An-Najah National University

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Increasing Customer Satisfaction on After Sales Service by Simulation Modeling in an Automobile Company

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Dedications

I dedicate this work to my parents and wife for their consistent support and prayers.

Acknowledgement

I would like to express my gratitude and appreciation to all who participated in putting this thesis together.

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I cannot end without thanking my family, whose constant encouragement and love were the basis for the preparation of this work.

الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان

Increasing Customer Satisfaction on After Sales Service by Simulation Modeling in an Automobile Company

أقر بأن ما شملت عليه الرسالة هو نتاج جهدي الخاص, باستثناء ما تمت الإشارة إليه حيثما ورد, وأن هذه الرسالة ككل أو أي جزء منها لم يقدم من قبل لنيل أي درجة أو لقب علمي أو بحثي لدى أي مؤسسة علمية أو بحثية

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degrees or qualifications.

Student's Name: **اسم الطالب:**

Signature **التوقيع:**

Date **التاريخ:**

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List of Abbreviations

UMT Co.	United Motor Trading Company
PNA	Process Analyzer
JOM Trading Co.	Jamal Omar Masri Trading Company
VW	Volkswagen
Repair	Any visit for repair and defect detection
Maintenance	Any periodic visit including oil check
CSI	Customer Satisfaction Index

Increasing Customer Satisfaction on After Sales Service by Simulation Modeling in an Automobile Company

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Abstract

This study aims to apply simulation technique on after sales-service in automobile field in Palestine, using UMT Co. service center as a case study, to increase customer satisfaction by reducing waiting time and total average service time. The study model was designed based on empirical data, and consisted of two main types of service: repairing visit and maintenance visit. The results showed that reducing total average service time and waiting time could be obtained by dividing the garage processes into two divisions (periodic check with two lifts and two workers, the other division with nine lifts and nine workers work on all vehicles repair). Reducing the waiting time required for the maintenance and repair increased customer satisfaction. Also, the study showed that the absence of one worker or increasing the number of cars arrival by 23%, still works as the best approach to keep the same level of customer satisfaction under the same conceptual model.

This study recommends the need for dividing or categorizing the operation of repairing and maintenance into two divisions: repair and maintenance, to reduce the total time spent in each visit that directly and positively enhance customer satisfaction.

Chapter One

Introduction

Chapter One

Introduction

Due to the increased complexities in automobile field, the relationship between the buyer and the seller never ends after the sales process. The buyer expects the value that comes from the product will satisfy his/her needs. Thus, integrating services and repair work has taken crucial importance. After-sales service is considered a tool for enhancing a valuable advantage for the customer as well as it is a business opportunity for the company.

The automobile sector is one of the most important business sectors in Palestine. Including after-sales service which is the main component of this industry by providing good maintenance and spare parts, is considered to be backbone of this business.

The concept “after-sales service” has become an important factor in the decision-making of buying a car. Buying decision is not only limited to car quality, shape or value, but also the process of buying the car depends on after-sales services, such as changing some of consumables as brakes, fabrics, belts or other parts. All these services contribute significantly to the continuation of the car quality and life, in addition to maintaining the original value of the car in case of the desire to re-sell it. (Kaladhar, 2016).

After-sales service has proven to be an important competitive advantage in automobile industry. This study focused on the Palestinian automobile service and repairing operations in after-sales. The purpose is to study the customers' satisfaction with after-sales service and the way to improve it, in one of Palestinian automobile company; UMT company.

Numerous studies addressed the issue of customer satisfaction in relation to the after-sales services in the automotive sector.

Kaladhar, (2016), studied the customer satisfaction and customer care support in car servicing industry after-sales. His study focuses on the procedure followed by the dealer to insure customer care and satisfaction after-sales service, and also used marketing technique to retain customers. The study used the procedure for automobiles maintenance, in order to achieve customer retention. This study found that customers' satisfaction increased by providing nice customer lounge with kind of entertainment for the customers while they are waiting on their cars to be repaired.

Chilin & Qin, (2013), used value flow technology to measure the effectiveness of technology in the after-sales service. The authors suggested that there must be a third party after the sale in order to ensure the provision of services to customers. This study confirmed that it is necessary to speed up the time of after-sales service through a technology system in order to enhance customer’s satisfaction.

Despite the importance of the previous studies regarding customers' satisfaction after-sales services, many studies focused on customer satisfaction without looking to increase service rate and to reduce the amount of waiting time after-sales services. They mostly looked at the use of technology in order to reduce the time to respond to the customers' needs.

This current study focuses on the use of simulation model in order to reduce total average service time and the waiting time.

There are several analysis tools which can be employed in order to improve after-sales service in the field of repair and maintenance of automobile industry, these include total quality management. The simulation system is the best model in the analysis of the current situation in order to improve customer service and to reduce waiting time and working hours, required for the repair and maintenance of an automobile because the input data and the required parameters are well defined.

In this study, the researcher studied the automobile after-sales service in Palestine using UMT Co. as a case study “Volkswagen, Skoda and Audi vehicles”. This study analyzes the problems of waiting time and total average service time that directly affect the customer satisfaction by simulation technique and in order to determine the best sequence of maintenance activities to minimize the waiting time and total average service time of a vehicle. Doing so can lead to faster delivery and can minimize the number of pending vehicles.

On the other hand, this study concentrates on improving the maintenance and repair process in after-sales service which includes: the periodic service inspection and fixing any problems. The service shop may have one or more stations for vehicle inspection and report recording that operate in parallel with each other. The improvement will be applied in each station in terms of reducing waiting time which will improve customer satisfaction.

Simulation

Simulation is an “imitation or illustration of a real system in order to improve system performance by using a computer model” (Harrell, 2004). Simulation tools “allow the modeler to be able to develop simulation entities as the natural system, to be understandable for human cognition, which is important to simplify the complex systems” (Booch, 1991).

Simulation is considered an important and powerful tool for process improvement (Gupta & Williams, 2004). Simulation is one of the most important tools in order to develop and analyze framework process and to identify the bottleneck (Mehmood & Jahanzaib, 2010). Recently, simulation modeling has wide uses in various industries (Herbst, et al, 1997), as it is used as a tool for evaluating the current situation and behavior under different sets of conditions.

Problem Statement

The after-sale service is one of the important factors that influence customer satisfaction and customer loyalty. This study tries to apply simulation technique on after-sales service in automobile field in Palestine, taking UMT Co. service center as a case study, aiming to increase customer satisfaction by reducing waiting time and total average service time.

Parasuraman, et al, (2006) this study founds that it is essential to provide after-sales service as the basis for building aggressive strategies to attract and win customers from the competitors. Unfortunately, there are no studies shown the scale of customers' losses or any statistics in Palestine.

Many companies do not give sufficient importance to the service of guarantee, so that some of these companies do not show commitment to their customers, which makes them vulnerable to loss of many of their customers and their inability to compete (Al-Mustafa, 2013).

Research Objectives

The study aims to examine the following objectives: -

- Develop and evaluate a simulation model to increase customer satisfaction level in after-sales service in automobile industry in Palestine and implement it in UMT Co.
- Develop an effective maintenance and repair conceptual model that aims to increase customer satisfaction in after-sales service.
- Decrease waiting time and total average service time in after-sales service to increase customer satisfaction.

Research Questions

- ➢ *What is the best conceptual model of service for automobiles maintenance and repair workshop to minimize the waiting time and total average service time, UMT CO. as a case study?*

  In addition, four sub research questions are formulated to support the main research question above.

1) *What is the best conceptual model to increase after-sales satisfaction?*

2) *Is simulation an efficient approach to increase customer satisfaction in after-sales service in this case study?*
3) *Will the optimal solution maintain its superiority when arrival rate changes?*
4) *In which arrival rate the optimal solution is working as a best solution?*

Significance of the Research

Customer satisfaction is the best indicator of how likely a customer will make a purchase in the future, in a competitive marketplace where businesses compete for customers, and it is a measure of customers' turnover.

Sang-Hyun, et al, (2006) after-sales revenues produced $2B in profits for General Motors, which is a much higher rate of profit than its $150B in car sales generated over the same time period. According to the same study, after-sales services and parts contribute only 25% of revenues across all manufacturing companies but are responsible for 40-50% of profits.

Accordingly, the significance of the research came to serve customers in the best way, and increase the customer satisfaction in after-sales service and create a systematic conceptual model to manage and control all after-sales services in the best way.

Methodology

This research follows the traditional engineering approach in problem-solving by simulation model by applying the following sequential steps. Time frame of this thesis is shown in Table (1.1).

Table (1.1): Thesis Time Frame

#	Stage	Time Frame
1	Problem analysis and define objectives and requirements	1 month
2	Data collection and analysis	6 months
3	Model building	2 month
4	Model verification	1 month
5	Model validation	1 month
6	Designing and conducting simulation experiments	3 months
7	Output Analysis	1 month
8	Final Recommendations	1 month

- Problem analysis and definition of objectives and requirements: the problem was analyzed and the objectives of the research were identified through many interviews with specialized persons from the management.
- Data collection and analysis:
    - Data collected through site visits, monitoring and recording. All variable parameters in the site and recent five years' historical data were taken and entered on excel sheet.
    - Data treated and then analyzed by input analyzer software and achieved the fit distribution that imitates the real system.

- Model building: the model was built by ARENA software. ARENA uses an entity-based on flowcharting methodology for modeling dynamic processes. Most other commercial simulation products are code-based and require programming in scripting languages, and it is easier to learn, validate, verify and debug than other simulation software. Appendix A shows the built model on ARENA software.
- Model verification: the researcher ensured that the conceptual model was built in the right way, and compared the conceptual model to the computer model that had already been implemented, by the following steps:
    - Input parameters and output statistics.
    - Using a debugger.
    - Using animation.
    - Sanity check.
- Model Validation: simulation outputs were compared with real parameters, statistics and results collected from the recent five years and it was approximately matched, that indicates how long the simulator is valid.
- Designing and conducting simulation experiments: after many interviews, meetings and discussions with experienced employees of UMT co., some changes were suggested on work approach and procedures, some of these suggestions were considered as experimental study.

- Output Analysis: the final results were collected, analyzed and validated. These final results from each experiment were compared with each other to decide which one is the best experiment.
- Final Recommendations: Determine the best method of work that obtained through the computer model.

Thesis Structure

The research consists of six chapters: chapter one is the introductory chapter, provides the reader with the general idea of the research including research objectives, questions and a brief description of the followed methodology. Chapter two reviews the related literature in the field of molding, simulation and software selection.

Chapter three reviews the related literature in the field of customer satisfaction and previous studies. Chapter four presents the methodology and the research tools followed in this thesis. Chapter five is a simulation experiments (UMT Co. case study). Chapter six consists of summary of the thesis findings, implications and recommendations.

Chapter Two

Simulation

Chapter Two

System

2.1.Overview

In this chapter, the researcher presents the main research components such as the system, model and simulation. Also, this chapter carefully represents the simulation model and explains its advantages and when it is appropriate to use it. Finally, the chapter summarizes the types of software used in the simulation process and how to choose the most suitable software.

2.2. System

A set of detailed methods, procedures and routines created to carry out a specific activity, perform a duty, or solve a problem (Blanchard, 1991).

Blanchard defines the system as a collection of elements that function together to achieve a desired goal. The systems have three types of variables according to C. Harrell et al. (C. Harrell, 2004) as following:

1. Decision variables (input or independent variables) which affect the behavior of the system.
2. Response variables (performance or output variables) which measure the performance of the system in response to particular decision.
3. State variables which indicate the status of the system at any specific point in time such as the current number of entities waiting

to be processed or the current status (busy, idle, or down such as unscheduled maintenance) of a particular resource.

David, (2002) simulation deals with models of systems. The system could be: process, facilities or stations either actual or virtual.

- Machines in a manufacturing plant, people, transport devices, conveyor belts, and storage space.
- A distribution network of plants, warehouses, and transportation links.
- An emergency facility in a hospital, including personnel, rooms, equipment, supplies, and patient transport.
- A supermarket with inventory control, checkout, and customer service.
- A network of distribution, warehouses, and transportation links.
- A freeway system of road sections, controls interchanges, and traffic control.
- A computer network on servers, disk drives, clients, networking capabilities, and operators.

This thesis simulates the repair and maintenance process, and is used when the people often study a system to identify and measure its performance, to improve the system's operation, or design if the system does not exist. Managers or researchers might also like to use it to easily manage and control day-to-day operations, in order to decrease the waiting time and total service time (David, 2002). Analysts recommend that the actual process that defines the system behavior and how the system works, must be identified before developing the simulation model, that allow to generates perfect changes.

2.3.Model

Modeling is a simplified representation of a complex system to provide predictions of system's performance measures, and it's an important component of engineering design. A model represents the system itself and its behavior and any relationships that influence on it. It can be as the following, (Tayfur & Benjamin, 2007) (David, 2002). There are four types of models:

- A physical model is a simplified or scaled-down physical objects (e.g., airplane, handling operations and restaurants and fast food shops).
- A mathematical or analytical model (e.g., a set of equations describing the workflow on a factory floor, system's behavior and assumptions).
- A computer model or Monte Carlo simulation model (e.g., the operation of a manufacturing process over a period of time).
- Graphical model provides a general methodology for approaching complex with random variables problems, and indeed many of the models developed by researchers in these applied fields are instances of the general graphical model formalism.

Simulation

Simulation is considered an important and powerful tool for process improvement (Gupta & Williams, 2004). Simulation is one of the most important tools, to develop and analyze framework process to identify the bottleneck (Mehmood & Jahanzaib, 2010). Recently, simulation has wide uses in various industries (Herbst, Junginger, & Kühn, 1997). Simulation is a tool for evaluating the current situation and behavior under different sets of conditions.

Computer simulation is becoming faster and cheaper, and the importance of simulation was exposed by other fields. However, simulation was used in manufacturing lines to find the bottleneck, it became a tool of choice and decision making for many companies, especially in automotive and heavy industries, to find the causes of problems. Simulation offers an efficient solution for problems before they happen or for future problems before implementation. At the same time simulation is standard part of industrial engineering and operations research area. By the end of the 1980s, simulation value was known by many larger firms, nevertheless it was not extensively used and not often used by smaller firms. Simulation began to grow up during the 1990s (Andradóttir, et al, 1997)

During simulation human decision is required and model development, experiment design, output analysis, conclusion formulation and taking a decision regarding the system under study are also needed. But the intervention of the human is not required in the running stage, which most simulation software performs efficiently.

Briefly, developing a simulation model often consists of designing a simulation experiment and performing simulation analysis (Andradóttir, et al, 1997), to identify the problem, determine the objectives, verify and validate the model. Appropriate experimental design should be selected, experimental design and performing simulation runs should be established, finally documentation and reporting and implementation are also required.

Advantages of Simulation Modeling and Analysis

Simulation modeling and analysis are often used in operation research techniques. When used wisely, simulation modeling and analysis makes it possible to conduct the following (Andradóttir, et al, 1997):

- Find a better understanding of the system behavior by improving the mathematical model of a system needs, and observing the system's operation in long periods of time.
- Study the internal interactions in the complex system or sub system.
- Test the hypotheses regarding the system possibility.
- Reduce the time needed to observe certain task over long periods of time to observe a complex task in detail.
- Allow training and learning in lower cost.
- Test the new or unknown situations, while weak information is available.
- Find the bottleneck in the system.
- Improve system throughput.

- Generate analytic solution.
- Illustrate operations through animation.
- Use multiple performance metrics for analyzing system configurations.

Disadvantages of Simulation

Even though simulation has many advantages, the following are some of simulation limitations (Andradóttir, et al, 1997):

1. Simulation results depend on accuracy of the input data, if the input data is inaccurate the results will be inaccurate.
2. Real systems are affected by wide range of uncontrollable and random inputs, causing their output to be random too.
3. Although modelers think carefully about designing and analysis, simulation experiments and output may still be uncertain.
4. Over simplifying model could be more expensive, increasing the probability of errors and requiring additional efforts.

When Simulation is not Appropriate

Besides simulation can be a time consuming and complex work from modeling in output analysis that should involve experts and decision makers in the entire process. The following are a list of pitfalls of simulation (Andradóttir, et al, 1997).

- Unclear objective and errors in assumptions.
- Using simulation when analytic solution is appropriate.
- Invalid model.
- Simulation is too complex or too simple.
- Using wrong input distribution.
- Identifying wrong performance measures.
- Bias in output data.
- Poor schedule and budget planning.
- No data is available; not even estimate simulation is not advised.

When Simulation is Appropriate

Simulation can be a good tool to study and analyze complex systems, if input data and parameters are well defined. The following are a list of appropriate uses of simulation (Andradóttir, et al, 1997).

- Study of and experimentation with the internal interactions of a complex system, or of a subsystem within a complex system.
- Informational, organizational and environmental changes can be simulated and the model's behavior can be observer.
- The knowledge gained in designing a simulation model can be of great value toward suggesting improvement in the system under investigation.
- By changing simulation inputs and observing the resulting outputs, valuable insight may be obtained into which variables are most important and how variables interact.

- Can be used to experiment with new designs or policies prior to implementation, so as to prepare for what may happen.
- Can be used to verify analytic solutions.
- By simulating different capabilities for a machine, requirements can be determined.
- The modern system (factory, water fabrication plant, service organization, etc.) is so complex that the interactions can be treated only through simulation.

Selection of Simulation Software

There are two types of simulation packages as shown in table (2.1) which are simulation languages and applications oriented (Andradóttir, et al, 1997).

Application Oriented Simulation

Simulation packages is based on the process of modeling a real system with a set of mathematical formulas. It is a program that allows the user to study and observe an operation through simulation without actually performing it. Simulation software is used widely to design equipment so that the final product will be as close to design specifications as possible without any extra cost in process modification.

The main advantages of application oriented simulation are:

- Provide most modeling features, so programming effort and cost are reduced.
- Natural framework and model for simulation modeling.
- Usually make it easier to modify models, user friendly.

- Better error detection for simulation-specific errors.
- Most oriented simulators software includes animations.

Simulation Languages.

simulation language is used to describe the operation of a simulation on a computer. Most languages also have a graphical interface and at least a simple statistic gathering capability for the analysis of the results.

The main advantages of simulation languages are:

- More widely known and available.
- Usually executes faster, if well written.
- May allow more modeling flexibility.
- Software cost is usually lower.

The simulation tool should be selected by the modeler. When all data implemented into selected program, a simulation model will be formed. In this study, ARENA simulation tool was used to develop the model. This software of simulation was selected because of its distinct properties as mentioned in section 2.4.2.

Table (2.1) shows some of simulation software's that usually used in simulation researches.

Table (2.1): Simulation Packages

Type of Simulation Package	***Examples***
Simulation Language	*Arena (previously SIMAN)* *AweSim (previously SLAM)* *Extend, GPSS, Micro Saint*
Application-Orientated Simulator	*Manufacturing: AutoMod* *ProModel, Quest, Taylor* *OPNET Planner* *COMNET 3*

(Andradóttir, Healy, Withers, & Nelson, 1997).

Simulation Methodology

The following steps represent simulation methodology (Harrell, 2004).

1. **Define Objectives.**

   The initial step involves defining the goals of the study and determine what needs to be solved. The problem is further defined through objective observations of the process to be studied. Care should be taken to determine if simulation is the appropriate tool for the problem under investigation or not.

2. **Collect and Analyze System Data**

   After formulating the model, the type of data to collect is determined. New data is collected and existing data is gathered. Data is fitted to theoretical distributions. For example, the arrival rate of cars to the garage may follow a lognormal distribution curve.

3. **Build the Model.**

   The model is translated into programming language. Choices range from general purpose languages simulation programs such as ARENA.

4. **Verify and Validate the Model.**

   Verification is the process of ensuring that the model behaves as intended, usually by debugging or through animation. Verification is necessary but not sufficient for validation, that is a model may be verified but not valid. Validation ensures that no significant difference exists between the model and the real system and that the model reflects reality. Validation can be achieved through statistical analysis. Additionally, face validity may be obtained by having the model reviewed and supported by an expert.

5. **Conduct Experiments.**

   Once a model has been validated, it is ready for experimental use. The experiments should have been designed at the articulated stage. From the experiments the model will usually have to be modified. Use existing techniques, as necessary, to control the experiments, replicate the runs, reset the random sequences for comparisons under identical situations, and to isolate random processes to reduce correlation.

6. **Present Results.**

   During the planning stage decide which performance measures best describe the phenomena under study and the best ways for presenting the results.

ARENA

The ARENA software consists a flexible and powerful tools that help the analyst to initiate animated simulation models in high accuracy, ARENA is a simulation language tool designed in graphical models, the analysts place graphical objects on a specific layout in order to define system components such as machines or operations to describe the real system, ARENA is built on the SIMAN simulation language, after the simulation model is done, the ARENA generates the underlying SIMAN model automatically to perform simulation runs (Takus & Profozich, 1997).

ARENA Template

The ARENA template contains sixty modules shown as components of the main ARENA software. It is working to produce and provide a general purpose of modeling for all simulation software. And also provide us the core features of the software such as parameters, recourses, queuing and inspection. ARENA template provides modules specifically focused on operation processes, manufacturing handling and supply chain process. ARENA template consists of three panels; the common panel contains modules representing arrivals, service and departures, the support panel contains modules for specific actions and decision logic, and the transfer panel contains modules that describe entities flow through the system (Takus & Profozich, 1997).

Input Analyzer

To simulate the production process, we need to make the computer know the practical steps and component parts of equipment, materials, people and places. There are many simulation programs that enable us to enter this information in non-complex programs such as: ARENA. (Sharma & Garg, 2012).

The Process Analyzer (PNA) is a new ARENA tool designed to assist users to estimate and draw the best distribution that fit and illustrate required inputs data, before being entered in the model. This makes the data more reliable and accurate, the input data is one of the most important factors to produce an efficient model.

Data is entered in a manner allowing the program simulating the regular and random changes that occur in reality. Therefore, we usually do not use the arithmetic mean to express the time of an operation, but we use many different measurements of this process, and so for the other times that we use in the simulation of this process, such as loading times and times of checking product and attendance rate customers. The possibility to simulate changes in the times of operation, transport and otherwise is one of the main advantages of the use of simulation. (Chilin & Qin, 2013).

Chapter Three

Literature Review

Chapter Three

Literature Review

overview

This chapter briefly reviews previous research related to after-sales service and customer satisfaction in after-sales service. Also, it explains the relationship between the after-sales service and customer satisfaction. The chapter is driven by the key factors affecting customer satisfaction in after-sales service.

After Sales Service

The relationships between seller and buyers can be described by the relationships between husbands and wives (Kandampully, 2010). The success of retaining customers depends on the relationship between buyers and sellers in after-sales service (Gutek, 2002). One study shows that the foundation of this relationship is a combination of commitment (loyalty) and trust (satisfaction) (Alvarez, 2011).

The success of companies and products always depends on customer satisfaction on the aftermarket. The sales and services are the two sides of the same coin. The growth of sales depends on how the company is able to achieve after-sales service and how to maintain it. When a company gives good after-sales service, sales will automatically go up and the company will become more visible. If their service is unsatisfactory, the reaction will not be positive which will lead to negative growth in sales. Customer satisfaction is not only achieved when they buy a car, as they are still in need for the after-sales service. Some of the services expected by the customer in advanced stages of after-sales service are to remind the customer in the periodic maintenance time, and a small fee will be added on customer's invoice against this service (Kaladhar, 2016).

After-sales service should be an integral part of any original sales strategy regardless of the firm size. Some firms might think that its role ends once the item is sold and the money is taken. However, customers may need other services after receipt of the item, such as getting assistance in the installation, receiving training in its use, maintenance, or even when they return a defective item (Kaladhar, 2016).

A good after-sales service helps get a reasonable share of the market the reducing of public expenditures in the after-market that are relevant to the products and services sold, and it contributes to maintain key customers. Most customers will not make a repeat purchase or continue to deal with the same establishment in the event of a bad experience (Celuch , et al, 2006), (Markeset & Kumar, 2003).

After-sales service includes temporary maintenance and service such as a guarantee for a year or more. It also includes replacing and renewing the product until the end of its life cycle when dealing with special customers (Bader AL deen & Easa, 2016).

Many companies underestimate the importance of after-sales in giving them a competitive advantage. Customers expect high-quality service, especially as they focus on getting good value for the money they pay, and are willing to spend more with the firm that offers the best service and product quality (Cacioppo, 2013).

Service providers' using modern computer programs to control the movement of goods and services, are able to provide effective management of network of sales, and to monitor challenges encountered which could lead to either product returns or adapting a solution that have been used to address them. Another benefit of such computer program is the continuous monitoring of the entire process in real time, and the quick access to all important data provided by marketing and sales management. This management of after-sales service gives complete control of the process and improves efficiency while reducing costs (Gebauer, et al, 2011). The use of technology facilitates better planning of assets, raises the predictability and accuracy of inventory management capabilities with efficiently, and regulate the management of financial affairs.

After-sales service strategies officially begin when the contract is signed. However, in anticipation of the after-sales service, sales representative sometimes begins to take action, "a precaution" even before the signing of the contract where he/she gives promises on how the after-sales service is provided.

The aim of the after-sales service is to build long-term relationships with customers in order to ensure repeat business and referrals (Martinez, et al, 2010). Businesses are either getting better or worse depending on the service before or after the sale. What matters is not what the customer buys for them yesterday, because yesterday's success is in the past. What matters is what the sales representative sells to customers today and tomorrow. The salesperson must meet customer satisfaction; otherwise competitors will attract them to their facility to maintain and develop prosperous business. Customer relations must be built on the basis of continuous improvement of customer service (Liljander & Roos, 2002).

Warranty is the Basis of After-Sales Service

Warranty is one of the important policies for after-sales services that affect the promotion of customer satisfaction. Warranty, is a declared promise (explicit or implicit) relating to a product performance and warranty period and responsibilities for product defects or defects in use, which is covered by the instructions laid down for the customers. Known Warranty explains the promises undertaken by the producer and the seller regarding specifications of the product that they sell (Chien, 2007).

Product warranty is designed to protect the client and to encourage them to purchase the product. There is trust and confidence, as well as physical benefits as a result of buying the product where the seller bears the responsibility for repairs, damages, modification, even replacing the product or refunding the price altogether. The warranty policy can achieve the sales targets, increase the sales volume, and can achieve the legitimate protection requirements of the product. Generally, warranty document has the following characteristics (Naeem, et al, 2009):

1. A guarantee is important and necessary for the marketing policy of the majority of durable products.

2. The warranty document is a pledge issued by the seller which is a commitment to the availability of certain characteristics and specifications of the product.
3. The period covered in guarantee policy is different depends on the industry and from one product to another.
4. In the event of the appearance of defects as a result of normal use, the companies' bindings are either to return the product to its natural situation, change the product or refund the buyer.
5. When the company formulates a warranty document, the document should define the vocabulary unequivocal or diligence, the liability must be identified and documented so that the customer can claim the defective remedy.
6. The guarantor must apply the document of guarantee with no complicated procedures that the buyer does not understand, such procedures might be an attempt by the guarantor to reduce the claims of the climates. This may damage the reputation of the company.

Certain companies today resort to providing warranty service and maintenance free, as a means of attracting customers to buy their products through the so-called reduced "the customer price". This means an increase in earned benefits due to paying the same price, particularly when the characteristics and attributes of product are similar to what is provided by competitors. Some of the companies which resort to this policy are automobile dealerships. For example, United States law focuses on sellers and producers to take responsibility and guarantee for their products.

Warranty document is a document written by the seller or supplier and it is dedicated to specific errors and defects (Gaiardelli, et al, 2007).

Good Relationship.

The importance of having a good relationship with customers is unquestionable topic (Sweeney & Webb, 2002). Having a good relationship between seller and buyer is not just a domination trend but it has significant returns to both parties (Walter, et al, 2001). There are certain benefits of good relationships between the buyers and sellers, such as; lower cost and better procedure, service benefits and faster delivery, image benefits (brand name and reputation), and better responsiveness (Kelly & Scott, 2012).

Bad Relationship.

Negative experiences caused by negative words or attitude will damage costumer's commitment to the seller and further on the relation between the two parties (Liljander & Roos, 2002). Negative incidents such as bad handling and bad communication with customers may lead to lack of trust which again impact negatively on the relationship between buyers and sellers (Bejou & Palmer, 1998).

Customer Satisfaction

Customers have good impression about a company when their expectations are met or exceeded over the lifetime of the product or service (Cacioppo, 2013). Customer satisfaction is a key to create differentiation between the firms and is a key of strategic planning in the good companies (Thusyanthy and Senthilnathan, 2012).

Customer satisfaction is a customer's feeling of pleasure or disappointment resulting from comparing the product's perceived performance with the expected one (Kotler, 1997). When the state of customer needs, wants, and expectation throughout the product life and service period, is met or exceeded customer satisfaction is likely to be achieved, and can enhance the possibility of repeat purchase and thus gain customer loyalty (Brown, 1992).

3.2.1 Factors Influencing Customer's Satisfaction in After Sales Service.

There are several factors that affect customer satisfaction. Some of these factors influence positively and others negatively. Figure (3.1) shows several factors that influence customer satisfaction in a negative way which lead to low customer satisfaction (Gupta & Williams, 2004). This study focuses on the waiting time factor, and tries to eliminate waste time or to decrease it as much a possible.

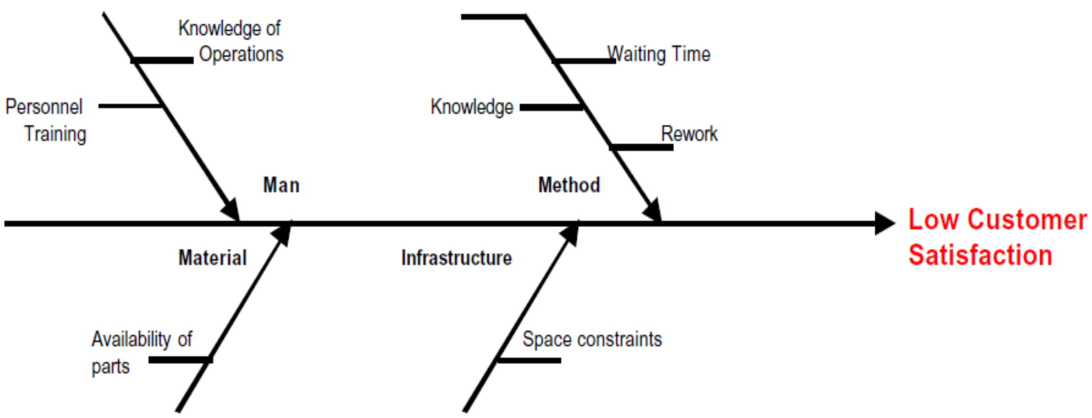

Figure (3.1): Low Customer Satisfaction Fishbone Chart in Automobile Garages (Gupta & Williams, 2004)

This thesis aims to study the effect of the method factor on customer satisfaction on after-sales service by reference to Figure (3.1). It focuses on waiting time and on how to improve the process flow in order to increase customer satisfaction in after-sales service. In a case study, and after several meetings and observations with UMT Co. employees and managers, the company has all the spare parts necessary for maintenance and repair operations. There is no problem of availability of spare parts as the companies use similar and identical mechanical parts in most of their cars.

The company owns a huge garage building, so it does not face any space restriction. Employed staff is one of the things that the company iud of. It has qualified workers who receive continues training by the manufacturer to be up to date for any changes.

Sureshchandar, et al (2002) did a comprehensive examination of customer satisfaction and determined that customer satisfaction is an emotional or cognitive feedback, related to a special focus on the product, expectations or consumption experience. Customer satisfaction occurs at a specific moment in time after the experience or the consumption of the product.

In literature, several authors found empirical evidence for the relationship between customer satisfaction and customer loyalty (Yu & Dean, 2001); (Rauyruen, et al, 2007); and (Parasuraman, et al, 1988); and (Naeem, et al, 2009) showed that customer satisfaction is strongly related to service quality. Sureshchandar, et al, (2002) found that there is a double connection between service quality and customer satisfaction.

After saleservice and customer satisfaction

Customers have a great knowledge and ability to evaluate the competitors' offers and provided services, and to form of prior expectations of what could be the brands of products and services offered after sales (Saccani, et al, 2007).

Research indicates that customer satisfaction with the product decreases over time in most industries, so the marketers resort to devise new methods to avoid this decline in customer satisfaction (Liljander and Roos, 2002).

Sending messages to customers from time to time, notifying them of the warranty services, and reminding them with the periodic maintenance, the customer feels that he made the right decision when buying their product, thus that gives him comfort. For example, by carrying out maintenance operations within the warranty in the event of occurrence of any failure, the customer feels the true commitment of the company to serve the customer in after-sales service. With time a personal relationship might develop between the employees of the company and customers through periodic maintenance (Saccani, et al, 2007).

Actually, the studies indicated that there are several types of customers and they differ from each other in their personal behavior, and the company should find appropriate ways and methods in dealing with each customer according to his requirements and personal desires. That makes it easy to access the psychological comfort and happiness of the customer in after-sales service (Mouly, et al, 2010).

Product warranty is intended to reduce fear of possibility of product failures and thus reduce the risk of the purchasing decision. So the customer becomes less confused in making buying decision. Warranty is a commitment to repair, exchange, or return the product. Therefore, warranty service is an important factor in buying decisions. Enhancing customer satisfaction plays a key role in the embodiment of after-sales service, although it is not enough alone to achieve customer loyalty, but it is one of the important factors of customer loyalty (Rauyruen, et al, 2007).

In case of the customer having a certain level of expected warranty service, he distinguishes between competitors' offers for buying-decision, which enhances the company's reputation in the customer's mentality later on. Good experience will establish trust and loyalty between customers and the company, and makes it an ideal choice for less risk in the future (Thusyanthy & Senthilnathan, 2012).

Customer satisfaction is currently one of the most important elements that contribute significantly to the promotion of the company and its products. Customer satisfaction leads to many positive factors, such as increasing sales and providing a good reputation for the company by consumer opinion. Customer satisfaction is the goal of every company witch must strive to achieve this goal constantly. The most important element of customer satisfaction is satisfaction on the after-sales service, because it is considered a practical experience for the customer after the purchase (Mouly , et al, 2010).

The existence of annual evaluation or assessment on customer satisfaction in after-sales service will enhance the presence of this service in most companies. After sales service must have unified standards for all similar companies in a given sector, with qualified employees to do that. All these services are offered in different fields and in different ways and are concerned with one aim that is customer satisfaction (Thusyanthy & Senthilnathan, 2012).

The scale of customer satisfaction standards does not appear to exist in many local companies, and a few local companies can be found who are interested in after-sales one. After-sales service is a moral service rather than a profitable service, and there should be regulatory organizations supported by local authorities overseeing after-sales service (Naeem, et al, 2009).

The reasons for the low level of customer satisfaction in after-sales service can be related to; lack of sufficient experience in this area or the absence of specialized persons in this field. International companies often employ people who are specialized in after sales service, in order to maintain its image globally. Many companies use the after-sales service as a promotional and marketing tool for their products (Thusyanthy & Senthilnathan, 2012).

In order to achieve consumer satisfaction or customer loyalty through after-sale services, the company must provide after-sales service in a high professional and distinctive manner. Providing a good after sales service leads to an increase in the number of customers and a sense of belonging to the company, which leads to attracting new customers, in addition to maintaining the existing customers, that will increase the company's profits (Martinez, et al, 2010).

Waiting Time and Customer Satisfaction

Waiting is something we all try to avoid, but it may not be possible to avoid waiting in real life. Whatever it is, there are many ways you can reduce the waiting time and eliminate lost time, which reduces the total average waiting time in any field of industries. In certain services, it is impossible to make average waiting time always equal to zero, because it needs excessive resources. For example, commercial markets (supermarkets) cannot provide a huge number of cashiers so that customers do not wait for any time before getting help. We can not avoid waiting in queues in heavy traffic. You can not go to any vendor and find a full-time employee waiting to assist you, but you may wait until the completion of the client or another service, when you go to the restaurant you wait for food preparation. There are certain ways to reduce the waiting time and make it short, but in the end, there would still be queues for in many places. But in after-sales services of the automotive sector, measuring the length of service and determining the time required for maintenance work to avoid the customer dissatisfaction is an important undertaking (Cacioppo, 2013).

There is a difference between real time and waiting time and the time that customer feels. The impact of waiting time on customers is different from one person to another, depending on the time constraints and customer's obligations (Palawatta, 2015).

Previous customer experience: When you go to make something and wait for half an hour before you make it, then you try to make it again and wait for twenty minutes, you will be happy as the waiting time is lower than expected. But when you go to a place where you are used to wait only three minutes, but this time you waited ten minutes you will feel upset and dissatisfied. Waiting acceptance depends on our previous experience of waiting in the same position.

The number of customers who ask for the same service: When you go to a restaurant on Friday and find that a large number of people have been present in the same restaurant for lunch, for example, you can accept an increased time for preparing food. On the contrary, when you go to an institution and there is no one before you and you have to wait, you feel very distressed because you do not find a justification for this waiting.

In a study conducted by the company J.D power car in the USA the consumer satisfaction index (CSI) dropped for the first time in six years, after recalling more than 51 million cars last year due to defects in production. CSI index is based on the degree of consumer satisfaction with the after-sales service. The study found that 70% of consumers are willing to wait between one and two hours in after-sales services, and 30% said they can wait longer than that (Bader AL deen & Easa, 2016).

Previous Studies

Customer satisfaction and customer care support in car servicing industry after-sales service.

(Kaladhar, 2016) studied customer satisfaction and customer care support in car servicing industry after-sales service. His study focused on the procedure followed by the dealer to insure customer care and satisfaction with after-sales service. The study used the following stations to build the model:

- Vehicle Entry.
- Security Check.
- Vehicle Receiving and Testing.
- Engine Room Space & Washing.
- Oil Change Felt.
- Workshop Bay Repair.
- Road Test.
- Final Inspection.
- Vehicle Parking at Ready.
- Security Check out.
- Vehicle Delivery to the Customer.

However, the study did not use any simulation model, as the current study does, where the Table below (3.1) shows the major results of the study which was inducted in two different companies Suzuki India Limited and Mercedes Benz:

Table (3.1): Previous study results.

Applied Study	Findings
Suzuki India Limited	Only 75% of customers are satisfied on customer lounge facility available in the dealer workshops in Maruti Suzuki India Limited.
MERCEDES BENZ	• 80% of customers were attended to within 10 minutes by the workshop staff on their arrival at the workshop. • 64% of dealer workshops are opened on Sunday for customer's convenience and 75% of Benz customers expect similar facilities from the dealers, who do not follow similar practices.

Customers' opinions were different in the study, as some of the customers focused their attention on the available lounge facility, others focused on waiting time and service time, and while some customers focused on working days and hours.

Flow technology to measure the effectiveness of technology in after-sales service.

(Chilin & Qin, 2013) studied value flow technology to measure the effectiveness of technology in the after-sales service. This study developed improved business flow chart of Auto after-sales maintenance. He found that there must be a third party after the sale in order to ensure the provision of services to customers. This study confirmed that it is necessary to speed up the time of after-sales service through a technology system that operates to enhance customer satisfaction.

Technology has been used to analyze the automobile after-sales service process to help understand customer requirements. The application of value flow technology process are as follows:

- Sales department. To finished sales and attract customer.
- After-sales station. For maintenance and identify the cause of replacing spare part. And final delivery of the car to customer.
- Industry chain of auto manufacture. This include two departments:
- After -sales service department and spare part supplier's. Also, this stage can be conducted by a third party. This means, outsourcing of after-sales services for a professional company in the field of maintenance and repair of cars and paying the outsourcing fee for it.

Measuring the first consumer satisfaction of the car agencies in the Kingdom.

The study aimed to highlight the negatives and positives of after-sales service in order to develop and improve its business and services in line with the satisfaction of consumers entitled to the service. The results of this study contributed to increasing the competition between the car dealerships in the Saudi market, to achieving the highest levels of consumer satisfaction for the services they provide (Ministry of Trade, 2015).

Table (3.2) shows the percentages of the survey regarding after-sales service in the Kingdom. The sample was selected from different social collection and included more than 25 car agencies.

Table (3.2): Customers satisfaction on after-sales service in Kingdom

Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
2.25%	9%	27.85%	30.35%	30.55%

(Ministry of Trade, 2015).

The study found that 61% of consumers expressed dissatisfaction with the level of services offered. In contrast, 11% were satisfied, while 28% said they are somewhat satisfied. The Ministry intends to communicate the results of the questionnaire to the manufacturers. These companies will be asked to be present directly in the Kingdom to supervise and follow up on the performance of their agents, in order to improve and upgrade the services provided to consumers (Ministry of Trade, 2015).

A Discreet Event Simulation in an Automotive Service Context.

A discreet event simulation in an automotive service context was conducted by Jeddi, et al, (2012). This study has modeled an after-sale service shop with Witness simulation software, to increase service rate while reducing the amount of waiting time in queues for the entire service shop which results in more customer satisfaction.

The simulation model used in this study to simulate customer arrival, maintenance, repair, and inspection report recording. The study has shown that the system can improve customer satisfaction and reduce the waiting time. Through a combination of two stations of inspection report recording 1 and 2, which are located after road test and periodic service inspection, the system can operate more efficiently. Also, there is a reduction in the amount of time spent in queues for all stations, in addition to reduced average time and reduced number of workers.

The results indicate that customer satisfaction has increased at the same time as improving service rate of the system.

Customer satisfaction survey for the automotive sector in Qatar.

This study was conducted on customer satisfaction in the automobile sector in Qatar. More than 4000 people participated in the questionnaire and the results were as follows (Ministry of Economy, 2015):

- 93.46% confirmed that the prices of new cars are high.
- 95.08% of the respondents complained about the high prices of spare parts.
- Consumers' opinions differed as to the efficiency of maintenance technicians in the workshops of car dealers or others, with 59.16% of respondents saying that the maintenance technicians who work in the workshops of the agent do not have the required efficiency.
- A large percentage of participants. (who over 69%) reported that the agent's workshops do not perform maintenance on time, compared with 50.04% who believe that the non-agent workshops do not meet the deadline.
- In the automotive spare parts sector, 73.06% of consumers surveyed said spare parts were not available in Qatar.

- 74.54% of the respondents believe that the agent deals with the customers satisfactorily when buying the new car but it is significantly reduced when the maintenance is carried out. 59.3% of the consumers expressed dissatisfaction with the agent's dealings with the customers during maintenance. 75.75% do not treat clients satisfactorily when trying to find solutions to complaints.

Chapter Four

Methodology

Chapter Four

Methodology

In this chapter, the researcher will use the following traditional engineering steps by simulation to study and define the case study (Tayfur & Benjamin, 2007):

Problem Analysis.

This thesis investigates the problem of delays during repairing operations and its negative impact on customer satisfaction in the after-sales service. Since there is an inverse relationship between time spent during repairing operations and the extent of customer satisfaction. This study attempts to reduce repairing time by building a model that simulates maintenance's operations in the after-sales service, to evaluate the possibility of re-structuring the workshop better, and then to put a clear conceptual model that reduces the time spends during these operations.

The first step of problem solving is analyzing the problem itself. This activity includes the identification of input parameters, performance measures of interest, relationships among parameters and variables, rules governing the operation of system components. This information will be collected through meetings and interviews with employees and workshop supervisors.

The required information was collected through frequent visits to the workshop, and meeting with experienced employees, by asking questions and taking all required data and the key information that will be studied and entered into the model. The data is already registered on their server, such as cars arrivals and service time in each maintenance process, finally samples were taken to cover the past five years' period.

Data Collection.

To study the performance measures, the following data has been collected from the UMT Co. and used in part as model parameter:

- ✓ Working time.
- ✓ Automobiles Arrival times to the service center.
- ✓ The time that each automobile starts receiving the service.
- ✓ Service time for each station in the service center.
- ✓ Number of work stations in the service center.
- ✓ Number of employees in the service center.

Data was collected through observations and interviews with workers in repair and maintenance sections, in addition to information collected from the company's database which covers the last five years, and data related to the garage operations.

Data collection was started by visiting the workshop, and then identifying all the processes and stations of the repair and maintenance operations. In addition, an understanding of all necessary maintenance procedures was developed by dividing the workshop into successive stations were each process was studied separately. This was studying the impact of each station on the next and identifying the effects and ambient factors. As such all the necessary inputs that is required to build the model and therefore to simulate the real operations was gathered.

Data Analysis.

All data were analyzed by one of the ARENA features, (the input analyzer) to estimate the distribution of the data to be entered to the model. In addition, basic data required and the key information were gathered such as; working hours, number of days that the company operates during a week, number of employees in the workshop, duties of each employee, number of cranes, and the mechanism of the garage in general.

The required raw data was identified and reflected on the developed model. The data includes arrival time and service time in each station. The raw data was taken from the records of the previous five years.

All service time exceeding two days was eliminated from the study. In certain cases, a car might need more additional time in order to bring in unavailable parts: these are placed in a special store and replaced by another job until the arrival of the required parts. According to UMT Co. workshop employees, maximum car repair time does not exceed 16 working hours.

This historical data of the last five years was employed to generate two distribution curves using ARENA analyzer. The first distribution fit, the data for each year was analyzed separately. The second fit utilized the entire data of the five-years period. The results of the two distributions were statistically similar in both the type of distribution and the generated factors. This suggested that the data was reliable.

Model Building.

All stages of the workshop (repair and maintenance) were identified and used in the design of the ARENA model. The model incorporated all the required data which was collected as explained before.

The model was built very carefully by reference of the real process of the repair and maintenance garage as you can see that in appendix A. The process of building the model always represents and reflects the real situation on the program so that the program can understand the flow of work and then can simulate the future. All necessary variables and parameters were entered into the model, to ensure that it can works properly.

After the model has been built on the program, all necessary variables have been entered carefully to make sure that the model works well and conforms to reality. Appendix A shows the built model on ARENA software.

Model Verification.

This is carried out in order to ensure that the model is correctly designed and constructed, and that it conforms to its specification and does what it is supposed to do (Jeddi, Renani, Malek, & Khademi, 2012, p. 4).

Ensuring that the structure of the system is verified is a necessary factor to success any simulation study. In this study, the simulation model has been verified by using several ways and tools as described in the following steps:

1. **Input parameters and output statistics:**

   In this step, the researcher is looked to check input parameters and output statistics to be sure cover all essential input parameters that influence model behavior, and then check the final results and statistics and compare the output counts with input, and ensure there are no dead ends in the model.

   once the input data was entered into the model, then all model inputs were reviewed by the researcher again to ensure that there is no errors or mistakes in the process of entering the data. And ensure that there are no technical errors in the work of the model, as the system is creating out the entities which are undergoing the operations process and departures successfully. Finally, ensure that all required results and statistics were obtained from the model such as (total average waiting time, service time).

2. **Using a Debugger:**

   In this study, the researcher used debugger to trace the entities over time and track them as they proceed through ARENA model, and revises the entire run history.

   ARENA model contains many entities, which are moving simultaneously but in this study used a debugger to move only one entity at a time. It operates by moving this active entity through the diagram as far as possible before it encounters a status or time delay. It then goes on to move any other required entities at the current simulation time. Time is then advanced to the next event.

3. Using Animation:

In this step, the researcher used animation to verify model logic, by making test runs to observe the model's behavior, and the entities flow. In this study, it was through the live observation of the movement of entity and monitor its behavior within the model, to ensure the number of entities created is equal to number of entities was departure, and make sure to not stand in or fade in a certain station. After making sure that all entities are moving properly in the model, it is confirmed that the system works as required.

4. Sanity Check:

In this step, the researcher compares observations and results with the logic, since the arrival rate is known then the researcher checked and compared the number of arrivals or departures with the expected. Then, all inputs and parameters that entered into the model are checked correctly and there are no printing errors and they are tending to logic, that means the system works as required.

Model Validation

In this study, the output of the model is closely examined and compared with empirical data in order to verify that the performance measures of the model (calculated waiting time and total service time) are very similar to those entered into the model. This is considered to be a pre-requisite for simulating the future.

Once the design of the main ARENA model has been completed and tested, it suggested that the average number of cars repaired on a daily basis was 29 (or 8650 cars a year). The historical data of the last five years indicates that the actual daily average was between about 28 and 31 cars. In addition, the model calculated an average service time of 218 minutes per car. The actual average time as based on the same historical data and on conversations with experienced employees of the workshop was between 204 and 240 minutes. These model outputs clearly indicate that the model was functioning well in terms of representing the reality of the last five years. As such, model verification was considered to be successful.

Designing and conducting simulation experiments.

Here, the objective is to design a set of simulation experiments in order to further verify the model and to test its performance. This is important in order to make sure that the model can help in addressing the project's problem and to test and to study all hypotheses and run the mode sufficient times to get insights into its working and to attain sufficient statistical reliability of scenario-related performance measures.

In this study, several meetings and interviews have been held with experience employees and many ideas have been forwarded and carefully analyzed before translated into experiments. Then all experiments were studied by simulation and the results of each experiment were recorded and selected separately for further studies and calculation.

Two experiments were mixed together and their results were carefully studied and recorded, to study and analyze all possible choices. Finally, some experiments were formulated and conducted to check the sensitivity of the study and check the validity of the study in higher arrival rate.

Output Analysis.

An automatic report of statistics summary is generated automatically at the end of a simulation run by a number of Arena constructs, such as entities statistics, queues and resources. Those statistics were implicitly specified by dragging and dropping those modules into an ARENA model.

After that, the important calculations and performance measures were subjected to a thorough logical analysis as a means of identifying the best hypothesis to achieve the best performance measures. Final results were written down in a table to be easy compared and distinguish later.

Final Recommendations.

Finally, the author used the output results to formulate the final recommendations for the underlying system, based on work important, time reduction and therefore better customer satisfaction.

Recommendations made according to the final results obtained, and some recommendations were made to improve the workshop by reducing waiting time and total average waiting time.

Chapter Five

Case Study

Chapter Five

Case Study

Introduction.

JOM was established in 1960 in Nablus, it was later renamed a to UMT, then it established a new high technical training center for its internal employees and has the authority to issue certificates which are approved by the ministry of labors.

In 1964 JOM become the official dealer for VW in Palestine, and opened the first showroom with area of 150 square meters, also it established the first service center in Nablus.

In 2016 the first and the most advanced headquarter in northern Palestine was established in Nablus, which consists of a large service center, VW showroom, Skoda showroom and general management offices. The new service center has an area of more than 500 square meters.

UMT specializes in the sale and service of heavy equipment. It owns the biggest after-sales network, as it launched multiple branches and assigned dealers for the company in the main Palestinian cities leading itself to the forefront of sales and maintenance. The sales centers are located in Nablus, Ramallah, Bethlehem, Hebron, and Tulkarm, in addition to two branches in Gaza strip. There are also six maintenance centers in Nablus, Hebron, Ramallah, Jerusalem, Bethlehem, and Tulkarm. UMT owns the biggest car service and maintenance center in Palestine, which was built in Ramallah in 2008. Recently, launched its biggest and most modern branch in North Palestine, which rests on a 5,000 square meter area in Nablus City.

UMT was chosen as a pilot case study because it has a significant growth in automobile industry, it is one of the largest automobile companies in Palestine and finally it has a strong data base and that can be used for the intended simulations of this study.

A Sample Application for Simulation Modeling with ARENA

5.2.1. Overview.

In this chapter the simulation methodology will be described as employed to simulate a real case study in after-sales service using UMT company. As mentioned before, the model of after-sales service will be used during repairing processes. This chapter will guide the modeler while developing simulation model of after-sales service.

The basic model and preliminary experiments will be carefully developed to validate the system. Experiments will be done by changing some operational procedures, such as; dividing the jobs as per service category (Maintenance, Repair) or specifying fast service line for any short repair, or changing the number of workers in order be achieved the workers' optimization with best service time. To increase the workers' utilization, while operating service time. Once developed and verified, the basic model can be employed to simulate new process sequences, new queue rules, etc.

5.2.2. Collecting General System (Company Properties).

The UMT Company was selected for this thesis. The main activity field for the company is sales cars and providing best after-sales service on those cars that have been sold.

In this type of work, models must be built on a limited replication length. This means that the simulation run will be completed when the replication length is finished, the number of replications in this study is five years and the replication length is one year (300 working days).

The workshop contains three reception employees, two advisers, one programmer, and eleven workers. Worker schedule consists of six working days a week from 8:00am to 4:00pm with 30 minutes' break. The resource available (machines and tools) include lifts, each lift contains all equipment's and tools that may be used in any repair operation. Each lift productivity depends on many factors (type of defect, worker productivity itself).

The repairing and maintenance operations at UMT consist of six main stages as described in the following subsections:

1. **Reception process.**

   The customer reports to any one of the three reception offices available at the work station for reception and opens a card for his car. The card some important data that will be reflected on the car's file on the company server to be as a reference later on. The data includes name and

ID of the car holder, kilometer reading, type of check, defect periodic service, and the next service time etc.

According to graph 1 in appendix F, table (5.1) shows the distribution of arrival time. Where it includes that the arrival time of cars that need maintenance or repair was based on the following distribution: LOGN (16.66, 15.82).

Table (5.1): Arrival time.

Arrival Times (minutes)	
Arrival Times	LOGN(16.66, 15.82)

2. **Body Check.**

   This operation, consists of finding out and drawing all body scratches and damages on a sheet that will be attached to the opening card. This is in order to ensure that all cars did not incur on any scratch or damage during the repairing operation. The sheet will be a reference if any conflict occurs with any customer.

3. **Road Test.**

   It is the process of checking the car on the road, to investigate the actual faults in the car by real driving. Certain mechanical faults cannot be detected by computer checking, they need real road driving to be detected. Any fault is recorded for later repair with the approval of the owner.

4. **Garage (Workshop).**

   Garage is the dedicated repair and maintenance area. It consists of eleven lifts, main computer and all tools and equipment that is used during repairing operation.

At this stage, the car enters into the garage after the diagnosis on the road and finding out any mechanical faults, where they are repaired.

5. **Programming.**

   The car is connected to the computer to reprogram its software, and reset all default software. Sometimes required to connect the computer online with the manufacturer company to get help for repairing complex faults.

6. **Road test 2.**

   It is the process of checking the car on the road after the finish of repair operations, to ensure that all faults recorded before in the road test 1 were solved. If some of the faults are not repaired well, the car is returned to the garage for rework again.

➢ Modeling the Garage

The processes flow chart for main repairing operation is shown in the following figure (5.1).

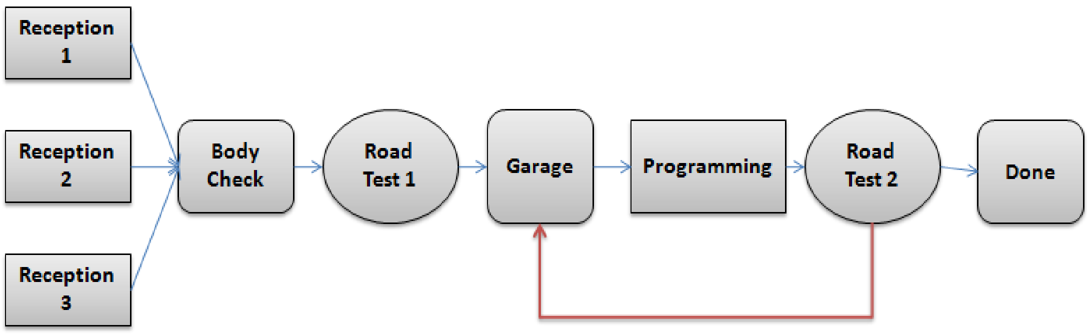

Figure (5.1): Processes flow chart for main repairing operation

According to graph number 2 in appendix F, the data shown in table (5.2) presents the process sequence for the main repairing operation for each stage, and the distribution of time needed for each stage.

Table (5.2) process sequence for main repairing operation.

Process sequence for main repair operation (minutes)	
Reception and Registration	TRIA (3,5,7)
Body Check	UNI(3,5)
Road Test 1	UNI(5,10)
Garage	TRIA(25,44.8,709)
Programming	UNI(15,30)
Road Test 2	UNI(5,10)

All stages time except the garage stage, was taken based on observations and an interviews with the maintenance staff and take the samples. Garage stage time represent the arithmetic mean for the last five years were analyzed by ARENA input analyzer.

It is noted from the table (5.2) above that the garage stage needs the longest time which is normal, as this is where the actual work is done. The time of garage stage varies from one vehicle to another due to the nature and size of the faults.

Processes flow chart for maintenance is shown in the following figure (5.2).

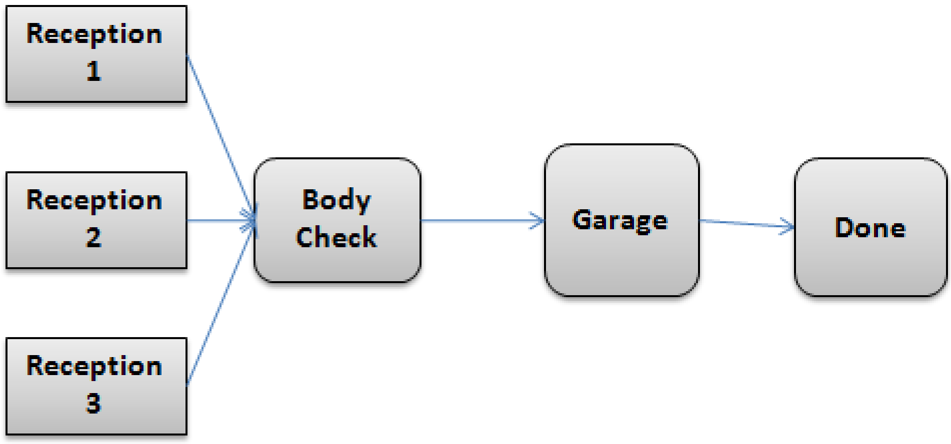

Figure (5.2): Processes flow chart for maintenance

According to graph 3 in appendix F, the table (5.3) presents the process sequence for maintenance operation and how much time maintenance takes in each station.

Table (5.3): process sequence for maintenance operation.

Process sequence maintenance operation (minutes)	
Reception and Registration	TRIA (3,5,7)
Body Check	UNI(3,5)
Garage	LOGN(10, 15.20)

Time of stations, except the garage stage, were taken based on observations and an interviews with the maintenance staff and take samples. Garage stage represent the arithmetic mean for the last five years were analyzed by ARENA input analyzer.

This process takes less time than main repairing operation, as this process does not always needs programming or a road test, and the type of process is known and easy to do.

Study Experiments

- Main model: all employees work upon their arrival at the workshop even if the specialist is not present.
- Experiment number 1: dividing the garage processes to two divisions (periodic maintenance: one lift with one worker, and ten lifts with ten workers work on all other repair work).
- Experiment number 2: dividing the garage processes for two divisions (periodic maintenance: two lifts with two workers, and nine lifts with nine workers work on all other repair work).
- Experiment number 3: dividing the garage processes to two divisions (periodic maintenance three lifts with three workers, and eight lifts with eight workers work on all other repair work).
- Experiment number 4: change the work approach from first arrived first served to lowest service time first served. In this experiment, there is only one division covering all types of repairing and maintenance, where are work requiring the lowest estimated repair time is served first.
- Experiment number 5: Mixed approach, “combining experiment number 2 and experiment number 4” dividing the garage processes for two divisions (periodic maintenance two lifts with two workers, and nine lifts with nine workers work on all other repair work). Then the cars in queue will be serviced by lowest service time first served.

Experiment number 4 is different from the main model in relation to expected repairing time. So, in the main test, the workers are dealing with the car upon its arrival at the maintenance center (first arrived first served).

While experiment number 4 gives priority to lowest expected repair time or maintenance.

Table (4.4) shows all the analytical results that obtained from simulating the model that built in this study and consists of the results of each experiment separately. It shows that total average service time in minutes for the main model was 213 minutes, and average waiting time for maintenance was 32 minutes. Also, average waiting time for the repair stage was 32 minutes.

Table (5.4) Simulation results

Experiment	Total Average Service Time (Min)	Garage Average Waiting Time (Min)	
		Maintenance	Repair
Main Model	213	32	32
Exp. #1	186	4	32
Exp. #2	167	1.5	11.7
Exp. #3	176	0	45
Exp. #4	200	18	18
Exp. #5	224	0	107

In the first experiment, the total average service time was 186 minutes, the average waiting time for periodic maintenance was 4 minutes and the average waiting time for repair stage was 32 minutes. These results are better than these of the main model, but they may not be the optimal.

In the second experiment, the total average service time (Min) was 167 minutes, and average waiting time for periodic maintenance was 1.5 minutes. Also, average waiting time for the repair stage was 11.7 minutes.

In the third experiment, the total average service time was 176 minutes, and average the waiting time for periodic maintenance was zero minutes, that means there is no average waiting time in periodic maintenance operation in this experiment. Also, the average waiting time for repair was 45 minutes. In this experiment, the ideal average waiting time of zero minutes for the periodic maintenance was achieved.

In the fourth experiment, the total average service time was 200 minutes, and the average waiting time for periodic maintenance was 18 minutes. Also, average waiting time for repair was 18 minutes. This experiment produced better results than each of the main model, with only insignificant change in process sequences.

Finally, in the fifth experiment, the total average service time was 234 minutes, and the average waiting time for periodic maintenance was zero minutes, that means there is no average waiting time in maintenance operation in this experiment. The average waiting time for the repair was extremely high 107 minutes.

The above results show that the best experiment that reduces waiting time in both stations is the second experiment. Its total average service time is the lowest. As such, the conditions and results of experiment 2 can be consisted to be the optimum for this case study.

4.4 Sensitivity Analysis

Extra experiments were carried out to support the research study and measure sensitivity and validity of the simulation. These are follows:

1. What are the average service time and the waiting time if one worker were removed or fired, in second experiment?
2. Is this conceptual model still valid at higher arrival rate?

Table (5.5) shows that this approach can provide very good results of total average service time and the average waiting time despite reducing the number of workers from nine to eight workers. This might not affect the level of customer satisfaction in the main situation to any significant degree.

Table (5.5): Sensitivity and validity of the research

Exp. #6	Total Average Service Time(Min)	Garage Average Waiting Time(Min)	
		Maintenance	Repair
	174	1.6	36

The results in the table (5.5) means that the conceptual model in experiment number six suggests that there is an opportunity to make a saving in one worker or the absence of on worker with while ensuring that the level of customer satisfaction is not affected.

❖ **Experiments of increase the arrival rate**

The below table (5.6) shows the results of simulating the previous experiments but with an increase in the arrival rate of 7%. The number of cars increases approximately 600 cars in a year, from about 8650 to about 9250 with insignificant change.

Table (5.6): Validity of increasing the arrival rate by 7%

Experiment	Total Average Service Time(Min)	Garage Average Waiting Time(Min)		
		Maintenance	Repair	
Main Model	262	77	77	
Exp. #7	197	5	52	
Exp. #8	176	2	22	
Exp. #9	191	0	69	
Exp. #10	225	41	41	
Exp. #11	289	0	232	

The above table (5.6) shows that total average time and waiting time for all experiments, and experiment 8 produces the best results. That means old experiment 2 itself still work as the best experiment even the arrival rate increase of 7%.

Table (5.7) shows the results of simulating the previous experiments but with an increased in the arrival rate of 23%. The number of cars increase to approximately 2000 cars a year.

Table (5.7): Validity of increasing the arrival rate by 23%

Experiment	Total Average Service Time(Min)	Garage Average Waiting Time(Min)		
		Maintenance	Repair	
Main Model	No Result	No Result	No Result	
Exp. #12	**489**	**7.7**	**606**	
Exp. #13	**238**	**3.6**	**115**	
Exp. #14	**358**	**0.26**	**470**	
Exp. #15	**636**	**435**	**435**	
Exp. #16	No Result	No Result	No Result	

The above table (5.7) shows that total average time and waiting time for all experiments, and experiment 13 produces the best results. That means old experiment 2 itself still work as the best experiment even the arrival rate increase of 23%. The no result block that shown above in table (5.7) means that the results were not taken because of the ARENA software is a student edition.

Chapter Six

Conclusions and Recommendations

Chapter Six

Conclusions and Recommendations

Conclusions

The aim of this study is to apply simulation technique on after-sales service in automobile field in Palestine using UMT service center as a case study, in order to increase customer satisfaction by reducing waiting time and total average service time. This study also attempts to answer the study questions by applying simulation modeling to increase customer satisfaction level in after-sales service in the automobile field in Palestine**.**

The best conceptual model of service concept for automobiles maintenance and repair workshop that minimizes the waiting time and total average service time is through dividing the garage processes to two divisions (maintenance: two lifts with two workers and nine lifts with nine workers in all other repairs). In this experiment, the total average service time was 167 minutes, which is the optimal solution when compared with all other alternatives. Also, this study shows that waiting time in, maintenance was the lowest and averages 1.5 minutes. with regard to waiting time in the repair station, it is also confirmed that this experiment is the best where the waiting time averages 11.7 minutes**.**

The study showed that the maintenance phase of automobile sector in Palestine the study model as expected. In order to ensure that the waiting time is reduced the separation of the garage to maintenance stage and repair stage is better than merging them together.

The study has shown that improved after-sales service and reduce the time required for the maintenance lead to increased customer satisfaction which is the main objective of the study.

The results clearly indicate that the second experiment is the best option that reduces waiting time and total average service time. And in the event of one worker being absent, the second experiment will continue to operate at approximately the same level of waiting time.

Finally, experiment number two has the potential of increasing the arrival rate by 23% and more, and it utilizes the workers more than any other experiment, thus it can increase worker's productivity.

Recommendations

- This study highlights the need for separation between the two types of work (repair and maintenance) in the workshop**.**
- Solving customer problems in the shortest possible time is one of the most important features of customer satisfaction. Successful and effective customer service means solving problems faced by customers in a short period. All employees must do their best not to leave their duties while the customers are waiting, rather they have to deal with them immediately and effectively.
- Automobile dealerships should seek to development technological programs, including simulation, in order to reduce the time required for the provision of services in order to maintain a competitive advantage.

- Automobile companies should design a simple questionnaire for each customer, and ask him to fill out the questionnaire in order to measure customer satisfaction.

Study Contribution

This study contributes to the literature in this field. Improving after-sales service will enhance customer satisfaction. The experimental approach of this study can be extended to other organizations in order to improve their after-sales service by focusing on the waiting time. This might contribute to their profitability and to improve their relationship with customers. More importantly, this study also contributes to increase awareness among industrial and service companies, to focus on technology in order to strengthen ties with customers and reduce the time required to provide services.

The proposed conceptual model that shown in figure (6.1) clarifies the mechanism of dealing with all visits to the workshop, regarding the type of visit and dividing it to two divisions: maintenance and repair. This model identifies all stations in each operation and next station. As this study recommended to dividing between the two types of visits, maintenance and repair visits, this model shows how to separate the steps and how to proceed at each step.

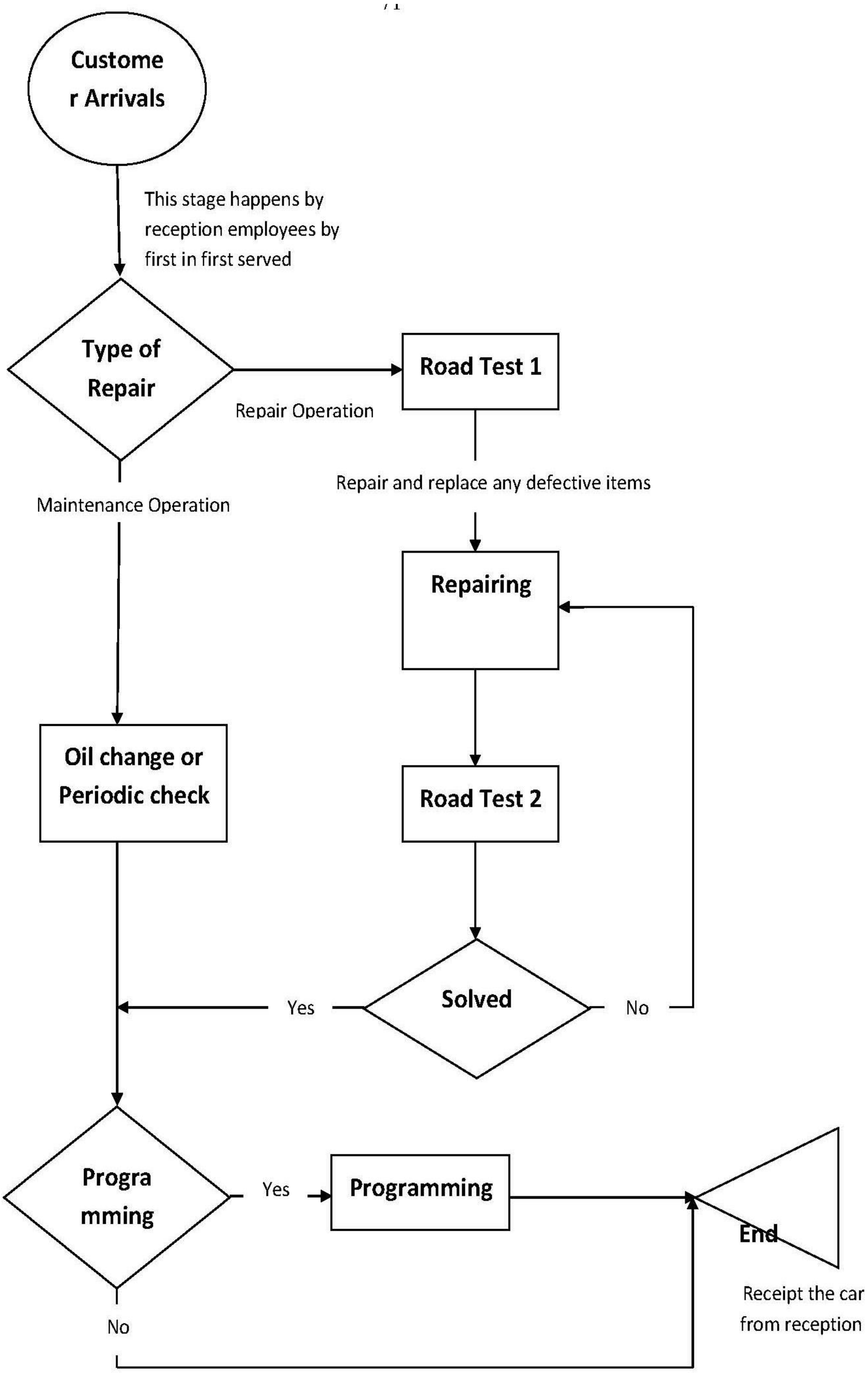

Figure (6.1): Proposed Conceptual Model

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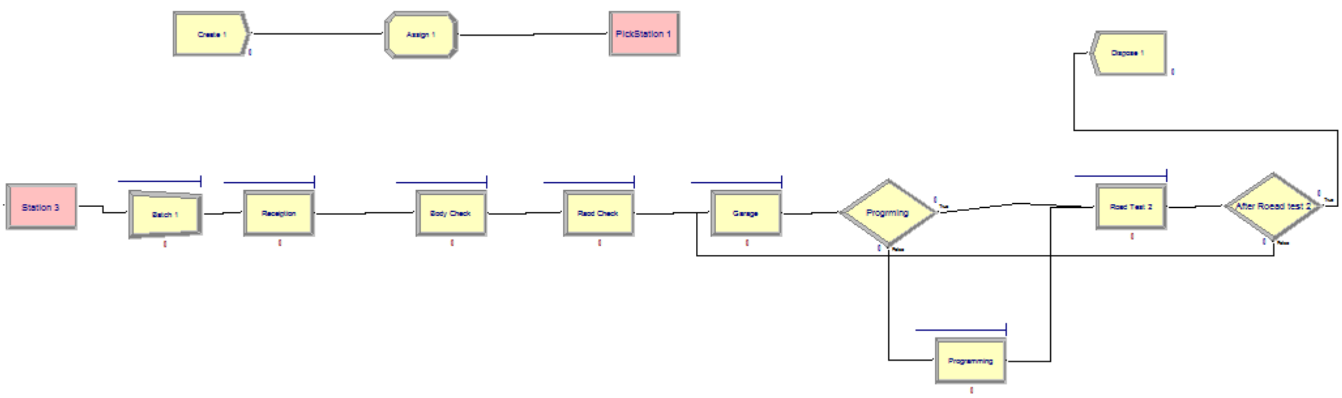
Appendices

Appendix A:

The below model shows the final simulator that illustrate and imitate the maintenance or repair operations in the workshop, it was built by ARENA software. Each block express on unique station from the workshop.



Appendix B:

1. The table below shows the waiting time conducted from experiment number one, for each station.

Replications: 5 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	2.2052	0.07	2.1389	2.2629	0.00	27.8224
Garage.Queue	32.0104	6.19	27.5988	39.7145	0.00	467.93
OC Garage.Queue	4.1142	0.19	3.9384	4.3500	0.00	78.0653
Programming.Queue	5.3045	0.40	4.8848	5.7810	0.00	113.63
Receiption.Queue	1.7065	0.05	1.6652	1.7443	0.00	24.5253
Road Test 2.Queue	2.3809	0.08	2.3052	2.4468	0.00	38.5952
Road Test.Queue	2.1696	0.13	2.0476	2.2880	0.00	38.8900

2. The table below shows the result conducted from experiment number two, for each station.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	5.1710	0.16	5.0296	5.3179	0.00	79.5439
Garage.Queue	11.7263	2.78	8.1244	13.9296	0.00	376.29
OC Garage.Queue	1.5299	0.15	1.4378	1.7195	0.00	51.7320
Programming.Queue	11.7486	0.56	10.9551	12.0607	0.00	154.07
Receiption.Queue	4.3347	0.14	4.2348	4.4555	0.00	77.9616
Road Test 2.Queue	5.1862	0.18	4.9980	5.3254	0.00	79.1484
Road Test.Queue	5.2492	0.21	5.0738	5.5135	0.00	84.5925

3. The below table shows the result conducted from experiment number three, for each station.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	5.1225	0.10	5.0290	5.2553	0.00	66.7877
Garage.Queue	45.2568	13.74	29.4747	57.2335	0.00	713.77
OC Garage.Queue	0.05327238	0.01	0.04419980	0.06491739	0.00	14.9468
Programming.Queue	11.1314	0.54	10.5909	11.7786	0.00	159.37
Receiption.Queue	4.2786	0.09	4.1787	4.3790	0.00	63.0153
Road Test 2.Queue	5.0471	0.28	4.7165	5.3118	0.00	71.5852
Road Test.Queue	5.1596	0.20	4.9981	5.4038	0.00	72.2735

4. The table below shows the result conducted from experiment number four, for each station.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	2.2089	0.06	2.1619	2.2641	0.00	29.8602
Garage.Queue	18.8792	1.78	17.0712	20.9966	0.00	433.58
Programming.Queue	6.3681	0.49	5.9907	7.0246	0.00	103.72
Receiption.Queue	1.6893	0.06	1.6262	1.7424	0.00	28.7899
Road Test 2.Queue	2.6121	0.11	2.4868	2.7139	0.00	36.7166
Road Test.Queue	2.4131	0.07	2.3308	2.4599	0.00	34.3419

5. The table below shows the result conducted from experiment number five.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	2.1669	0.08	2.0905	2.2682	0.00	42.8939
Garage.Queue	107.62	17.21	94.6142	127.99	0.00	1132.99
OC Garage.Queue	0.07541694	0.01	0.06063885	0.08760498	0.00	11.0460
Programming.Queue	5.4343	0.38	5.0242	5.6776	0.00	95.2164
Receiption.Queue	1.6746	0.09	1.5906	1.7843	0.00	42.3691
Road Test 2.Queue	2.2019	0.03	2.1675	2.2205	0.00	33.1951
Road Test.Queue	2.0520	0.11	1.9777	2.1905	0.00	33.0481

Appendix C.

1. The table below shows the result conducted from experiment number one, when the arrival rate increased up by 7%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	3.0020	0.18	2.8159	3.2047	0.00	32.8762
Garage.Queue	51.9818	18.18	40.5661	77.4078	0.00	557.53
OC Garage.Queue	5.0868	0.25	4.8700	5.2693	0.00	125.04
Programming.Queue	5.7420	0.27	5.4904	5.9701	0.00	84.8254
Receiption.Queue	2.3311	0.16	2.1651	2.5155	0.00	33.0664
Road Test 2.Queue	2.5318	0.12	2.4510	2.6456	0.00	34.6572
Road Test.Queue	2.4091	0.09	2.3335	2.5069	0.00	36.9763

2. The table below shows the result conducted from experiment number two, when the arrival rate increased up by 7%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	7.3629	0.40	6.8088	7.6023	0.00	91.6742
Garage.Queue	22.7665	4.64	19.4113	28.7164	0.00	395.09
OC Garage.Queue	2.0845	0.11	1.9732	2.2198	0.00	50.3378
Programming.Queue	12.8167	1.29	11.9168	14.5226	0.00	174.19
Receiption.Queue	6.2968	0.39	5.7743	6.5810	0.00	89.1870
Road Test 2.Queue	6.0229	0.61	5.6085	6.6589	0.00	92.5673
Road Test.Queue	6.0954	0.78	5.5092	6.9273	0.00	87.4319

3. The table below shows the result conducted from experiment number three, when the arrival rate increased up by 7%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	7.5868	0.55	7.2206	8.2858	0.00	82.5209
Garage.Queue	69.0570	14.76	51.4140	83.7505	0.00	752.39
OC Garage.Queue	0.08280298	0.01	0.07040201	0.0998	0.00	15.9995
Programming.Queue	11.7968	1.20	10.5549	13.1768	0.00	193.33
Receiption.Queue	6.4646	0.53	6.0955	7.1348	0.00	77.6368
Road Test 2.Queue	5.7497	0.34	5.4122	6.1188	0.00	85.0398
Road Test.Queue	5.8141	0.22	5.5571	6.0324	0.00	73.0286

4. The table below shows the result conducted from experiment number four, when the arrival rate increased up by 7%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	3.0777	0.05	3.0104	3.1065	0.00	35.7909
Garage.Queue	41.0158	11.85	30.9946	54.9146	0.00	728.41
Programming.Queue	6.2952	0.30	6.0360	6.5520	0.00	101.13
Receiption.Queue	2.3946	0.06	2.3415	2.4629	0.00	32.9037
Road Test 2.Queue	3.0099	0.09	2.9180	3.1154	0.00	45.7904
Road Test.Queue	2.9064	0.08	2.8101	2.9906	0.00	42.1942

5. The table below shows the result conducted from experiment number five, when the arrival rate increased up by 7%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	3.1637	0.14	3.0358	3.2790	0.00	33.6233
Garage.Queue	232.68	129.48	99.64	375.78	0.00	1474.43
OC Garage.Queue	0.1133	0.02	0.0967	0.1364	0.00	12.3958
Programming.Queue	5.6386	0.39	5.1483	5.9598	0.00	87.9583
Receiption.Queue	2.4878	0.11	2.3952	2.5810	0.00	33.2813
Road Test 2.Queue	2.4719	0.14	2.2979	2.6102	0.00	44.8495
Road Test.Queue	2.4152	0.17	2.2696	2.6035	0.00	37.1668

Appendix D.

1. The table below shows the result conducted from experiment number one, when the arrival rate increased up by 23%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	6.7196	0.40	6.3095	7.1464	0.00	75.3647
Garage.Queue	606.66	288.97	398.32	967.57	0.00	2135.07
OC Garage.Queue	7.7450	0.63	7.1541	8.1860	0.00	107.71
Programming.Queue	7.0210	0.49	6.4055	7.4458	0.00	107.31
Receiption.Queue	5.5860	0.38	5.2247	6.0169	0.00	76.7549
Road Test 2.Queue	3.2343	0.14	3.1109	3.3959	0.00	50.9002
Road Test.Queue	3.3461	0.16	3.2111	3.5486	0.00	50.4621

2. The table below shows the result conducted from experiment number two, when the arrival rate increased up by 23%.

3. The table below shows the result conducted from experiment number three, when the arrival rate increased up by 23%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	19.0938	1.12	18.2190	20.5834	0.00	147.94
Garage.Queue	470.21	200.35	311.95	715.74	0.00	2584.46
OC Garage.Queue	0.2681	0.04	0.2375	0.3165	0.00	23.0301
Programming.Queue	15.4361	1.48	13.3254	16.2243	0.00	176.73
Receiption.Queue	17.3765	1.13	16.4834	18.8996	0.00	145.26
Road Test 2.Queue	8.1373	0.58	7.7475	8.8517	0.00	91.3931
Road Test.Queue	8.4576	0.57	7.8029	9.0956	0.00	94.2003

Road Test 2.Queue	[illegible]	[illegible]	[illegible]	[illegible]	0.00	[illegible]
Road Test.Queue	9.0797	0.46	8.6818	9.5041	0.00	134.79

4. The table below shows the result conducted from experiment number four, when the arrival rate increased up by 23%.

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Body Check.Queue	6.1910	0.14	6.0758	6.3605	0.00	59.9337
Garage.Queue	435.48	164.55	336.78	658.03	0.00	2961.24
Programming.Queue	7.4547	0.34	6.9604	7.5886	0.00	107.83
Receiption.Queue	5.0765	0.14	4.9574	5.2556	0.00	58.1976
Road Test 2.Queue	3.6726	0.06	3.6164	3.7430	0.00	48.2081
Road Test.Queue	3.8834	0.11	3.8022	3.9962	0.00	47.1392

Appendix E:

1. Number of cars arrived in year in main arrival rate.

Number In	Average	Half Width	Minimum Average	Maximum Average
Entity 1	8675.40	51.81	8614.00	8721.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
Entity 1	8664.40	50.74	8608.00	8709.00

2. Number of cars arrived in year in increased arrival rate by 7%.

Number In	Average	Half Width	Minimum Average	Maximum Average
Entity 1	9259.80	135.07	9143.00	9385.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
Entity 1	9247.00	133.09	9133.00	9371.00

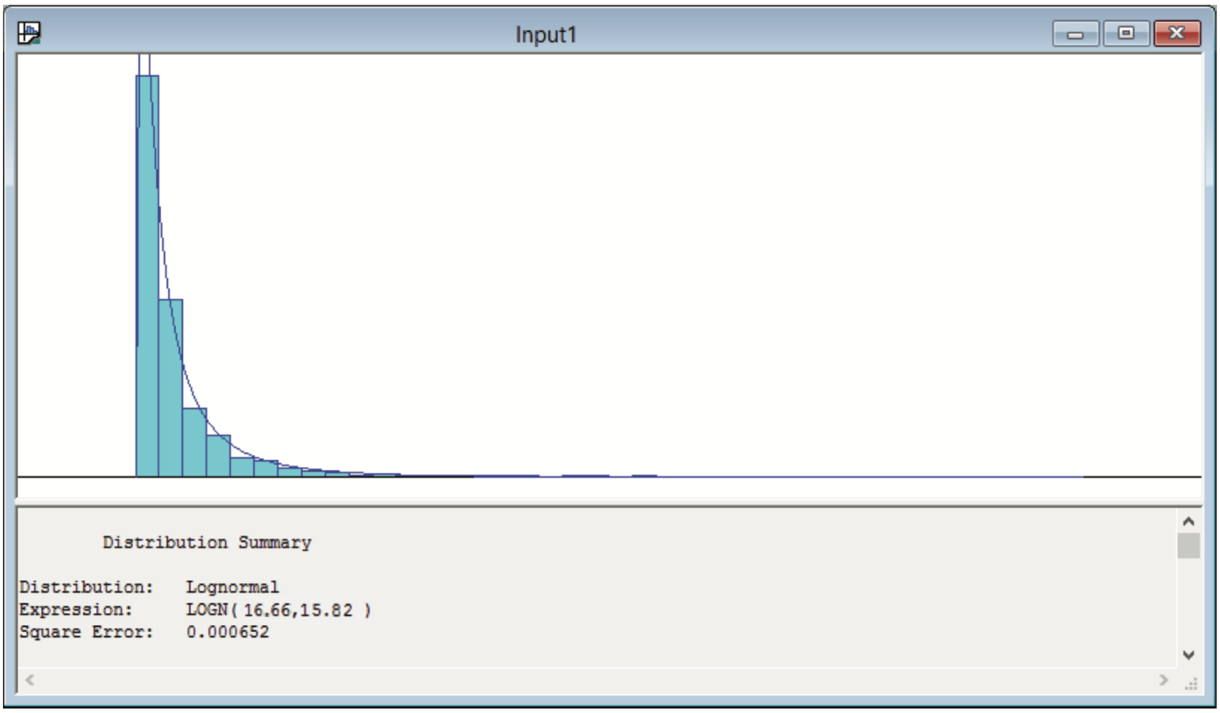
3. Number of cars arrived in year in increased arrival rate by 23%.

Number In	Average	Half Width	Minimum Average	Maximum Average
Entity 1	10668.20	179.51	10519.00	10870.00

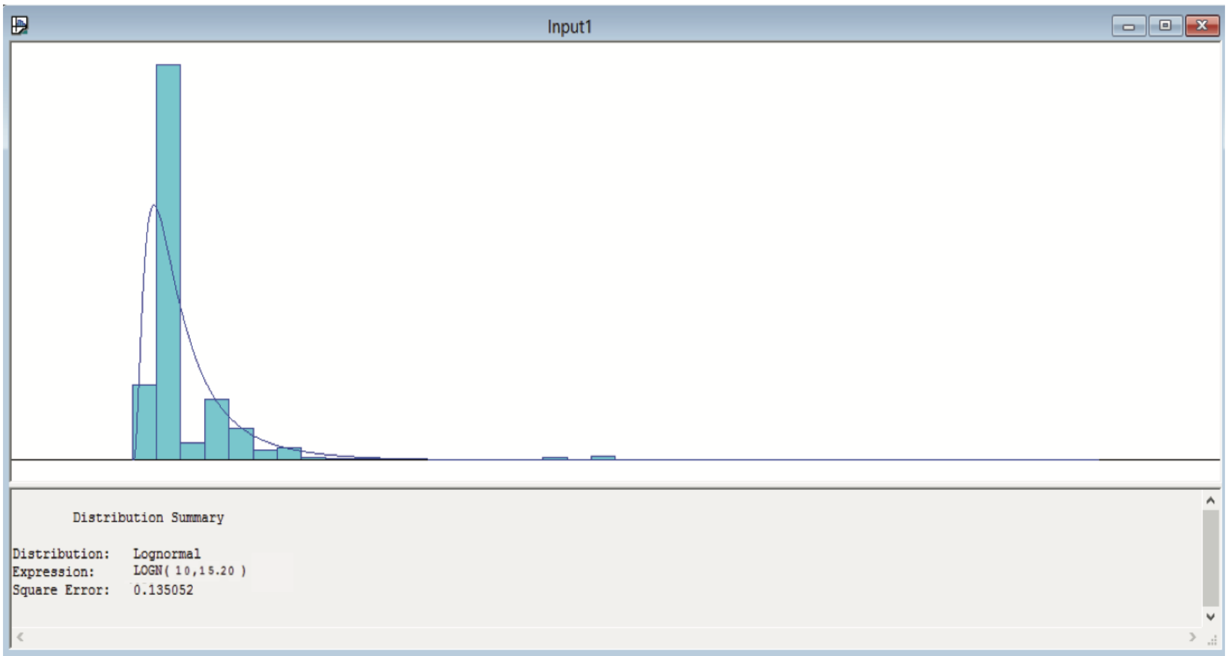
Number Out	Average	Half Width	Minimum Average	Maximum Average
Entity 1	10643.00	167.78	10502.00	10820.00

Appendix F:

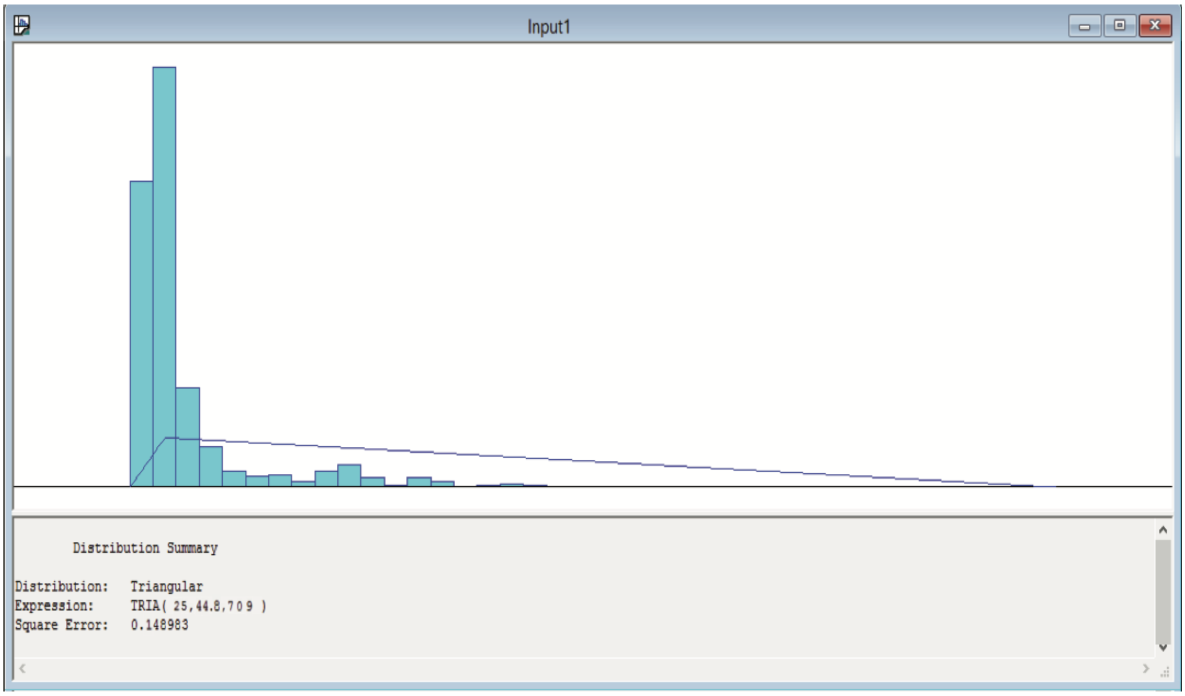
1. The graph below shows the distribution of arrival rate calculated by input analyzer.



2. The graph below shows the distribution of maintenance stage calculated by input analyzer.



3. The graph below shows the distribution of repair stage calculated by input analyzer.



جامعة النجاح الوطنية

كلية الدراسات العليا

زيادة رضا العملاء على خدمة ما بعد البيع من خلال محاكاة النمذجة في شركة السيارات

إعداد

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إشراف

د.بكر عبد الحق

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

2017

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الملخص

تهدف هذه الدراسة إلى تطبيق تقنية المحاكاة على خدمة ما بعد البيع في قطاع السيارات في فلسطين، ومركز خدمة الشركة المتحدة لتجارة السيارات كدراسة حالة، لزيادة رضا الزبون عن طريق تقليل وقت الانتظار ومتوسط وقت الخدمة في عمليات الصيانة.

تم تصميم نموذج الدراسة على أساس دراسة البيانات التجريبية بواسطة المحاكاة، ويتكون من مرحلتين رئيسيتين (صيانة الأعطال والصيانة الدورية). وأظهرت النتائج أن الطريقة الأمثل للحصول على اقل وقت إنتظار ومتوسط وقت الخدمة، هو تقسيم عمليات ورشة الصيانة إلى قسمين (الصيانة الدورية حيث تتم العملية بواسطة اثنين من العمال مع رافعتين،صيانة الاعطال تتم بواسطة تسعة عمال مع تسع رافعات يعملون على جميع الصيانات الاخرى) والتي تؤدي إلى تحسين خدمة ما بعد البيع من خلال تقليل وقت الانتظار المطلوب لعملية الصيانة مما يؤدي إلى زيادة رضاء الزبون عن خدمة ما بعد البيع، كما أظهرت الدراسة أيضاً أنه في حال غياب عامل واحد أو زيادة عدد السيارات التي تزور ورشة الصيانة بنسبة 23% سنويا يبقى النموذج المقترح في الدراسة يعمل كأفضل نهج للحفاظ على نفس المستوى من رضا العملاء.

توصي هذه الدراسة أيضاً بضرورة تقسيم أو تصنيف عملية إصلاح المركبات الى قسمين (صيانة أعطال والصيانة الدورية) لتقليل الوقت الإجمالي الذي يقضيه الزبون أثناء زيارته لعملية الصيانة والتي من شأنها تعزيز وزيادة رضا الزبون عن خدمة ما بعد البيع.