%
Mar-17	107	2772	290	7633	75%

4.2.2. Step 2: Current State

The current state includes all steps involved in the current process. The data gathered and used are the process time, lead-time, activity ratio, materials used, and number of employees.

- Process time (PT): The process time is the time it takes to perform the work if the employee is able to work on it uninterrupted. It includes all tasks related to the completion of the task.
- Lead-Time (LT): the elapsed time from the time work of specific task is received from the previous step until it is done and passed to the next step. It includes all tasks wither its related to the completion of the task or not.
- Activity Ratio (Service Quality): Activity ratio is also called the service quality. Simply it's a measurement of the how quickly the work passes

from step to step in the process. In ideal processes, the AR is 100%. One hundred minus the AR equals the time work is idle.

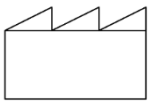
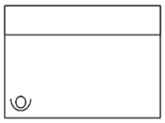
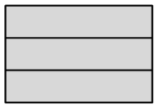
- Materials used (TM): the materials used in the project in the number of papers.

4.2.2.1.Symbols:

The table below illustrates the symbols used to draw VSM of the current state of SER process, and their meaning:

Table 3

Symbols Used to Draw VSM

Symbol	Meaning
	Indicates the customer or the supplier. In this project it's the customer
	Indicates a process. The upper space shows the process name and the lower space shows the function of the process
	Indicates flow of data from a process to a process
	Indicates time segment of certain process. Upper space shows process time and the lower space shows lead time.
	Indicates the summary metrics.

4.2.2.2.Assumptions:

- Number of employees is fixed.
- Employees work 8 hours in a day for 6 days in a week
- Only the longest path is studied.
- The process assumes happy scenario. Which means it is assumed that the all job done good without Failed on Road test.
- The flow indicates the journey of only one vehicle.

4.2.2.3.Current State:

Figure 6 shows the Value steam mapping for current state to identify the non-value-added activity which considered as waste

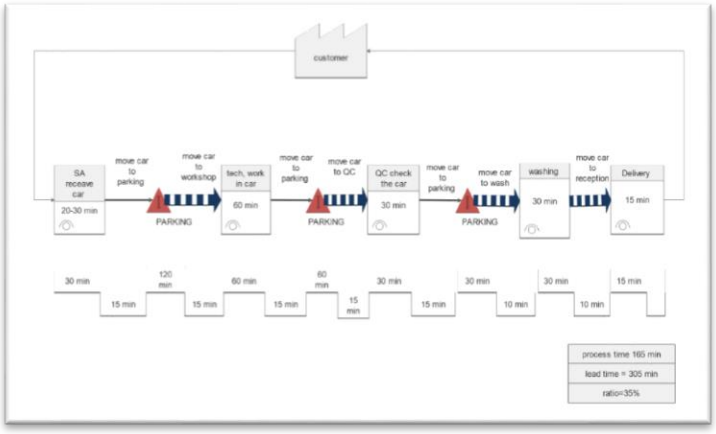


Figure 6: VSM of Current State

4.2.2.4.Analyses of The Current State:

Current VSM shows that total process time is 165 Minutes, and total lead time includes the buffer which non-value-added activity is 205 Minutes, with activity ratio of 35%, which means that 65% of the activity is not adding any value to our customer which considered as Waste. Some of this waste won't be able to eliminate, but it must be reduced and minimized the waste as much as possible.

From the VSM it's noticeable that moving the car during different stages makes a huge waste in the procedure and takes considerable time which has an effect on the throughput time of the process which directly affects the Customer's satisfaction and waste manpower for non-vale added activity. Moving the car from to the parking during the work consumes 95 minutes for each Vehicle.

On the other hand, the time spent to move the car is directly affect the productivity of the staff, specially that different staff with different skills are wasting their time moving the car. And some of this stage is a bottleneck on the system, for example: a technician wastes 15 minutes to bring a vehicle to workshop and another 15 minutes to send it back to parking area.

4.2.2.5.Root Cause Analysis:

To know the reason of the delay, the study applied Root cause analyses as the following:

- Waste of Moving the Vehicle

To investigate more about the reason of the waste, Root case analysis has been applied on the system by using 5 why methods, staff who are responsible for moving the car has been asked the following question:

Table 4

Root Cause Analysis (5 Why Method)

Question	Answer
1)Why moving a car takes much time?	Parking is too big and Staff parking the vehicle at any empty slot.
2) why	There is no record of car location, and car may move several times.
3) why	Lack of communications between WS & Drivers.
4) why	Nobody was raised this concern.

- Buffer in Workshop

To find reasons that lays behind the buffer in workshop root cause analysis applied to find the waste in technician time, the results show that:

1- technician spends time searching for the car, and time to park the vehicle out the workshop after finishing the job.
2- technician spends time arranging the parts from part store located at the corner of the workshop.
3- Customers arrived on nonlinear and in unpredictable pattern.
4- Number of technician is not enough.

A job tracking sheet was filled for all technician in one week to find the amount of time technician waste on non-value-added activity appendix B shows that 1.1-hour average waste on moving the vehicle and arranging the parts for each technician.

- Buffer in QC Stage:

To find reasons that lays behind buffer in Quality check stage root cause analysis applied to find the waste on road test time, the results show that:

1- Road tester needs to search the vehicle on the parking.
2- Traffics on roads in the industrial area due to the road constructions.
3- Some of customers complaints appear sometimes which required multi road test.

- Buffer in Wash Stage:

Similarly, the researcher studies to find the reason for the buffer in wash stage and the results indicates:

1- Number of wash team is not enough to wash all the vehicles.

Some customers don't arrive on the same day, that the worker has to rewash the vehicle again specially because of the dust in the industrial area which messes the car up again.

4.2.3. Step 3: Future State

After study the current situation and the core of the problem the researchers offer the following suggested solutions.

4.2.3.1. Solution No.1: Appointment System:

to make equalize the load on stages the investigators suggest working on appointment system by using a notebook and reserve an appointment to payments on time that is suitable for both customer and workshop which will eliminate the buffer in the process, and be prepared to arrange a technician, tools and parts for customer before arriving to service center.

The Figure 7 shows the VSM for the future state for solution No.1

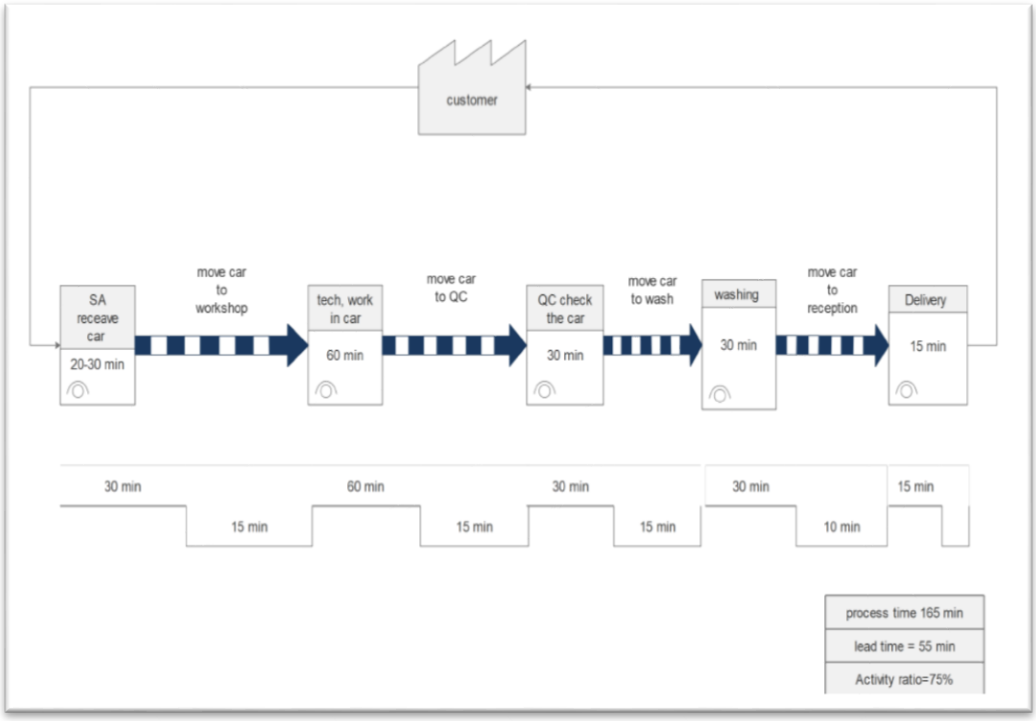


Figure 7: VSM of Solution 1

However, this solution cannot be implemented at this time since customer's behavior does not supported to perform the exact appointment system, where most of customers arrive late or not show at all which makes the appointment system not effective. also, this approach required high communication and cooperation from staff.

4.2.3.2.Solution No.2: Reorganize Parking Area:

In the second suggested solution is to rearrange the parking area by allocate area to cars to be easy to find and reduce the movement. By allocating area for each status like ready, pending allocation, pending quality check and pending wash, and the vehicle pending. approval from customer as well. Figure 8 shows the parking area after allocation. Reorganizing the parking area helps to reduce the movement in significant

way. The time of Moving the vehicle reduced from 15 minutes to 7 minutes.

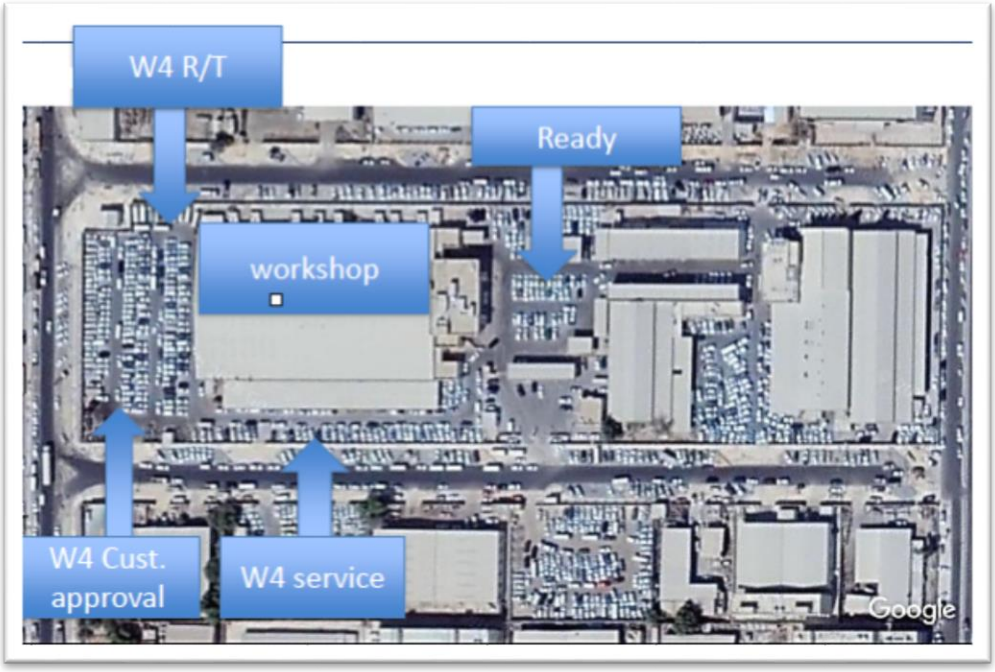


Figure 8: Organized Parking Map

Also, redesign the process by removing arranging vehicles responsibility from the productive employees like technicians and road tester, then allocate drivers on Workshop. The workshop drivers are responsible for arranging the vehicle in and out the workshop, and arranging the spare parts to tactician, so the technician will not waste time searching for the car. Figure 9 shows the new process flow for technician

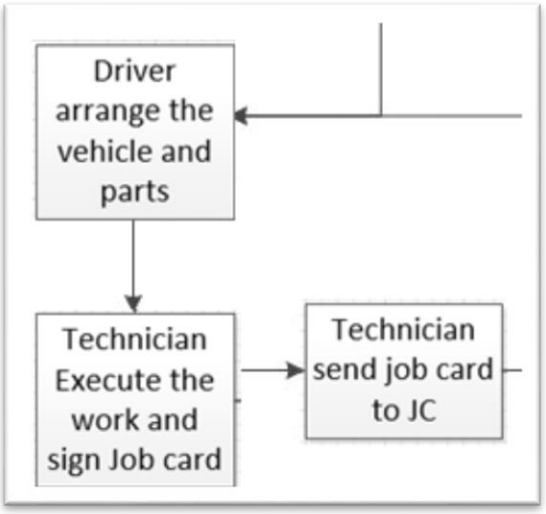


Figure 9: Technician Process Flow Chart After Kaizen

This task was consumed an average of 1.1 hour for each technician. Since this task is moved to another employee. Technicians productivity is expected to increase by 10%, since, 1.1 hour will be saved out of the eight working hours.

Lost productivity= 1.1 Saved time / 8 working time = 13.7%

By assuming technician productivity increases by 10% the researchers also assumed that workshop buffer may be reduced by 10%, which will make average buffer equals 108 minutes instead of 120 minutes.

Road testers productivity may be reduced by 5%, this assumption was made after studying the time they spend in finding the vehicle. So, by decreasing 5% from the QC buffer time may be reduced from average 60 minutes to 57 minutes.

By this improvement in VSM, solution 2 shown in Figure 10.

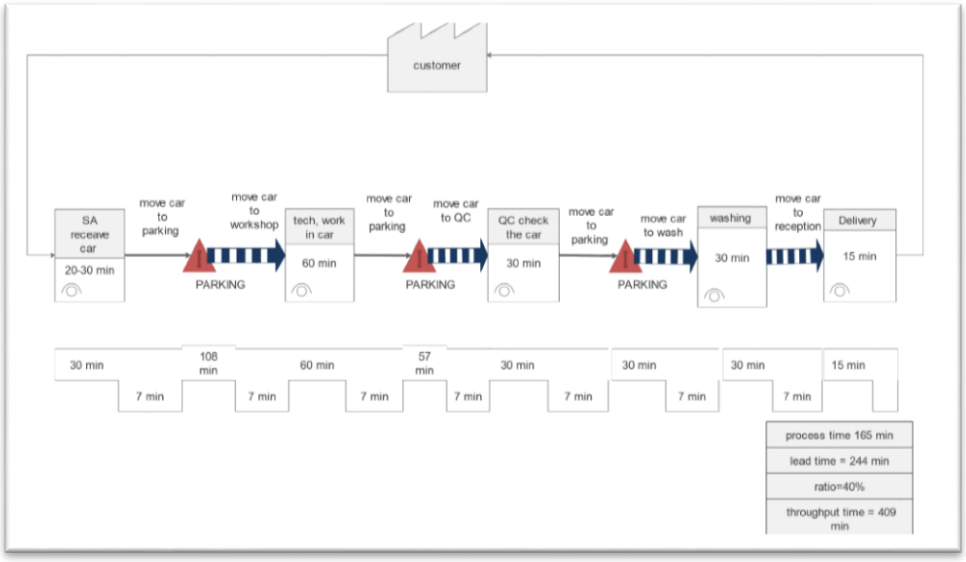


Figure 10: VSM of Solution 2

from VSM shows that waste time reduced from 305 minutes to only 244 minutes, which directly reflected to throughput time which also reduced from 470 minutes to 409 minutes only, which is the main objective for the study.

This improvement is already implemented in the main service center in June 2017 and great result had been achieved. The table summarized the improvement achievement in 2017 in comparison to 2016.

Table 5

Statistic for Service Report for The Last Two Years.

Year	2016	2017
Technician utilization	78%	85%
Customer satisfaction	90.4%	92%
Yearly Income labor per technician	20800 QAR	27600 QAR

In real life Toyota Qatar faces issues to sustain this process, the reason for that is the implementation ally on employees which is hard to supervise the process from management. After six months, drivers and employees came back to park the vehicle randomly which affects the process. That forces the technician to search for vehicle again which directly affects technician utilization to decrease from 85% in 2017 to 80% at first quarter of 2018.

The implementation sustainability issues force the investigators to think of alternative solutions.

4.2.3.3.Solution No.3: Vehicle Tracker System:

To overcome the human aspect of the process, the study suggests other solutions based on fix vehicle tracking system on the vehicle in the service center. The study was made for the tacking available system.

4.2.3.3.1. OBD Tracking System

This system operated by installing electronic device connected to each vehicle, this device uses SIM card has access to the internet in order to track vehicle by GPS system. This allows all employees to track the vehicle in Qatar with tolerance of 30 meter using mobile application, Figure 3.3.3.1 shows the device and device specification appears in appendix C.

Figure 11: Example of OBD Tracker.

- Financial analysis has been performed on OBD tracker for 500 vehicles.

Fixed cost:

OBD tracker cost 1200 QAR per device.

Fixed cost = 1200 * 500 = 600,000 QAR

yearly Operation cost:

Reach device need monthly 35 QAR for SIM internet connection.

Yearly operation cost = 35*500*12= 210,000 QAR.

This solution is not financially efficient so is not recommended.

4.2.3.3.2. PET Tracking System

The PET tracker is a chip designed to track the pets and animals at houses and parks, it works by Bluetooth waves with range of 200 meter with accuracy of 5 meter. this system can be modified to extend the distance to cover 400 meters by installing amplification system. This chip can be attached to each vehicle while receiving stage and update its serial number on service operation system. This system allows drivers to allocate the vehicle immediately

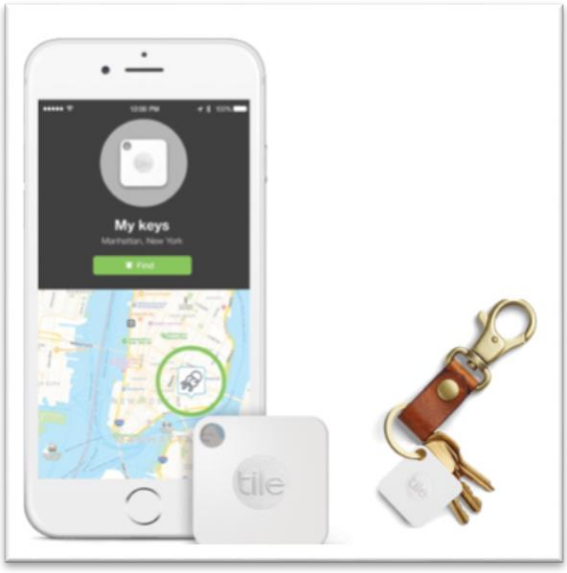


Figure 12: Example of PET Tracker.

Financial analysis has been performed on PET tracker for 500 vehicles.

Fixed cost:

The major part of the fixed cost for install the system and expand the range of waves which cost 100,000 QAR. And the device itself 20 QAR per chip.

Fixed cost = 100,000 + (20*500) = 110,000 QAR

Operation cost:

This device doesn't need operation cost, however maintenance and replacement lost, and damage chips estimated to be 1000 QAR/ year.

Yearly operation cost = 1,000 QAR.

Assuming this implementation expect to increase the average technician utilization from 80% on first quarter of 2017 to 85%. Which will directly reflect on technician labor Income. So, refer to technician labor income on last year, improve utilization by 5% will increase technician labor income by 287.5 QAR monthly per technician and since 100 technician work system will payback itself after 4 months only.

Payback = 287.5 * 100 * 4 = 115,000 QAR

To study the expected effects on this implementation in Toyota service center, a demo test has been done using test chips from the supplier, and the average time to move the vehicle was only 3 minutes.

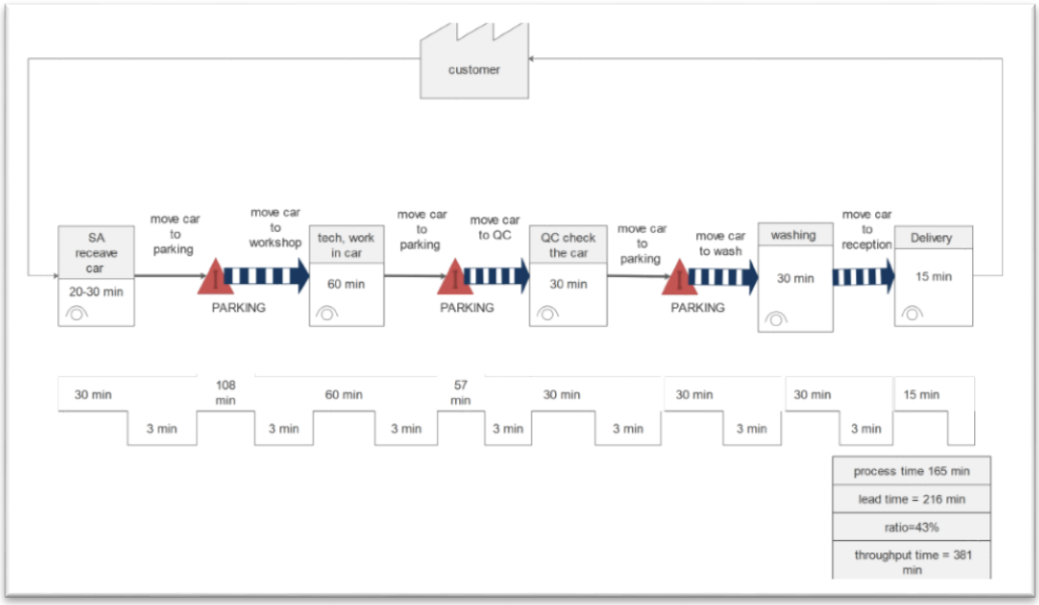


Figure 13: VSM for Solution 3.

From VSM shows that waste time reduced from 305 minutes to only 216 minutes, which directly reflected to throughput time, that also reduced from 470 minutes to only 381 minutes, which the is the main objective of the study.

4.2.4. Step 4: Planning and Implementation

In this step, an action plan was managed in order to achieve the desired future state or the ideal state shown in the results chapter. The action plan for this case is as follows:

- Set a meeting with service management team to discuss the time frame of implement solution 3.
- Select contractor to perform the work and install the system.
- Train driver and staff to use the new system.
- Record the movement of the vehicle to measure the actual waste time reduced.
- Monitor the system work.

CHAPTER 5: RESULTS AND ANALYSIS

5.1. Results:

The processes of Toyota Qatar main service center show that there are some steps which are non-added value, thus they are considered as waste. The action plan steps listed in chapter 3 for the periodic maintenance and general repair process were implemented and a new online system was developed with all requirements needed to reach the objective of this project.

5.1.1. Periodic Maintenance Process

Wastes of the periodic maintenance process are either unnecessary waiting, unnecessary transport, or unnecessary extra processing as highlighted in Figure 13 by kaizen events.

- Extra Waiting:

There is excess waste of time in moving the vehicle steps. Moving the vehicle steps requires time to moving the vehicle through work stages.

- Unnecessary Extra Processing on Bottleneck:

The extra process is in the fixing stage, searching and moving the vehicle in and out the workshop and pick the parts from part store takes time since the technician waste time on it. This step removed from technician responsibility and assigned to drivers to reduce the buffer on bottleneck.

After implementing, the steps in the action plan shown in Figure 12 represent the new VSM, which will be called the solion 3 VSM.

The table below shows the percentage of improvement when comparing the current state to the future state value stream maps:

Table 6

Statistic for Improvement Results

Metric	Current State	Future State	% improvement
Lead Time (mins)	305	216	29.1%
Throughput time (Mins)	470	381	19%
Technician utilization (%)	78%	85	9%
Labor per technician (QAR)	20,700	27,600	33.3%
Customer satisfaction indicator CSI	90.4%	92%	1.6%
Activity Ratio (Service Efficiency)	35%	43%	8%

The percentage of improvement calculated using the following formula for first five metrics:

% improvement= $\left|\frac{(current\ state)-(future\ state)}{(current\ state)}\right| * 100$

The percentage of improvement of the activity ratio increased by 8%

The calculation of activity ratio (service efficiency) done by the below equation:

Activity ratio (service efficiency) = $\frac{Total\ process\ time}{Total\ Lead\ time} * 100$

5.2. Analysis:

Results of Toyota Qatar main service periodic maintenance and general repair process show significant improvement in the total process time and total lead-time when comparing the current state and the future state. This improvement calculated after implementing the solution 2. The new process eliminates considerable waste indicated by kaizen bursts in the future state VSM. The total lead time improved by 29.1% The improvement percentage is higher in the lead-time since processes that were eliminated were having big lead-time compared to their process time.

Although the process time and the lead-time are improved, the activity ratio (service efficiency) improvement did not increase a lot, which gives us an indication that the difference between the process time and lead time is high in both states (current and future).

On the other hand, by redesign the process and responsibility technician utilization improved by 9% which reduce the buffer on the bottleneck on the system. This lead to increase the labor revenue for technician 33%.

The most important intangible result that was benefited from the new lean process is increasing the customer satisfaction. Considerable improvement in throughput time of the system by 19% lead directly to increase the Toyota Qatar Customer satisfaction by

1.6% to overachieve the internal target of 91% by 1%.

Also, the study suggested to implement effective appointment system, to smooth the process and overcome the buffer generated due unnormal distribution of the demand which customer arrival in our case. However, this suggested cannot implement at this time due to customer lifestyle, main service center location and lack of communication.

- Customer culture and lifestyle:

To build exact and effective appointment system need cooperation in the system and commitment to the appointment time, which cannot achieve in this point since customer lifestyle and culture not support. Most of the customer like to show on time suitable for them or at least be late, Qatar unpredictable traffic congestion and many other reason force customers to be late for the appointment time. That effect directly on the appointment system and technician scheduling time.

- Main Service Center Location:

Main service center located on an industrial area which makes it difficult to reach there on time due to continue construction on the road on the last two years. Moreover, the unfamiliarity of the area for most Toyota customers. However, appointment system partly applied on other quick service center distribution on Qatar

- Lack of Communication:

High level of communication and cooperation between staff and department on Toyota Qatar is required to operate appointment system effectively, cooperation between department like customer relation department, Part department and service department are must achieve that, which need high coordination from top management to apply this system effectively.

CHAPTER 6: CONCLUSION AND FUTURE WORK

This project demonstrated that lean thinking principles had achieved high improvement of processes in the service industry. Applying lean methods was challenging idea since it is used to be implemented mainly in the manufacturing industry; however, recently it became a common method to improve service industry too. It is concluded from the literature that lean thinking in the service sector does not have specific tools or procedure; it is a mixture of tools and practices that can be applied referring to the situation of the concerned process to be improved. Even though there are no specific tools, its best practices, extracted from manufacturing, when applied to services shows large financial results, improvement in the employee's behavior, and increase customer satisfaction. Thus, in this project, the lean thinking principles were implemented in one of the Toyota Qatar main service center especially periodic maintenance and General repair. Processes at Abdulla Abdughani & Brothers Company. The results show a great improvement in the percentage of technician utilization, lead-time, throughput time and customer satisfaction. It also shows a good improvement in the activity ratio of the process.

For further improvement of the process of periodic maintenance in the main service, it is recommended to set an action plan to implement appointment system to gain the huge impact on the performance and customer satisfaction and service market share. Performing root cause analysis can improve the current process flow; also, it can straighten the brainstorming technique of searching for causes of problems and their solutions. Hight level management needs to cooperate with each department to study and perform appointment system; customer incentive should be offered as a special

discount on price or special gifts to encourage the customer to face the difficulty and appear on appointment time.

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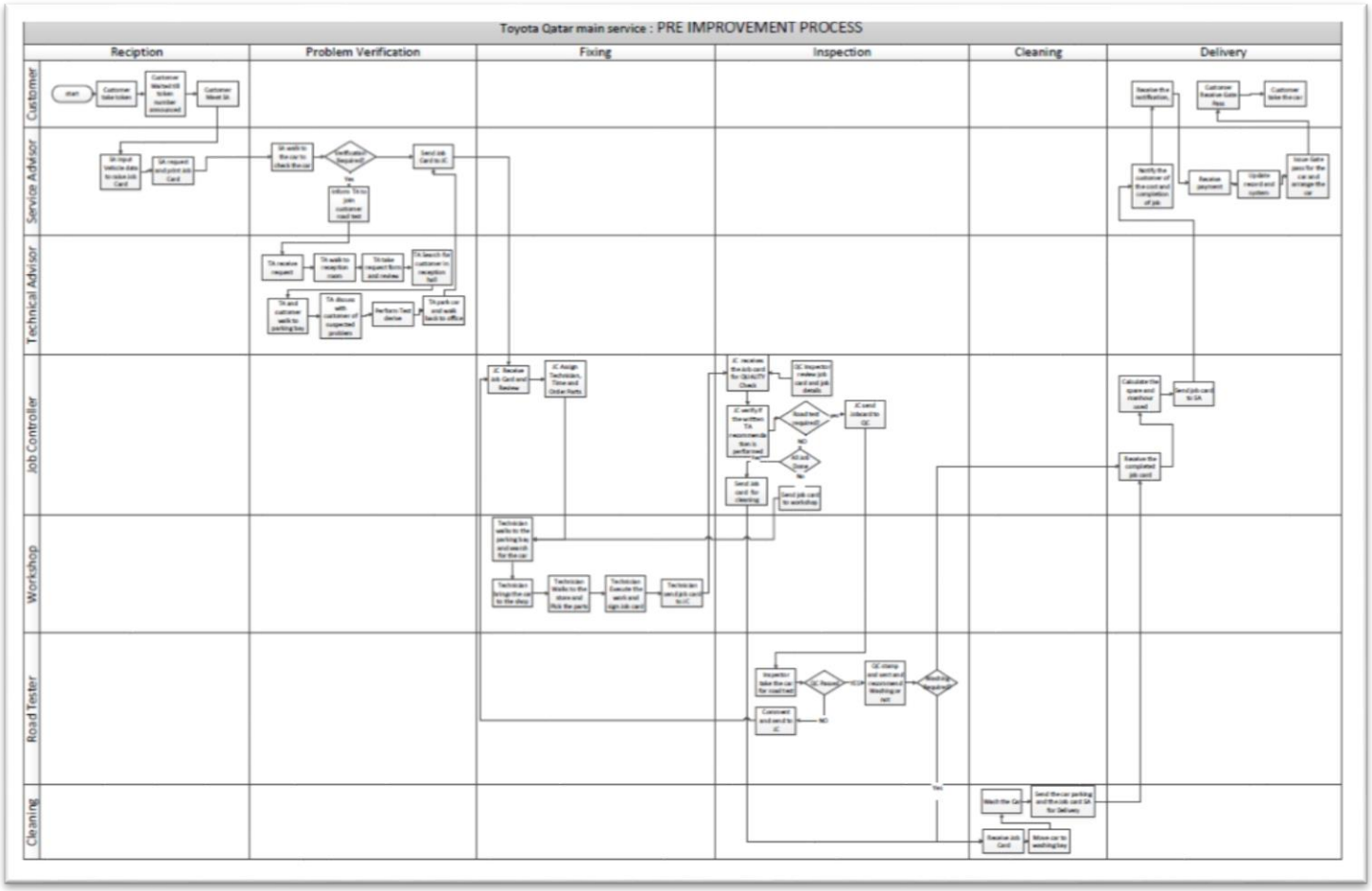
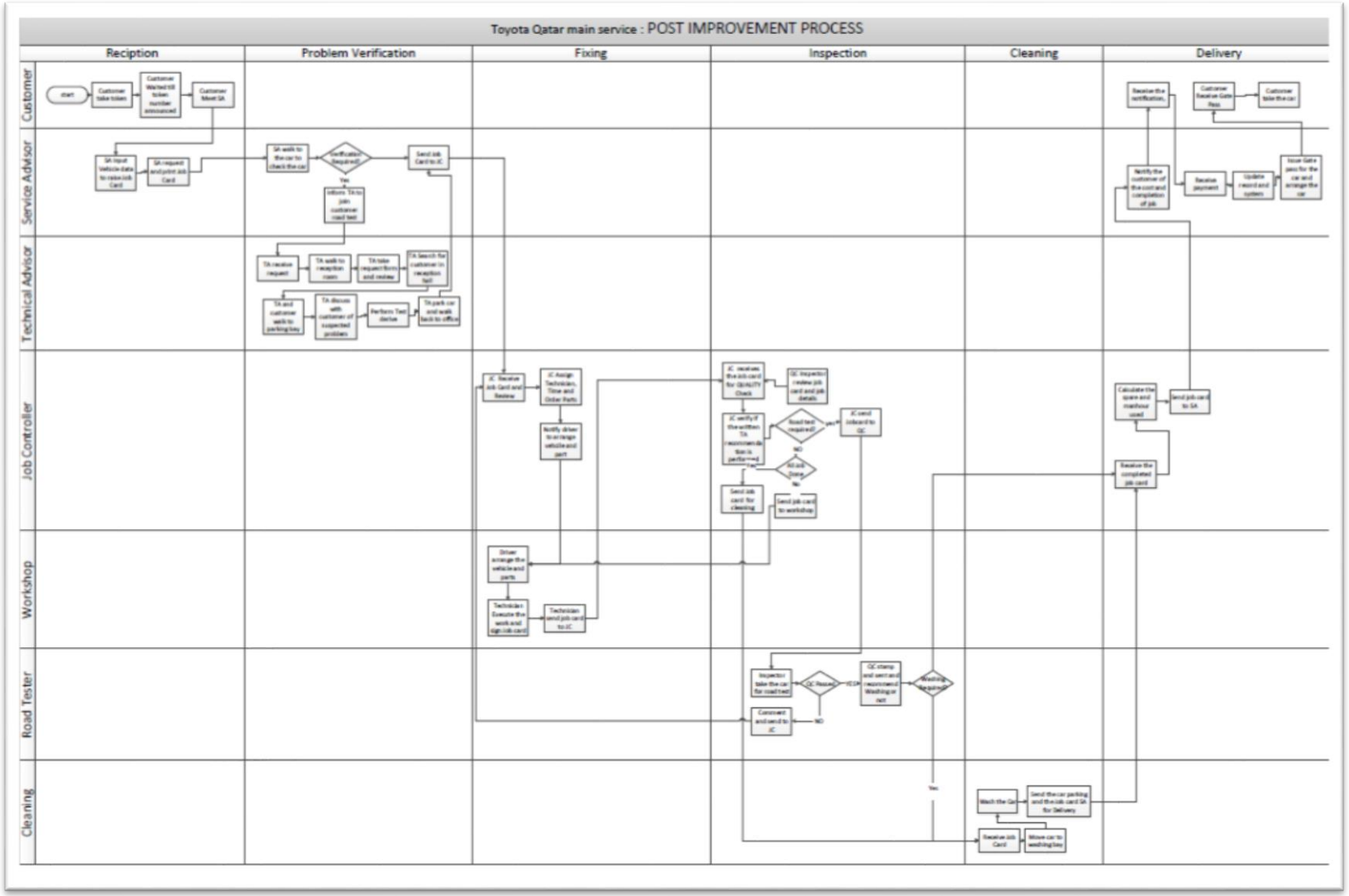
APPENDIX

Appendix A: current and future process flow chart

- The flowcharts shows the all process,




Toyota Qatar main service : POST IMPROVEMENT PROCESS
Reception
Problem Verification
Fixing
Inspection
Cleaning
Delivery
Customer
Service Advisor
Technical Advisor
Job Controller
Workshop
Road Tester
Cleaning

Appendix B : technician job track sheet :

Job Tracking sheet

Sl. No.	Name	1		2		3		4		5	
		Date :- 30/1/2017									
		Time In	Time Out	Time In	Time Out	Time In	Time Out	Time In	Time Out	Time In	Time Out
1	K.VENUMA	4:16	7:21	7:46	9:22	9:42	12:15	12:43	2:30		
2	A.APPAVO	3:50	12:50	12:55	2:15						
3	B. KISHOR	3:40	7:40	9:15	10:13	11:10	12:15	12:45	1:28	1:30	2:30
4	K.GUTAS	4:22	4:52	5:25	5:45	6:10	6:46	6:51	10:18	10:30	12:50
5	DOLRAJ	3:35	5:45	6:40	10:55	10:57	12:45	12:47	2:30		
6	JIVAN	3:30	5:00	5:35	6:05	6:20	11:05	11:07	12:35	12:48	2:30
7	AMADO	3:20	5:45	6:10	6:55	7:00	8:00	9:00	10:18	10:30	11:30
8	SHIVA	3:30	12:40	1:17	2:30						
9											
10											
11											
12											
13											

This sheet has been filed by all technician for one week to observe the waste time.

Apendix C: OBD
tracker specification :

1. Introduction

This product is based on GSM / GPRS network and GPS satellite positioning system, built-in GSM and GPS antenna, built-in 2.4G attendance management functions. Insert into the car OBDII interface directly to read the data from car computer, you can locate and manage the vehicle remotely via SMS or GPRS. Easy to install, no wiring harness.

2. Applications

Mainly used for vehicle management and location tracking services.

3. Product Appearance

4. Accessories

No.	Photo	Item	Specification	Note
1		OBD extension cord	1.5Meter	Optional

5. Specification

Content	Specification
DIM	64.5×50×27mm
Weight	60g
Network	GSM/GPRS

Band	850/900/1800/1900Mhz
GPS Sensitivity	-165dBm
GPS Accuracy	5m
GPS Start Time	Cold status 30s Warm status 11s Hot status 1s
Backup Battery	Chargeable changeable 3.7V 200mAh Polymer Li-Battery
Storage Temp.	-40℃ to +85℃
Operation Temp.	-20℃ to +70℃
Humidity	5%--95% non-condensing

6. Operating Instructions

6.1. OBD compatibility

6.1.1. Protocol compatibility

The product supports existing OBD protocol:

- SAE J1850 PWM
- SAE J1850 VPW
- ISO 9141-2
- ISO 14230-4 (KWP2000_5BPS)
- ISO 14230-4 (KWP2000_FAST)
- ISO 15765-4 (CAN500_11BIT)
- ISO 15765-4 (CAN500_29BIT)
- ISO 15765-4 (CAN250_11BIT)
- ISO 15765-4 (CAN250_29BIT)

6.1.2. Vehicle Compatibility

Applies to all vehicles which are compatible with OBDII(Including, but not limited to the following models)

- US-produced gasoline vehicles are sold after 1996; all Chinese domestic car are sold after 2003;
- European gasoline vehicles are sold after 2001 or are produced after 2000; Diesel vehicles are sold after 2004 or are produced after 2003 .

Support vehicle models:

No.	Model	No.	Model	No.	Model	No.	Model
1	Mercedes-Benz	2	BMW	3	Audi	4	Land Rover
5	Buick	6	Chevrolet	7	Ford	8	Honda
9	TOYOTA	10	Volkswagen	11	Hyundai	12	SSANG YONG
13	Citroen	14	Mazda	15	subaru	16	Roewe

17	Peugeot	18	Chery	19	Cadillac	20	*JINBEI*
21	Haima	22	Kia	23	BYD	24	SKODA
25	FAW	26	Nissan	27	Geely	28	JMC
29	Dongfeng	30	MITSUBISHI	31	Porsche	32	Suzuki
33	Soueast	34	Isuzu	35	Acura	36	Volvo

6.2. SIM CARD Installation

SIM Card:

Open the cover with SIM Card marking, and insert the SIMCARD as picture shows(chip down), and then put cover back.

Note:

- Make sure there is enough balance in the sim card.
- PIN code should be locked.
- Displaying incoming calls function is available.

6.3. Plug into the car OBD socket

The tracker device will beep a sound after plugging into the car OBD socket, it means tracker device is connected to power successfully. Then turn on the battery switch.

After plug into car OBD socket, tracker will search for the match protocol. It will sound 3 times when the protocol is matched successfully.

6.4. GSM/GPS LED Indicator

- Green LED indicator on: No GSM network signals.
- Green LED indicator flashes fast (one time each second): GSM Network signal is normally, and tracker works under GSM mode.
- Green LED indicator flashes slowly (one time each three second): Tracker works under

Appendix D PET tracker manual

10 Minutes per day
Spent by the average person looking for misplaced stuff.

3,000 Items per year
Misplaced by the average person.

$5,591 Over a lifetime
Lost by the average American.

Benefits

Loud sound
With a simple tune that's easy to hear rooms away.

Largest lost & found network
Put all other Tile apps on the lookout if the item's not where you last left it.

Zero upkeep
Hassle-free 1 year non-replaceable battery.

Sharing feature
Share Tiles with a roommate or friend to increase finding power.

Web application
Find your phone via the web at thetileapp.com/web

Simple and easy to use app
Download from your app store or downloadtile.com
Also available on Apple Watch

Appendix E: Time Required for Periodic Maintenance

Labor Value Number	Description One	LV Target Time	Target quantity UoM
M0B4A13	1,000 KM (600 MILES) SERVICE INSP	0.2	H
M0B4A43C	5,000 KM (3,000 MILES) SERVICE (RR D/C	0.8	H
M0B4A63C	10,000 KM (6,000 MILES) SERVICE (RR D/	1.2	H
M0B4A93C	15,000 KM (9,000 MILES) SERVICE (RR D/	0.8	H
M0B4B23H	20,000 KM (12,000 MILES) SERVICE (A/T,	1.6	H
M0B4B43C	25,000 KM (15,000 MILES) SERVICE (RR D	0.8	H
M0B4B73C	30,000 KM (18,000 MILES) SERVICE (RR D	1.3	H
M0B4C03C	35,000 KM (21,000 MILES) SERVICE (RR D	0.8	H
M0B4C23H	40,000 KM (24,000 MILES) SERVICE (A/T,	2	H
M0B4C53C	45,000 KM (27,000 MILES) SERVICE (RR D	0.8	H
M0B4C83C	50,000 KM (30,000 MILES) SERVICE (RR D	1.2	H
M0B4D03C	55,000 KM (33,000 MILES) SERVICE (RR	0.8	H
M0B4D33H	60,000 KM (36,000 MILES) SERVICE (A/T,	1.6	H
M0B4D63C	65,000 KM (39,000 MILES) SERVICE (RR D	0.8	H
M0B4D83C	70,000 KM (42,000 MILES) SERVICE (RR D	1.2	H
M0B4E13C	75,000 KM (45,000 MILES) SERVICE (RR D	0.8	H
M0B4E43H	80,000 KM (48,000 MILES) SERVICE (A/T,	2.2	H
M0B4E63C	85,000 KM (51,000 MILES) SERVICE (RR D	0.8	H
M0B4E93C	90,000 KM (54,000 MILES) SERVICE (RR D	1.2	H
M0B4F23C	95,000 KM (57,000 MILES) SERVICE (RR D	0.8	H
M0B4F43B	100000 KM (60000	1	H
	avarage time required for service	1.081	

The report shows the time required for each periodic maintenance, its noticeable that some of the service take short time like 1000km, 5000 km service, which consider minor service.
Other type of service consumes more time like 40000 km, 80000 km service where takes approximately 2 hours.
On average periodic maintenance takes 1.081 hour.

Appendix F: Type of Job Perform in Main Service Center