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The application of Lean Six Sigma Methodology to improve the process of connecting a new electricity service in Jerusalem District Electricity Company (JDECO)

By
Reem Hamzeh AL Barghouthi

Supervisor
Dr. Ashraf Al-Mimi

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This Thesis was defended successfully on 25/9/2021 and approved by:

Defense Committee Members	**Signature**
▪ **Dr. Ashraf Almimi / Supervisor**	.....
▪ **Dr. Yahya Salahat /External Examiner**	.....
▪ **Dr. Raid Shomali/ Internal Examiner**	.....

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 degree or qualification.

Student's Name: Reem Hamzeh Barghouthi

Signature: 

Date: 30/12/2021

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Abstract

Lean Six Sigma (LSS) is considered an effective methodology to improve process performance, it has been applied across service sector as a management strategy to achieve process excellence. Moreover, implementing LSS leads for improving the quality of service and increasing the customer satisfaction.

The importance of this study lies in improving a key process at Jerusalem District Electricity Company (JDECO) -Ramallah Branch- which is connecting a new electricity service to customers. The existing process contains non-value-added steps with a long cycle time to provide the electricity service that caused customers of JDECO to be dissatisfied. Moreover, no previous or similar studies have been conducted in Palestine which confirms that there is a gap to be covered by implementing LSS within the Palestinian electrical distribution companies.

To this end, this study aims at applying LSS methodology to improve the process of connecting a new electricity service by JDECO to customers. More specifically, the well-known LSS-DMAIC (Define, Measure, Analyze, Improve and Control) methodology has been applied. Several lean tools have been employed, namely, problem context diagram (PCD), project charter, SIPOC, flow charts, eight wastes, quick wins, value stream mapping (VSM), control charts, voice of customer (VOC) and cause and effect diagrams.

Relevant data and information were collected from three main source; interviews with different levels of staff at JDECO, records from the billing system which were analyzed using Minitab 19, as well as customer complaints system at JDECO which were analyzed by Microsoft Excel.

The research results concluded the process current performance, the process problems, and the root causes of the problems, these results were discussed with JDECO management. Based on that,

the research resulted in providing a set of recommendations and practical solutions that should be applied by the company to improve the process. But there were challenges to apply the recommended solutions during this research which included the financial barriers, and the time limitation. The top management promised that they will conduct the recommendations once they allocate the needed budget to achieve the process improvement.

Key words: Six Sigma, Lean, Power sector.

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CHAPTER ONE

Introduction

1. Introduction

1.1 Overview

Due to sharp competition, companies are looking for strategies to improve their processes performance (Antony et al., 2012). The Palestinian electricity distribution companies face increasing competition because of the increase in number of domestic competitors. Thus, to compete, it is important to improve their operational efficiency and effectiveness. Improving operational efficiency and effectiveness includes quality improvement, productivity improvement, time reduction, and waste reduction (De Koning, Does, and Bisgaard, 2008).

A service that has been provided by a company includes a continuous process of interactions between customers and service provider; this means that service quality has a big impact on customer satisfaction and customer loyalty. So, by providing a service with high quality to customers, a company creates good perception of customers about quality of service (Khan and Fasih, 2014).

Service quality has been affected by different factors, some of them are controlled and some of them are uncontrolled factors. These factors include: lack of staff, unskilled staff, delay in service delivery, defects during service delivery, lack of system…etc. Therefore, companies might have a big challenge to achieve process improvement unless they have enough resources to place the process for their operations.

One of the most effective methodologies to improve process performance is Lean Six Sigma (LSS), it has been applied across service sector as a management strategy to achieve process excellence. Moreover, implementing LSS leads for improving the quality of service and increasing customer satisfaction. In addition, Lean is considered as a powerful process improvement methodology to minimize waste and non- value-added activities, whereas Six Sigma is an effective methodology to reduce variation and defects rate within a business process (Antony et al., 2012)

The concept of LSS is considered an approach to process improvement (Bendel, 2006). Moreover, LSS is a quality improvement methodology that is applied by manufacturing and service organizations to provide a superior value to their customers, improve product and service quality, improve organization's profit, and sustainable competitive advantage (Sony, 2019). A well-known approach of LSS has been applied in this research is DMAIC (Define-Measure-Analyze-Improve-Control) approach, the DMAIC method in Six Sigma is often described as an approach for problem solving.

The electric power is considered a driving force for economic and social development, and improving quality of life (El Chaar and Lamont, 2010). Moreover, electric energy is very important for processes of production, manufacturing, and services, and it plays a key element for sustainable development. In the electric power sector, due to the high growth of population, high standards in living, rapid growth in both industrial and service sectors, there is a continuous increase in energy demand in Palestine (Juaidi et al., 2016). The main objective of the power sector is to meet the electricity needs of customers, there is a basic need for low cost and uninterrupted power (Sony, 2019). In addition, a customer in the power sector will be satisfied when there are supply of electricity service at the right time, right quantity, right quality, and also at right cost (Yadav and Naim, 2017).

LSS is a strategy that is highly needed for electricity distribution companies in the power sector to improve their processes performance, enhance customer satisfaction, reduce the non-value-added steps, and reduce variations in their processes.

Based on the above, in order that Jerusalem District Electricity Company (JDECO) – which is one of the main electricity distribution companies in Palestine - wins the competition in the business world, it must provide the electricity service for their customers with high quality, high quantity, high speed, with lower costs, and this will be achieved by adopting LSS as an approach for process improvement.

The research has been implemented in the power distribution sector in the Palestinian context. This research presents the implementation of LSS methodology to improve a key process of connecting a new electricity service within Jerusalem District Electricity Company (JDECO) – Ramallah branch.

By applying the DMAIC approach and analyzing the process, JDECO improves this major service (connecting a new electricity service) through the identification and elimination of waste and variation in the process, and this includes reducing the time taken to perform this process, in addition, decreasing the expenses by eliminating the unnecessary steps in the process.

The expected outcomes of this research are to increase the performance, efficiency, and effectiveness of the process of connecting a new electricity service, and ultimately, achieving customer satisfaction. Besides, the knowledge and skills that are gained by JDECO's team during applying this research can be used to improve other processes in JDECO.

1.2 Jerusalem District Electricity Company (JDECO) Profile

Jerusalem District Electricity Company (JDECO) has been established in 1914, it has four branches in the following four cities: Jerusalem, Ramallah, Bethlehem, Jericho. JDECO provides the electricity service for 315000 customers in the areas of Jerusalem, Ramallah, Bethlehem, and Jericho. JDECO has 968 employees working in the following eight departments: customer services department, technical department, financial department, quality management department, survey department, installation department, planning department, warehouses. JDECO's annual budget for 2020 is $400 million, and the maximum load of the company reached 564 Megawatt (JDECO Annual Report, 2020).

According to the annual report 2020, JDECO has the following important tasks:

1- Providing a new electricity service for new consumers.

2- Issuing the service bills.

3- Conducting maintenance.

4- Installing the electric networks.

5- Building and operating the electrical plants.

6- Implementing renewable energy projects in the company areas.

1.3 Problem Statement

Palestinian electricity distribution companies provide electricity for their customers through the process of connecting a new electricity service. The effectiveness and efficiency of this process affect distribution companies' performance. Specifically, the performance of this process is highly connected with one of the key performance indicators for the distribution companies, which is the

quality indicators of electricity service provided to consumers measured by (average time for connecting new electricity service for customer, number of customer complaints) (Palestinian Electricity Regulatory Council (PERC), Performance Indicators Report for Electricity Distribution Companies, 2018). Hence, to provide this service with high performance and meet customer needs, each distribution company must investigate its problems and find solutions to achieve an improvement of this process.

Through conducting interviews with the quality manager and two electrical engineers in the quality management department in Jerusalem District Electricity Company (JDECO) in Ramallah branch, they explained that there is a problem in a key process which is connecting a new electricity service process, as it takes a long cycle time to be implemented approximately six months. This affects the company performance and customer satisfaction. In addition, data which were taken from customers' complaints handling division during the period from beginning of 2019 until September 2020, showed that 47% of customer complaints are related to this key process, as a result of this, this process needs to be investigated.

Connecting a new electricity service process is one of the major services provided by JDECO; however, the process includes many non-value-added steps that caused customers of JDECO to be dissatisfied with the long cycle time it takes to provide electricity.

1.4 Importance of The Research

The electric power sector in Palestine plays a significant and critical driving force for socio-economic development, and improved quality of life. In addition, electric power is important for the processes of production and manufacturing, and it constitutes a key element for sustainable development.

About 98% of electricity has been imported from Israel Electrical Corporation (IEC) and the rest of electricity has been imported from Jordan (Palestinian Energy and Natural Resources Authority (PENRA), Annual Report 2019). The total cost of imported energy has been estimated in the year 2019 with $ 2.6 billion, $ 1.7 billion costs of petroleum and natural gas, and $ 900 million costs of electricity. This bill is equivalent to 18% from Gross Domestic Product (GDP) (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020). The performance of the Palestinian electric power sector affects the economic and social sides for Palestinian citizen. The Palestinian electricity distribution companies are responsible for securing sufficient and reliable electric power for their customers. The lack and need of reliable and sufficient energy system is a significant reason that leads to curtailed Palestinian community development and economic development even before accounting for expected population growth and economic potential (Hamed et al., 2012).

The Palestinian electric power sector has a big challenge which is the incapability to secure sufficient energy to meet the needs of electricity with the population growth. The electric power sector faces major problems that affect customer satisfaction and affect the performance of electricity distribution companies. One of the major problems is the high electricity tariff (price of electricity) that has been determined by the Cabinet decision No. (17/68/24) for the year 2015, the prices ranged between 0.44 – 0.66 Shekel/Kwatt, the price depends on the quantity of consumed electricity (Number of Kwatts), the Cabinet in their decision determined five categories of electricity consumption started from 0-160 Kwatt and until 600 Kwatt and more, each category of electricity consumption is related to specific category of price, and this tariff is considered the highest in comparison with the neighboring countries, namely, Jordan and Egypt (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020). The

electrical tariff is the main source of revenues for the electricity distribution companies, as it includes a targeted return on the investment of these companies and a recovery of their operating costs related to the activities stipulated in the distribution license. According to tariff categories, the price of electricity has been affected by two factors: the first factor is the electrical loss (technical loss) in the electric networks of the distribution companies that are providing electricity to customers. The second factor is the power factor which is a concept by which the electric power efficiency is defined, and its value depends on the quality of providing the electricity service to customers, the power factor value must be at least 92% (Palestinian Electricity Regulatory Council (PERC), Annual Report 2018).

In addition, one of the major problems, that is facing the electric sector, is the increase in technical loss of electricity within the distribution networks, technical loss leads to financial loss, the yearly technical loss reaches 22% with financial loss of $168 million yearly from the total imported electricity, this leads to increase in electricity cost (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

The main electricity problems in Palestine are classified as: electrical current weakness (28%) electrical current disconnection (26%), old electricity network (24%), non-served areas (17%), and others (5%) (Juaidi et al., 2016).

Palestinian Electricity Regulatory Council (PERC) adopts key performance indicators that measure the performance of electricity distribution companies toward the electricity service which is provided to the customers. The key performance indicators are as follows: customers performance, continuity of electricity (power interruption) indicators, the quality indicators of electricity service provided to consumers (average time for connecting new electricity service for customer, number of customer complaints), financial indicators (related to technical loss),

technical indicators, work staff indicators (Palestinian Electricity Regulatory Council (PERC), Performance Indicators Report for electricity distribution companies, 2018).

Depending on the mentioned performance indicators, the performance of the process of connecting a new electricity service for customers is highly connected with these indicators. The performance of this process is connected with the quality indicators (average time for connecting new electricity service for customer, number of customer complaints). Moreover, the performance of this process is connected with the financial indicators, this is because the financial indicators significantly depend on the technical loss (technical loss leads to financial loss) which is related to technical reasons during the installation of the new electricity service for customers.

Improving the process of connecting a new electricity service in distribution companies will highly affect the company's performance to provide electricity to their customers in the right way, at the right time. In addition, improving this process will indirectly affect the electricity price, and this will affect the customer satisfaction.

Electricity purchases by JDECO amounted to $ 280 million, on average for the last three years, and these purchases constitute 38% of the total imported electricity from Israel Electrical Corporation (IEC) (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

By referring to the Performance Indicators Report for electricity distribution companies for year 2018, it was founded that with regard to the quality performance indicators of electricity service provided to consumers, JDECO has the highest average time for connecting new electricity service to their customers, and the highest percentage of customer complaints (45%) when it is compared to the other distribution companies. Besides, with regard to the financial performance indicators,

JDECO has the highest percentage of technical loss (22%) with the highest percentage of technical loss costs (66%) when it is compared to the other distribution companies (Palestinian Electricity Regulatory Council (PERC), Performance Indicators Report for electricity distribution companies, 2018).

Based on the above, this research aims to apply LSS to improve the process of connecting a new electricity service within JDECO – Ramallah branch. This is done by analyzing the root causes that affect the process performance, and to analyze the sources of process variation in order to improve the process effectiveness and efficiency.

This research contributes to improve JDECO processes performance, and it enhances JDECO technical and economical levels. In addition, to increase customer satisfaction and to improve the company's image. On the other hand, this research presents learnt lessons whereas LSS can be implemented within other Palestinian electricity distribution companies to improve their processes performance, so it contributes to enhancing the performance of the whole Palestinian electric power sector. The research leads to a knowledge contribution through applying LSS within the electric power sector in Palestine.

The implementation of LSS would provide knowledge about the electrical distribution companies' performance and their behavior in the Palestinian electric power sector. This in turn would create opportunities for improvement within the process of connecting a new electricity service, so it would cover the gap of implementing the LSS within the electrical distribution companies in Palestine, where there has been hardly any study on the usage of LSS in the power sector (Sony, 2019).

1.5 Research Question

The research has the following formulated question:

How can the implementation of LSS improve the process of connecting a new electricity service in JDECO?

1.6 Research Objectives

The main objectives for this research can be summarized as follows:

1. Applying Lean Six Sigma to improve the process of connecting a new electricity service.
2. Reduce the non-value-added steps in the process of connecting a new electricity service.
3. Reduce the time of connecting a new electricity service for customers.
4. Reduce the number of customer complaints associated with connecting new electricity service.
5. Increase customer satisfaction.

1.7 Research Limitations

The limitations of this research are as follow:

1. The research is limited to electricity distribution sector, where as both generation and transmission sectors are excluded. Moreover, the research has been implemented only within one Palestinian electricity distribution company which is JDECO. In addition, it is implemented within one branch of JDECO which is Ramallah branch.
2. The research has been carried out during the period of January 2019 to December 2020, therefore the results don’t apply to other periods.

3. There were difficulties in collecting data needed for the research. This was because the employees were busy and always have a work load, in addition to COVID-19 pandemic, as they were quarantined from Corona. These affected the collecting data process and there was a delay to obtain the needed data.

1.8 Thesis Structure

The thesis divided into eight chapters as follows:

Chapter One presents an introduction and overview of the study. Chapter Two presents a comprehensive literature review about LSS methodology and the Palestinian power sector, in addition to related issues. Chapter Three addresses the research methodology that has been followed in the thesis. Chapter Four provides the work that has been carried out to implement the steps in the Define phase of the DMAIC approach. Chapter Five provides the work that has been carried out to implement the steps in the Measure phase of the DMAIC approach. Chapter Six provides the work that has been carried out to implement the steps in the Analyze phase of the DMAIC approach. Chapter Seven provides the Improve and Control phases in the DMAIC and discussion of results. Chapter Eight presents conclusions, recommendations, and future work.

Chapter Two

Literature Review

2. Literature Review

2.1 Overview

This chapter presents various previous articles that had explored the concepts of Six Sigma, Lean management, and LSS methodology. Moreover, this chapter addresses the implementation of LSS in service sector and implementation of LSS in power sector for both electricity generation and distribution. In addition, the literature review presents the Palestinian electric power sector.

2.2 Introduction to Six Sigma

Six Sigma was developed at Motorola through Bill Smith efforts in 1980 **(**Pepper and Spedding, 2010). Abbott et al. (2006) explained that six sigma is a systematic method for process improvement and product and service development that relies on statistical methods to reduce defects rates. However, Frings and Grant (2005) stated that Six Sigma methodology implementation emphasizes the importance of reducing process cycle time and improving customer satisfaction in determining optimal levels and costs of service quality. Magnusson et al. (2003) defined six sigma as a business process that enables companies to improve their bottom line by designing and monitoring business activities in a way that minimizes wastes and resources and increases customer satisfaction. While, Maleyeff and Campus (2007) defined six sigma a statistical measurement of variation that is achieved when each potential defect would have a chance of occurrence, expressed as 3.4 defects per million opportunities. In addition, Montgomery and Woodall (2008) added that six sigma focuses on reducing variability in product quality characteristics around specific target values to the level that defects are unlikely.

According to Setijono, (2009), a significant metric of Six Sigma focuses on defects per million opportunities (DPMO) defined as follows:

DPMO = DPU X 1,000,000/opportunities for error.

Where DPU are the defects per unit.

Six Sigma represents a quality level of 3.4 defects per million opportunities; it is defined in the context of a manufacturing specification, where Six Sigma represents six standard deviations from the process mean to the specification limits, when the process is centered

2.3 Introduction to Lean

Wilson (2010) explained that lean is a long-term philosophy that generates a value for the customer, society, and the economy with the objectives of reducing costs, improving delivery times, and improving quality through the elimination of waste. However, Womack et al. (1990) stated that lean production approach pioneered by Toyota but also the subject of the Machine that changed the World. While, NIST (2000) defined lean a systematic approach that is used to identify and eliminate waste through continuous improvement. Besides, Womack and Jones (1996) stated that lean thinking helped us to understand the principles of lean: the identification of value, the elimination of waste, and the generation of flow (that adds value to the customer). Key tools and techniques within the lean system, include: Value Stream Mapping (VSM), Kanban, 5S, Poke Yoke, SMED (single minute exchange of dies) (Melton, 2005). Lean manufacturing initiatives, which are also known as the Toyota production system (TPS), were originated by Ohno and Shingo at Toyota, these initiatives were applied to remove wastes inside the organization and were oriented fundamentally to productivity improvement rather than quality (Shingo, 1989). On the other hand, NIST (2003) argued that implementing lean techniques in the organization leads to

cutting costs, reducing non-value-added steps, increasing inventory turns, reducing cycle time, and improving customer satisfaction.

2.4 Introduction to Lean Six Sigma

Pepper and Spedding (2010) explained that the integration of lean and six sigma is important to create improvement within the organization. The two concepts lean and six sigma leads for the same aims through creating improvement, minimizing wastes and resources, in addition to increasing customer satisfaction and improving financial results (Dahlgaard-Park et al., 2006). Wheat et al. (2003) emphasized that Lean eliminates waste and establishes a standard, while Bendell (2005) clarified that six sigma focuses on identifying and reducing variation from the proposed standard. Waste is defined as any activity that increases cost without adding any value (Cudney et al., 2014). There are differences between six sigma and lean such that six sigma looks at variation reduction, it relies on statistical process control (SPC), but lean thinking focuses on waste elimination and cost reduction, also lean talks about standardizing the process (Sony, 2019). Lean six sigma methodologies has been applied in different sectors like services, manufacturing, healthcare, education, etc, (Antony et al., 2016). Antony, Rodgers and Cudney (2017) emphasized that applying LSS increased process performance and capability, improved customer satisfaction, increased savings.

2.5 Lean Six Sigma in Service Sector

According to Shamsuzzaman et al. (2018) a study has been conducted by implementing LSS methodology on a telecom company to minimize the company's response time to customer requirements in order to increase customer satisfaction. The study applied the DMAIC approach. Both qualitative and quantitative research methods were used. The results showed that the average lead time for fulfilment of sales orders and value-added service orders was reduced from 10.3 to

5.9 days and from 1.5 to 0.5 days, respectively. In addition, the sigma level increased for sales orders and value-added service orders from 0.44 to 1.26 and from 0.37 to 2.66, respectively. On the other hand, implementing LSS methodology resulted in 600,000 $ per year as a financial savings in operational costs.

According to Laureani, Antony, and Douglas (2010), the study illustrated the application of LSS methodology in a Call Centre of a service industry corporation, this was done by applying DMAIC approach. The study aimed to increase first-call resolution ratio. The study resulted in reducing the percentage of unresolved first-time calls from 11.82% to 8.45%.

Nabhani and Shokri (2009) studied the implementation of LSS in food service by adopting DMAIC methodology, statistical tools were applied as approach to reduce wastes in this service. The study resulted in improving layout utilization, and this leads to reducing the number of causes of defects by 40%, and improving the sigma level from 1.44 to 2.09.

Kaushik and Khanduja (2009) explored the success of deploying the LSS methodology in Indian healthcare sector. The study carried out the DMAIC - Lean methodology to improve the registration process in the health information department in a hospital in India. The results showed that the process cycle time was reduced from 3 to 1.5 minutes, and 94% reduction in patient's average waiting time, in addition to 91% reduction in queue length, and 48% reduction in the scheduled utilization of the staff.

Al-Aomar et al. (2016) conducted a study on a company that provides services and goods supporting aviation equipment in Abu Dhabi, UAE, the study applied LSS methodology. The problem was that the company has experienced unexpected increase in downtime in its process. The study aimed to implement LSS to reduce the downtime in the process of providing services

and goods supporting aviation equipment. The current process capability was low, with average of 2.52 and with sigma level less than 3, it was founded that the operating shift and the years of experience are the two factors that have a significant impact on the process downtime. After applying the DMAIC tools: process mapping, Pareto chart, fishbone diagram, ANOVA, design of experiment DOE, the project team recommended that the night shift staff with high experience should be mixed with the evening shift staff who has a low experience. The result of improvement showed that the sigma level increased for more than 3, and the downtime has been reduced, so that the process capability increased and customer's complaints reduced.

2.6 Applications of Lean Six Sigma in the Electric Power Generation Sector

According to an Indian study conducted by Singh and Bakshi (2014), the researchers studied optimizing backup power systems (diesel genset) in an educational institute through applying Six Sigma, the study aimed to improve the process of power generation by optimizing genset's critical parameters. The problem was formulated so that the diesel consumption in liter on monthly basis was high, so the running cost in generation process was high and it must be reduced, in addition the mileage (unit produced (KWH) per liter) was low and it must be improved. The study adopted the DMAIC approach to investigate the factors that affect the mileage, this was done by applying DMAIC tools: histogram, fish-bone diagram, ANOVA analysis, Design of Experiment. The researchers deduced three parameters that affect the mileage which were: coolant temperature, oil pressure, and the load. A monitoring plan was designed and implemented with applying optimal solutions resulted in improving the mentioned three parameters. The results showed that the mileage has been improved from 2.17 to 3.72 KWH per liter, in addition, the study resulted in savings of 6924-liter diesel per year, and Rs 272,960 per year.

Sony (2019)'s study applied the LSS methodology in a thermal power plant in India. The main objective of the study was to reduce the demineralized water consumption and reduce variation, where the demineralized water is considered one of the most expensive input raw materials in the thermal power plant. The current demineralized water consumption was 68,400 m3 per month, with a standard deviation of 15,732. In addition, a reduction of 0.1% of demineralized water consumption reduces the generation cost by 90 lakhs annually. The DMAIC statistical tools were applied during the five phases, and this resulted in demineralized water consumption reduction to 62,635 m3 per month (8.4% reduction), and the standard deviation was reduced to 13,643 (13% reduction), besides, the total generation cost was reduced due to the reduction in demineralized water consumption.

2.7 Applications of Lean Six Sigma in the Electric Power Distribution Sector

Sony (2019) conducted a study in an Indian electricity distribution company, the study included three case studies related to the electricity distribution sector. The first case study aimed to reduce the time taken for issuing a new electricity connection process. It was decided to improve the process of issuing a new electricity connection because of customer dissatisfaction, and media was highlighting the issue of long waiting time for the new customers, besides, the company image was coming down. LSS methodology was implemented by applying its successful tools: project charter, SIPOC, CTQ, process mapping, histogram, Pareto analysis, seven waste analysis, fish bone diagram, 5 why's, brain storming, standard operating procedure, control charts. The study showed that the waiting time of a new electricity connection process was reduced from 24 to 11.28 hour (53% reduction), and the standard deviation was reduced from 12 to 6.14 (48% reduction). In addition, reduction in the waiting time resulted in increasing customer satisfaction. Besides, standardization of the process resulted in increasing employee morale.

Sony (2019) focused in the second case study on customer complaint in electricity service center in an Indian electricity distribution company. Customers reported their complaints due to various faults related to electricity distribution. It was noted that when the number of faults increased, customers were dissatisfied. Data was collected, and the faults were classified into six categories from A to F, the DMAIC – Lean tools were applied to analyze the root causes for each fault. The study revealed that as a result of improvement type A faults were reduced by 21%, type B faults were reduced by 16%, type C faults were reduced by 18%, type D faults reduced by 32%, type E faults were reduced by 33%, and type F faults were reduced by 33%. Reducing number of faults resulted in increasing customer satisfaction and reducing the corrective maintenance time.

Sony (2019) investigated in the third case study, through applying LSS methodology, the reduction of electricity losses in an Indian electricity distribution company. The management observed that the average technical and commercial losses were high, with mean around 35%, and standard deviation of 12%. the study aimed to reduce technical and commercial losses. The specialist team used the DMAIC tools: project charter, SIPOC, CTQ, process mapping, histogram, Pareto analysis, seven waste analysis, fish bone diagram, 5 why's, brain storming, standard operating procedure, control charts. It was founded that implementing DMAIC -lean tools was effective, so that it resulted in reducing technical and commercial losses to 23% per month and reducing the standard deviation to 8.4%. The reduction in technical and commercial losses lead to increase the revenue to the company.

According to Asyraf (2014), a study has been implemented in Faculty of Computer and Mathematical Sciences in Malaysia. It was observed that there has been a high electrical energy consumption. So, the study aimed to evaluate the electrical energy consumption in the Faculty, and to seek the factors that lead to high electrical energy consumption. DMAIC approach with its

tools have been adopted to conduct this study. Measuring the current total electrical energy consumption showed that in 2011 it was 1, 648,791 KWH, and 1, 657,808 KWH in 2012, which was increased 0.5% (9017 KWH). Pareto analysis showed that air conditioning is the main factor that leads to high consumption of electricity (57%), followed by lighting (22%), sockets (16%), and others (5%). The improvement has resulted in 2% reduction in electrical consumption.

Mkhaimer et al. (2017) developed LSS energy management model (LSS_EnMg) in a pharmaceutical company in Jordan, this model based on international organization for standardization ISO 50001 (Energy Management System) supported by DMAIC-Lean methodology. The study aimed to create a successful energy management system that detects opportunities with minimum investments. The LSS_EnMg model defines requirements, analyzes energy data, and applies a systematic approach to determine the energy opportunities to create system improvements. The results revealed that applying the model of integrating DMAIC- lean approach with ISO 50001 resulted in creating effective Energy Management System.

2.8 Palestinian Electric Power Sector

This section presents an overview of Palestinian electric power sector, its current performance, challenges, barriers for improvements, and opportunities.

2.8.1 Overview of Palestinian electric power sector

Due to the high growth of population, high standards in living, rapid growth in both industrial and service sectors, an increase in energy demand in Palestine in continuing (Juaidi et al., 2016). The main objective of the power sector is to meet the electricity needs of customers, there is a basic need for low cost and uninterrupted power (Sony, 2019).

The General Electricity Law no. (13) for year 2009 constitutes the legal and administrative framework under which all components of the Palestinian energy sector operate, and they are as follows: Palestinian Energy and Natural Resources Authority (PENRA), Palestinian Electricity Regulatory Council (PERC), Palestinian Electricity Transmission Ltd. (PETL), and Palestinian Electricity Distribution Companies. Palestinian Energy and Natural Resources Authority (PENRA) plays the role of regulator of electric sector in zones under their control (Areas A and B), Palestinian Electricity Regulatory Council (PERC) is working as a supervisory authority to protect customers, prevent monopoly, encourage competition, recommend tariffs and licenses. Palestinian Electricity Transmission Ltd. (PETL) has the responsibility of building and operating the electric transmission system to transmit electricity from Israel Electrical Corporation (IEC) to the Palestinian Electricity Distribution Companies networks (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

Palestinian electric power sector has three main resources of energy: conventional energy, renewable energy, and energy generated by petroleum and natural gas derivatives (Palestinian Energy and Natural Resources Authority (PENRA), Annual Report 2018).

Electricity in Palestine has been distributed to customers by six distribution companies, five companies are located in the West Bank, and one company is located in Gaza Strip, the companies are as follows: Jerusalem District Electricity Company (JDECO), North Electricity Distribution Company (NEDCO), Hebron Electricity Company (HEPCO), South Electricity Company (SELCO), Tubas Electricity Distribution Company (TEDCO), and Gaza Electricity Company (Palestinian Electricity Regulatory Council (PERC), Annual Report 2018).

In the year of 2018, number of customers for each distribution company has reached as follows: JDECO 291,313, NEDCO 105,087, HEPCO 53,409, SELCO 33,219, TEDCO 19,282 (Palestinian Electricity Regulatory Council (PERC), Annual Report 2018).

The Palestinian electric power sector depends on importing electricity from Israel Electrical Corporation (IEC); 98% of electricity has been imported from Israel Electrical Corporation (IEC) and 2% of electricity has been imported from Jordan. Electricity with total amount of 6,840,379 MWh in the year of 2019 has been distributed in 5,062,115 MWh for West Bank, and 1,095,255 MWh for Gaza strip. Electricity has been transmitted from Israel Electrical Corporation (IEC) to the distribution companies by Palestinian Electricity Transmission Ltd. (PETL). Then the distribution companies provide electricity to their customers through their electric networks. Customers in Palestinian electric power sector are categorized as residential, commercial and services, industrial, and agricultural (Palestinian Energy and Natural Resources Authority (PENRA), Annual Report 2019).

The total cost of imported energy has been estimated in the year 2019 with $ 2.6 billion, $ 1.7 billion costs of petroleum and natural gas, and $ 900 million costs of electricity. This bill is equivalent to 18% from Gross Domestic Product (GDP) (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

All electrical networks in Palestine are considered distribution networks (Ibrik and Mahmoud, 2002). Electricity has been provided from Israel Electrical Corporation (IEC) to West Bank by 270 connecting point within medium and low voltage range, while electricity has been provided from IEC to Gaza strip by 10 connecting points (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

The average electric power consumption per habitant in Palestine is 1148.7 Kwatt in the year 2018. Residential consumption forms 60% from the total electricity consumption in 2018, while 26% for both commercial and service sectors, in addition to 12% only for industrial sector (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

2.8.2 Performance of the Palestinian Electric Power Sector

The Palestinian Electricity Regulatory Council (PERC) adopts key performance indicators that measure the performance of the electricity distribution companies toward the electricity service which is provided to the customers. The key performance indicators are as follows: customers' performance, continuity of electricity (power interruption) indicators, the quality indicators of electricity service provided to consumers, financial indicators, technical indicators, work staff indicators (Palestinian Electricity Regulatory Council (PERC), Performance Indicators Report for electricity distribution companies, 2018).

According to the Performance Indicators Report for electricity distribution companies (2018), the Tables 2-1 to 2-4, and Figures 2-1 and 2-2 present the performance of electricity distribution companies.

Table 2-1: Sales, purchases, and annual growth (GWh).

Indicator	Year	JDECO	NEBCO	TEBCO	HEPCO	SELCO	Total
Total sales	2018	1,776	532	113	369	148	2,937
	2017	1,778	510	106	360	138	2,893
Annual growth 2017-2018		0%	4%	7%	3%	7%	2%
Total Purchases	2018	2,334	650	137	466	188	3,775
	2017	2,299	631	134	468	200	3,732
Annual growth 2017-2018		2%	3%	2%	0%	-6%	1%

Table 2-2: Continuity of electricity (power interruption) indicators.

Indicator	Unit	Year	JDECO	NEBCO	TEBCO	HEPCO	SELCO
Power interruption frequency indicator in the system	Number	2018	6	13	9	3	11
		2017	5	11	29	9	8
		2016	7	9	20	9	6
Average power interruption (at one time) indicator per consumer	Minute	2018	48	52	72	36	97
		2017	53	76	27	56	103
		2016	61	84	51	61	172

Table 2-3: The quality indicators of electricity service provided to consumers.

Indicator	Unit	Year	JDECO	NEBCO	TEBCO	HEPCO	SELCO
Average time for connecting a new electricity service for customer	Day	2018	27	21	16	17	21
		2017	40	21	8	18	9
		2016	49	20	3	15	7
Number of complaints per 1000 customer	Number	2018	1	2	5	4	3
		2017	2	3	5	3	1
		2016	2	4	2	12	2

Table 2-4: Financial indicators related to the percentage of technical losses, and the financial losses resulted from technical losses.

Indicator	Unit	Year	JDECO	NEBCO	TEBCO	HEPCO	SELCO
Technical losses	%	2018	23%	18%	18%	21%	21%
		2017	23%	19%	21%	23%	31%
		20016	24%	18%	21%	19%	32%
financial losses resulted from technical losses	Million Shekel	2018	237	52	11	43	18
		2017	230	53	13	47	27
		2016	217	45	11	34	24

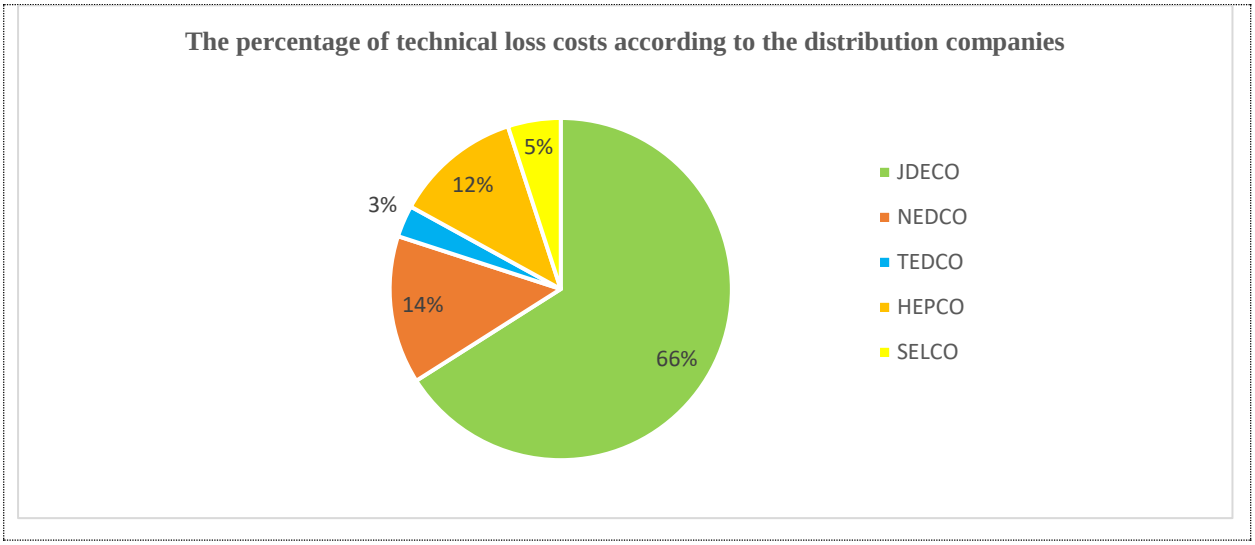

Figure 2-1: The percentage of technical loss costs according to the distribution companies.

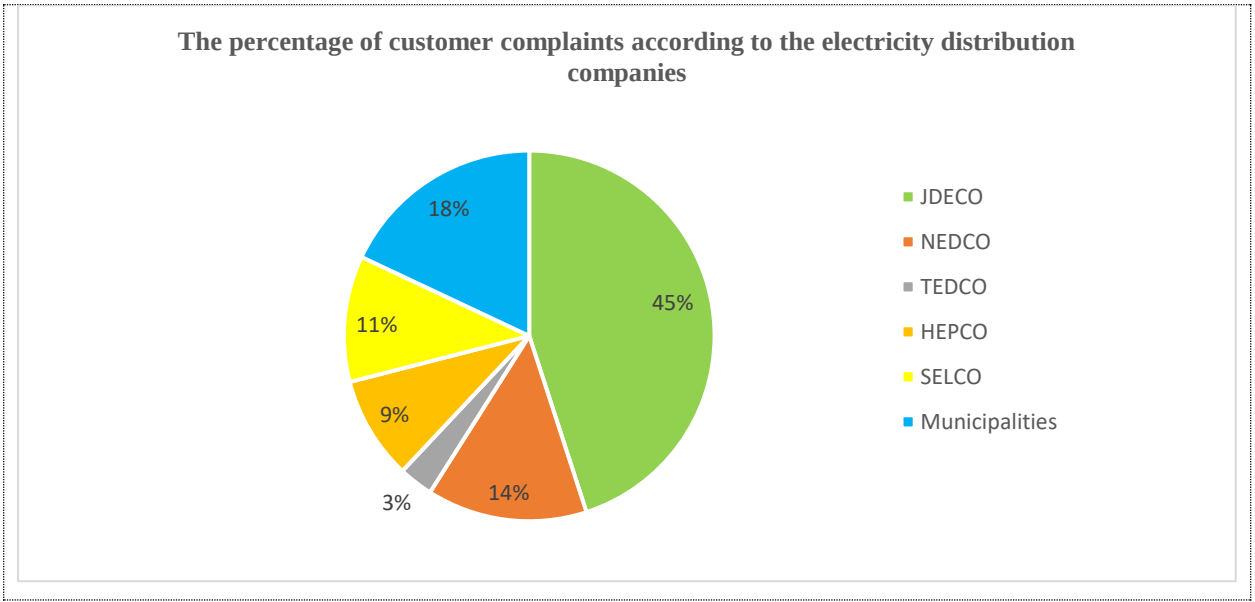

Figure 2-2: The Percentage of customer complaints according to the electricity distribution companies.

The highest percentages of customer's complaints in year 2018 have referred to the new electricity service fees (36%), electricity tariff (22%), lack of electricity (8%) (Palestinian Electricity Regulatory Council (PERC), Performance Indicators Report for electricity distribution companies, 2018).

2.8.3 Problems, Challenges, and Opportunities of the Palestinian Electric Power Sector

Palestinian electric power sector has a big challenge which is the incapability to secure sufficient energy to meet the needs of electricity with the population growth. The major problems that are facing the Palestinian electric power sector are as follows: shortage in supply of energy (especially in electricity and petroleum products), and shortage in natural resources. In addition, the lack of an institutional infrastructure for electricity generation and transmission. Moreover, due to the political situation, the Palestinians totally depend on Israel for their energy needs, the dependence on electricity imports from Israel has increased the costs paid by Palestinians, energy prices in Palestine are high not only due to reliance on monopoly supplier but also because of the high electric losses in electric transmission lines and electric distribution networks. Besides, Palestine faces continuing growth in electricity demands. Moreover, the future generation of electricity will rely upon increasingly expensive fossil fuels. So, the previous mentioned factors create strong economic and environmental incentives and opportunities to invest in renewable energy sources and also to undertake energy efficiency and conservation measures in sectors with high energy consumption (Ibrik, 2009).

The main electricity problems in Palestine are classified as: electrical current weakness (28%) electrical current disconnection (26%), old electricity network (24%), non- served areas (17%), and others (5%) (Juaidi et al., 2016).

Electricity in Palestine is unique when it is compared to other countries in the Middle East. The consumption of electricity for Palestine was equal to 0.79 MW h/inhabitant in year 2011, this data has been compared with neighboring countries in year 2011: United Arab Emirates 9.39, Qatar 15.75, Kuwait 16.12, Bahrain 10.02, Israel 6.93, Oman 6.29, Lebanon 3.50, Jordan 2.29. It is

concluded that Palestine has the lowest value of electricity consumption per inhabitant (Juaidi et al., 2016). In addition, the electricity consumption for Palestine was equal to 950 Kw/inhabitant in year 2013, while the electricity consumption for Jordan in 2013 was 1854 Kw/inhabitant, and in Israel 6710 Kw/inhabitant (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

In addition, one of the major problems, that is facing the electric sector, is the increase in technical loss of electricity within the distribution networks, the yearly technical loss reaches 22% with value of $ 168 million yearly from the total imported electricity, this leads to increase in electricity cost (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

High costs of electricity in Palestine are a major problem, this refers to two main reasons: the first reason refers to that Israel impose non-competitive energy prices and tariff on the Palestinian Authority (World Bank Sustainable Development Department: Middle East and North Africa 2007). The second reason refers to the increase in technical loss in the electric distribution networks, the technical loss in distribution networks leads to financial loss within distribution companies, as a result of this, electricity prices for customers will increase. Electricity tariff has been determined by the Cabinet decision No. (17/68/24) for the year 2015, the prices ranged between 0.44 – 0.66 Shekel/Kwatt, the price depends on the quantity of consumed electricity (Number of Kwatts), the Cabinet in their decision determined five categories of electricity consumption started from 0-160 Kwatt and until 600 Kwatt and more, and this tariff is considered the highest in comparison with the neighboring countries Jordan and Egypt (Palestine Economic Policy Research Institute (MAS), Disengage from the Israeli Economy, 2020).

Palestinian electric power sector has great opportunities to increase the share of locally produced energy from renewable energy within the current basket of purchases. On the other hand, the lack of electricity is an incentive for increasing investments related to the construction of electric power plants. (Palestinian Electricity Regulatory Council (PERC), Annual Report 2018).

Due to the problems, challenges, and barriers that are facing the electric power sector, Palestinian electricity distribution companies must work hard to enhance their performance, and improve their processes of providing electricity to their customers in order to meet customer needs of electricity with the sufficient quantity and high quality of electricity service.

2.9 Chapter Summary

This chapter of literature review presented the Lean and Six Sigma concepts, in addition to presenting the LSS implementation in service sector and in power sector (generation and distribution of electricity). Moreover, this chapter addressed the Palestinian power sector performance, challenges, and opportunities. The literature review revealed that there is a gap of implementing the LSS methodology in the Palestinian electricity distribution companies, where there are no researches of the application of LSS within the electricity distribution companies in the Palestinian electric power sector.

Chapter Three

Research Methodology

3. Research Methodology

3.1 Introduction

Research methodology refers to the way to solve the problem systematically, whereas the research method refers to all those techniques and tools used to conduct the research (Kothari, 2004). LSS methodology identifies effective tools to solve the problems in order to improve the performance, efficiency, and effectiveness of the process. In the previous chapter of literature review LSS methodology was applied in service sector and in power sector to solve problems, and it was an effective and successful methodology to achieve the researches goals.

This research aims to apply LSS methodology in the process of connecting a new electricity service at JDECO, where this methodology utilizes effective tools to solve the problems and to understand the causes of the delay in the process.

3.2 Research strategy

This research is considered exploratory research where the causes that are causing the problem were not clear. Therefore, a mixed research methodology has been applied, quantitative and qualitative to achieve the research objectives and to answer the formulated research question.

The research has followed the Action Research Method. The Action Research Method provides scientific approach to study the resolution of organizational issues with those who experience these issues directly, it is considered a participative method. Besides, this method works through a cyclical four- step process: planning, taking action, evaluating the action, and leading to further

planning. Moreover, the action research method is both a sequence of events and an approach to problem solving (Coughlan and Coghlan, 2002).

In addition, the DMAIC methodology and interviews were used to collect the sufficient information and data to identify the problems that JDECO has facing which lead to the delays in the process.

3.3 Research Focus – Connecting a New Electricity Service Process at JDECO

Implementing LSS methodology at Jerusalem District Electricity Company (JDECO) can improve the quality of services that are provided and increase the efficiency of the processes. Moreover, applying LSS can improve the procedures and policies in the company. Therefore, LSS methodology has been chosen to improve the process steps of providing a new electricity service to customers. This led to use the DMAIC tools to reduce the time wasted for customers, and to eliminate the non-value-added steps in the process.

3.4 DMAIC Approach (Objectives and Tools)

LSS methodology has been implemented, a well-known approach of LSS has been applied which is DMAIC (Define-Measure-Analyze-Improve-Control) approach, The DMAIC method in Six Sigma is often described as an approach for problem solving (De Mast et al., 2012). Nilakantasrinivasan et al. (2005) mentioned that the true value of DMAIC can be realized only when it is used to identify root causes of the problems and derive solutions to overcome the root causes. Statistical analytical tools within DMAIC phases are applied to analyze the root causes that affect the performance of the process of connecting a new electricity service, and to analyze the sources of process variation.

The DMAIC approach utilizes LSS tools through which the problem is defined, measured, analyzed, improved, and controlled, and through which the research question has been answered. It has been confirmed that simple tools could be applied in service small, medium enterprises (SMEs) and there is no limitation for using these tools for any specific stage of DMAIC (Antony, 2006). In *define* phase, the problem was defined, the goals of the research were determined, customer needs and expectations were defined, the project boundaries were determined to reflect process begin and end, and the process to be improved. In *measure* phase, the current process performance was measured, a plan of collecting data was developed, and the data were collected, in addition, process variation and defects types were identified. In *analyze* phase, the problem converted into statistical problems so that root causes of defects and sources of variation were identified, prioritized and analyzed, the current performance and goal performance were compared to identify the gap, moreover, the opportunities for improvements were prioritized. In *improve* phase, developing and implementing a plan for process improvement by designing and developing optimal solutions that prevent problems, the selected solutions were tested. In *control* phase, monitoring plan was developed, documented, well communicated, and implemented to control the improved process and the future process performance.

DMAIC methodology offers successful tools to solve the problem and improve process quality, the tools that have been applied in the research are as follows:

- In define phase: problem context diagram, project charter, SIPOC.
- In measure phase: Process flow chart, eight waste analysis, quick wins, value stream mapping (VSM), control chart, VOC.
- In analyze phase: Cause and effect diagram (Fishbone Diagram).

- In improve phase: brain storming, solutions prioritizing for improvement, flow chart, value stream mapping (VSM), control chart.,
- In control phase: Out of Control Action Plan (OCAP).

3.5 Research Area

The research has been implemented at Jerusalem District Electricity Company (JDECO) at Ramallah branch. Ramallah branch has been chosen because the statistical data that were taken from JDECO's headquarters revealed that Ramallah branch has 46% of total JDECO customers, in addition, it has 47% of new installed electrical services related to this branch in 2019, and it has 43% of new installed electrical services until August 2020. Besides, Ramallah branch has 53% of new electrical service applications until 31/8/2020 from the total applications on the level of JDECO branches.

The research has investigated the process of connecting a new electricity service from its first step which is receiving applications from customers to the final step which is installing the service to provide electricity to the customers.

3.6 Data Collection

In this research, many sources and methods were used to collect the data needed to conduct the research.

3.6.1 Interviews

The qualitative data have been obtained through conducting several interviews. The interviews with determined questions have been conducted with top managers, engineers, and technicians in JDECO.

The objectives of the interviews were as follows: to understand the problems and the obstacles that are facing JDECO in the completion of its work. Also, to obtain clear understanding about the nature of customer complaints. In addition to understand the work flow to create flow chart of the process. Moreover, to create the problem context diagram (PCD) and supplier, input, process, output, customer (SIPOC).

Interviews have been conducted with the managers and selected employees from the targeted departments (Four departments in JDECO are responsible for implementing the process of providing electricity to the customers): quality management department, customers services department, financial department, technical department (services division, estimation division, installation division, survey division, networks division).

The interviews have been conducted with eleven persons as follow:

1- Quality management department manager and two engineers from the same department.
2- Customer services department manager.
3- Technical department manager.
4- Engineer from networks division.
5- Technician from survey division.
6- Technician from estimation division.
7- Technician from services division.
8- Employee from financial department.
9- Technician from installation division.

A list of questions that has been asked for each manager and each selected employee were as follows:

1- What is going well for you in the work?

2- What problems do you face on daily basis?

3- What is the biggest problem that you failed to solve?

4- Which process would you choose to be improved?

5- What are the steps of connecting a new electricity service process?

6- What is your role in the process?

7- What do you think about the current time that the process takes to be accomplished?

8- What is your suggestion regarding the suitable time that the process needs to be accomplished?

9- What is the nature of customer complaints?

10- What are the factors that impact process performance?

11- What are the obstacles that are facing the employees to complete the process?

The previous questions for the interviews were set based on a brain storming.

3.6.2 Records from the Billing System in JDECO

JDECO has a working system which is called “Billing system”, this system tracks the process steps status and the dates of performing the steps from the first step which is inserting the application to the final step which is the installation of the new electricity service. The Billing system records the start and end dates for each step of the process for each inserted application.

Thirty applications were chosen randomly from the beginning of year 2019 to the end of February 2020. For each application, the start date and end date for each step of the process were recorded to be analyzed.

3.6.3 Customer Complaints System

Data were obtained from the customer complaints system during the period from the beginning of 2019 until September 2020, to understand the Voice of Customer (VOC), and to identify their needs.

3.7 Data Analysis

The Minitab software program was used to analyze the data which were obtained from the Billing system. In addition, the Microsoft Excel program was used to analyze the data which were obtained from the customer complaints system.

3.8 Chapter Summary

This chapter addressed the LSS methodology that has been followed to conduct the research. Furthermore, this chapter highlights the DMAIC approach and its tools which were used to understand the process steps and to identify the problems facing JDECO in their works. In addition, summarizes the data collection sources and methods that have been followed to gather data and information.

Chapter Four

Define Phase

4. Define Phase

4.1 Introduction

In this research the DMAIC approach has been applied to improve a major service which is connecting a new electricity service that JDECO delivers to their customers. Customers of this service are the citizens of Ramallah and Al-Bireh Governorate.

The define phase is the first phase in the DMAIC approach, the objective of this phase is to define the problem, define the scope, the purpose, and the goals of the project, in addition to the definition of the project boundaries that where the process begins and ends, the benefits of the project, the key players, risks and barriers, and support estimate. In this phase the improvement team was formed.

The process of connecting a new electricity service has several steps: First, the applicant goes to Customer Service Department (fund division) to deliver the needed documents, then the application is registered on the system and it is given a number. After that the documents are sent manually to cards and contracts division in Customer Services department to be reviewed and archived. Second, the documents are sent manually to the estimation division in the technical services department, equipment estimation step is then conducted by scheduling a site visit to the facility in order to estimate the required equipment for the new electricity service, then the estimation division prepares equipment order. Third, a technical decision (technical approval) is issued by the estimation division engineer then by the technical department manager. Fourth, the equipment order is sent manually to the financial department, the financial claim is then prepared

and the fees of the new service are calculated, then a financial approval is issued by the financial department manager, after that the financial department informs the customer by message on his/her mobile to attend to the company to pay the service fees and signs the supply contract with JDECO. Fifth, the financial department returns the approved equipment order to the technical services department, then the technical services department orders the equipment from JDECO warehouses by sending an email. Sixth, JDECO warehouses prepare and ship the equipment to the facility site, after that the technicians in the technical services department install the equipment for the new service to the facility of JDECO's customer.

4.2 Problem Definition

After conducting intense interviews with the technical manager of the technical services department and with five employees from the same department, in addition to interviews with the manager of quality management department and two engineers from this department, and interviews with the manager of customers services department and with the manager of financial department, all of them emphasized that the priority of improvement must be to the major process which is connecting a new electricity service. They mentioned many problems in this process including: there is a large number of applications under processing, always there is a lack of equipment needed for installing the new electricity service, in addition to the insufficient resources (employees, transportation) to perform this process, the routes of application documents between departments are manual (high paperwork), not all the process procedures are documented, in addition to the lack of system to convert the documents between the departments. Based on the above this creates challenges to measure the performance of each step in the process, moreover the process takes long cycle time to be performed.

The tools that have been used in the define phase were: Problem Context Diagram (PCD), Project Charter, SIPOC.

4.3 The Problem Context Diagram (PCD)

The PCD is a diagram that defines the boundary between the system, and its environment, showing the entities that interact with it. This diagram is a high-level view of a system (Sarmah, & Kakoty, 2017).

After conducting the interviews, the project team has created the PCD which is shown in Figure 4-1, the PCD illustrates the upstream and downstream process steps, also it illustrates the process step where the problem is first seen.

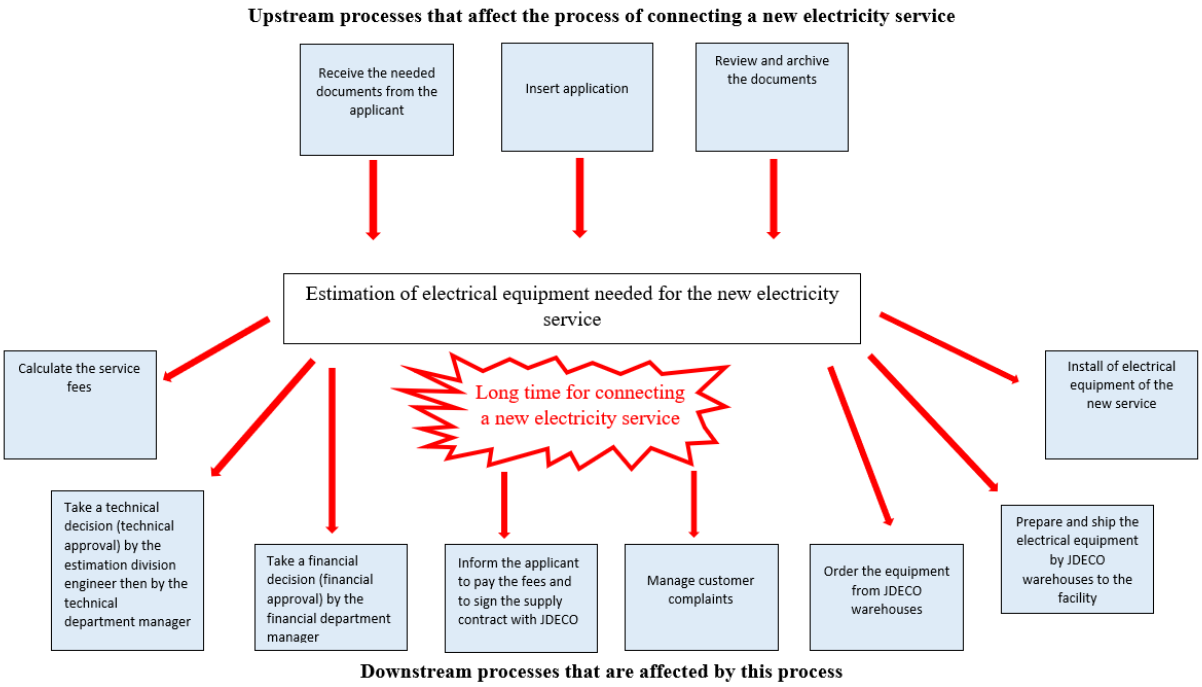

Figure 4-1: Problem Context Diagram (PCD) for connecting a new electricity service process.

Figure 4-1: Problem Context Diagram (PCD) for connecting a new electricity service process.

By using the PCD tool, the project team was able to determine the upstream steps that contribute in the process of connecting a new electricity service, these steps are as follows:

- Receiving the needed documents from the applicant.
- Inserting application.
- Reviewing and archiving the documents.
- Estimation of electrical equipment needed for the new electricity service.

Furthermore, the PCD tool identified the downstream steps that are affected by the process of connecting a new electricity service, the steps are as follows:

- Taking a technical decision (technical approval) by the estimation division engineer then by the technical services department manager.

- Calculating the service fees.
- Taking a financial decision (financial approval) by the financial department manager.
- Inform the applicant to pay the fees and to sign the supply contract with JDECO.
- Managing customer complaints.
- Ordering the equipment from JDECO warehouses.
- Preparing and shipping the electrical equipment by JDECO warehouses to the facility.
- Installing of electrical equipment of the new service.

Moreover, the project team has determined the departments that are responsible about the process performing, the departments are:

- Customers services department.
- Technical services department.
- Financial department.
- Quality management department.

Finally, the project team has been formed of the following persons:

- Reem Barghouthi: The Project Leader.
- Tha'er Jaradat: Manager of Technical Services Department.
- Suhad Ateyeh: Technical Services Department (Networks Division).
- Mohammad Etewy: Technical Services Department (Estimation Division).
- Feda' Abdalrahman: Quality management Department.
- Manal Nassar: Quality management Department.

4.4 The Project Charter

The project charter is an important tool in the define phase of DMAIC methodology. The project charter is important to the success of a project, transforming agreements and facts into a documented project management approach (Hayes, 2000).

The project charter has been developed and approved by the project team as shown in Table 4-1; it shows the following elements:

Project problem: the long cycle time it takes for connecting a new electricity service process.

Project purpose: to reduce the time of connecting a new electricity service to JDECO customers by 50%, reducing the process average time from 182 days to 91 days.

Project scope: the scope of connecting a new electricity service process in JDECO from the first step which is inserting the application to the final step which is installing the electrical equipment in the facility.

The business case: The long cycle time for connecting a new electricity service process affects negatively JDECO customer's satisfaction and their loyalty. It causes customers dissatisfaction, and bad reputation for JDECO and the employees. Moreover, the long cycle time of the process increases customer complaints, and handling with customer complaints costs the company time and money. On the other hand, the long-time of the process reduces the rate of performed processes, so that, this will result in reducing the company's performance. Improving the process of connecting a new electricity service is considered high priority because this will increase customer satisfaction, also it will contribute in improving JDECO performance and productivity, and therefore this improvement will increase the revenues for JDECO.

Table 4-1: The project charter for connecting a new electricity service process.

Project Sponsor	Tha'er Jaradat
Team Leader	Reem Barghouthi
Project Title	Improving the connecting new electricity service process at Jerusalem District Electricity Company (JDECO)
Date	
Issue	

1. Problem Definition and Purpose

What is the problem or outcome you do not like? What is the project trying to accomplish? Which process gives this output? What measure will show any improvement? What is the present performance? What is the goal performance? What is the timing for reaching this goal?

Problem Definition: the long time it takes for connecting new electricity service process.
Project Purpose: to reduce the time of connecting new electricity service to JDECO customers by 50%.

Jerusalem District Electricity Company has the process of connecting new electricity service, and there is a problem in this process that it takes long time to be performed. the process takes maximum 182 day to be accomplished. The project aims to reduce the time to 50% of the process current time, from the first step which is inserting the application to the final step which is installing the electrical equipment in the facility.
Present Performance = Average time = 182day, min = 21day, max = 344day
Goal Performance = Average time ≤ 91day
Project Duration = 6 months

2. Business Case (Issues to be addressed/process to be improved)

What impact is this problem having on our customers/the business/employees/the environment?
Why is this a priority? What are the key deliverables to be expected? What other indirect benefits may arise from this work?

The long time for connecting new electricity service process affects negatively JDECO customer's satisfaction and their loyalty. It causes customers dissatisfaction, and bad reputation for JDECO and the employees. Moreover, the long-time of the process increases customer complaints, and handling with customer complaints will cost the company time and money. On the other hand, the long-time of the process will reduce the rate of performed processes, so that, this will result in reducing the company performance.

Improving the process of connecting new electricity service is considered high priority because this will increase customer satisfaction, also it will contribute in improving JDECO performance and productivity, and therefore this improvement will increase the revenues for JDECO.

Key Players Who is the Sponsor/ Team Leader/Team Members/ Other Key People who need to be involved?		**Scope -** نطاق المشروع Which area/department within the organisation or product/market segments/customers is to be covered? What is out of scope?
Sponsor	Tha'er Jaradat	In scope: -The process of connecting a new electricity service in JDECO from inserting the application to installing the electrical equipment in the facility. - Customers services department (fund division, cards and contracts division). - Technical services department (Estimation division, Survey division, services division, columns division, networks division, projects division). - Financial department. - JDECO's Warehouses. - Quality management department.
Team Leader	Reem Barghouthi	

<table>
<tr><td></td><td></td><td>- Data analysed for this project from the beginning of January 2019 until the end of February 2020.</td></tr>
<tr><td>Team Members</td><td>-Feda’ Abdalrahman
-Manal Nassar
-Suhad Ateyeh
-Mohammad Etewy</td><td rowspan="2">Out of scope:
-Data before January 2019</td></tr>
<tr><td>Other Key People</td><td>Quality management department manager</td></tr>
<tr><td colspan="2">Enablers/Risk Mitigation
What needs to be in place to ensure the project progresses?</td><td>Barriers/Risks
(Not the opposite of enablers)
What are the potential barriers to the work?</td></tr>
<tr><td colspan="2">- Top management commitment.
- Project budget.
- Time availability for the team.
- Periodically meetings.
- Employee’s training.
- Data availability.</td><td>- quarantine due to Corona
- Employee’s resistance to change.
- Limited resources.
- Insufficient time.</td></tr>
<tr><td colspan="3">Support Estimates
Estimate of the people, equipment, expertise, capital required for the project.</td></tr>
<tr><td colspan="3">- Team members.
- Hiring and training employees.
- Software development.</td></tr>
</table>

4.5 The SIPOC

SIPOC is diagram for process mapping usually drawn at a high level. However, it can also be used to map a process with increasing levels of detail (sub-processes and processes) (Pyzdek, 2003). The SIPOC identifies Supplier, Input, Process, Output and Customer.

After understanding each step in the process of connecting a new electricity service, the SIPOC has been created as shown in Figure 4-2, and the project team agreed on the SIPOC. The SIPOC determines the process measures and current data to be measured in each process step to measure the current performance, in addition SIPOC states the goal performance, and the sources of variation and it clarifies its impact on the process performance.

Key Business Process Name: Connecting a new electricity service.				
Suppliers	**Input**	**Process**	**Output**	**Customers**
Customer Customer JDECO JDECO	Required documents Application System Process staff	**Process Purpose:** to connect a new electricity service with high quality at the right time. **Process Owner:** The technical services department in JDECO.	New electricity service.	Citizens of Ramallah and Al-Bireh Governorate.

Process Steps (High Level)	Insert application →	Estimate the electrical equipment needed. →	Approve technically →	Approve financially →	Order and ship the equipment from JDECO warehouses →	Set columns locations →	Install of electrical equipment of the new service	**Results Measures** **Time taken to complete the process** The actual current average time to complete the process = 182 days. **Target** The target is to reduce the average time of the process to 50% (to be less than 91 days).	**Customer needs** Connecting a new electricity service at shortest time with highest quality.
Process Measures	- Time to review the application. - Check the accuracy of documents.	Time taken to complete the task.	Time taken to complete the task.	Time taken to complete the task.	Time taken to complete the task.	Time taken to complete the task.	Time taken to complete the task.		
Present Data	Within 1 day	From 10–11 days	From 1-2 days	From 1-2 days	From 64-65 days	From 5-6 days	From 16-17 days		
Goal Performance	Within 1 day	Less than 5 days	Less than 1 day	Less than 1 day	Less than 32 days	Less than 3 days	Less than 8 days	**Results Concerns** The time to connect a new electricity service is more than the target.	Date 25/6/2021
Sources of Variation & Waste	Inaccurate checking of documents	- Work pressure. - Lack of resources. - Delay in completing the task.	Work pressure	Work pressure	Lack of equipment availability	-Work pressure. - Lack of resources. -Delay in completing the task.	-Work pressure. - Lack of resources. -Delay in completing the task.		Version 1
Impact on Performance	Inaccuracy of inserting application	Late for the next step	Delay of completing the work.	Delay of completing the work.	Late for the next step	Delay of completing the work	Delay in installing the new service.		

Figure 4-2: SIPOC for the process of connecting a new electricity service.

The SIPOC highlights the following:

- Customer needs: Connecting a new electricity service at shortest time with highest quality.
- Results measures: cycle time taken to complete the process.
- Target: to reduce the average cycle time of the process to 50% (to be less than 91 days).
- Results concerns: The cycle time to connect a new electricity service is more than the target.

After understanding the process steps, the SIPOC revealed that there are many steps that have a waste in time, variation, and there is a lack of resources.

4.6 Define Phase Tollgates

The Define phase has three tollgates that were reviewed to ensure that each tollgate is completed successfully. The three tollgates are as follows:

1- Create the project charter:

   The project charter was created and it provided the business case for the project, problem statement, and project scope.

2- Voice of Customer:

   Based on data were obtained from the customers' complaints system in JDECO and were analyzed, the Voice of Customer was identified, in addition to identifying the needs of customers.

3- Map the process: the process mapping was created at the high level by applying the SIPOC.

4.7 Chapter Summary

In the define phase the problem in the process of connecting a new electricity service was defined. In addition, the project charter was created with its items, and the SIPOC was created by which the process steps were explained.

Chapter Five

Measure Phase

5. Measure Phase

5.1 Introduction

The objective of the Measure phase in DMAIC Methodology is to understand and analyse the current process of connecting a new electricity service and to establish the baseline performance of the process, in addition to identifying areas in which improvements can be made. Moreover, to identify the problems, defects in the process that are causing inefficiencies and wastes. In this phase the data were collected to determine where the sources of variation and defects. The following tools were applied to understand the as-is situation of the process: Flow Chart, Eight Wastes, Quick Wins, Value Stream Mapping (VSM), Voice of Customer (VOC), and Control Charts.

5.2 Flow Chart

The flow chart is a tool used to place a series of tasks into a logical order using a set of symbols. The flow chart of the current process of connecting a new electricity service was created as in Figure 5-1, the flow chart illustrates the detailed process steps, and this helps in understanding the process steps and determining the unnecessary non-value adding steps.

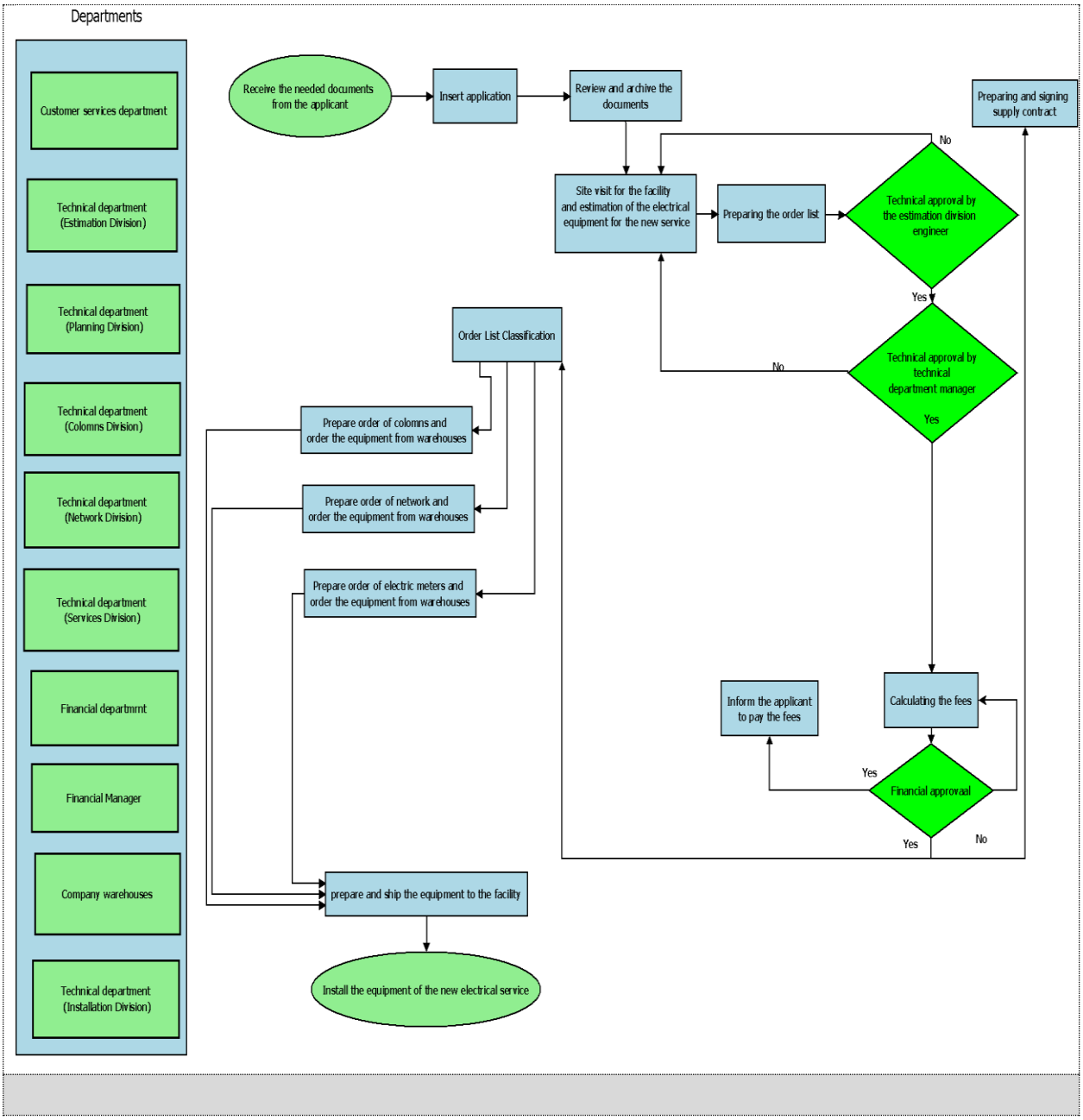

Figure 5-1: Flow Chart of the process of connecting a new electricity service.

From the Flow Chart above, it is noticed that:

- The process has many steps to be performed.
- The process has three approval stages.
- Non-value-adding steps exist in the process.

- Non-value-adding steps cause waste in time and defects were identified.

5.3 Eight Wastes

Waste is defined as any step in the process that does not add value to the customer (Hassan, 2013). Wastes are categorized into eight categories which are Defects, Overproduction, Waiting, Non-Utilized Talents, Transportation, Inventory, Motion, and Excessive Processing (DOWN TIME), and it was called Muda by the Japanese (Ohno, 1988). Other forms of wastes which are named Mura and Muri. Mura refers to unevenness in production volume, while Muri refers to overburden or overloading the equipment or human resources beyond their capacity (Pieńkowski, 2014).

In this section the steps of the connecting a new electricity service process was analysed to determine and recognize the waste in each step as illustrated in Table 5-1.

Table 5-1: Eight wastes that exist in the process of connecting a new electricity service.

Workflow: Connecting a new electricity service process			Eight Wastes							
Step	**Steps of process**	**Executed by**	**Defects**	**Over production**	**Waiting**	**Non-Utilized talent**	**Transportation**	**Inventory**	**Motion**	**Excessive Processing**
1	Receive the needed documents from the applicant.	Customers Services department (fund division).								Small task that doesn't need a separate stage
2	Insert application	Customers Services department (fund division).								Small task that doesn't need a separate stage
3	Review and archive the documents.	Customers Services department (cards and contracts division).	Wrong or missing information occur while reviewing the required documents							
4	Site visit for the facility and Estimation of electrical equipment for the new service.	Technical department (Estimation Division)	Estimation of equipment more than or less than what needed may occur		High workloads in the estimation division delay the step of electrical equipment estimation.	Unskilled estimator, lack in employees, Lack in drivers.	Lack in transportation (cars) to transport estimators to the site of facility	Accumulation of applications		
5	Preparing the order list	Technical department (Estimation Division)	Mistake may occur while preparing the order list of estimated equipment							

6	Technical approval by the estimation division engineer	Technical department (Estimation Division)								
7	Technical approval by the technical department manager.	Technical department manager								Non-value-added step (Unnecessary step)
8	Calculate the fees	Financial department	Mistake may occur while calculating the fees							
9	Financial approval	Financial Manager			Financial Manager is busy with other work that delays issuing the financial approval					
10	Inform the applicant to Pay the fees.	Financial department	The employee may forget to inform the applicant because the informing step is manual not automated step							

11	Prepare and sign of supply contract	Customer Services department	Wrong Items in the contract.							
12	Classify the order list	Technical department (Planning Division)	Inaccurate classification of the order list may occur because it is manual classification							
13	Prepare order of columns and order the equipment from warehouses.	Technical department (Columns Division)	Mistake may occur while preparing the order of columns to be requested from warehouses							
14	Prepare order of network and order the equipment from warehouses.	Technical department (Network Division)	Mistake may occur while preparing the order of network to be requested from warehouses							
15	Prepare order of electric meters and order the equipment from warehouses	Technical department (Services Division)	Mistake may occur while preparing the order of electric meters to be requested from warehouses							

16	Prepare,and ship the equipment to the facility	Company warehouses	Inaccurate preparing of electrical equipment that are shipped to the facility site				Lack in transportation whereas one truck distributes all the daily needed equipment to all facilities sites	Always there is a lack in equipment especially lack in columns		
17	Install the equipment of the new electrical service	Technical department (Installation Division)			High workloads in the installation division delay the installation step	Lack in technicians	Lack in transportation (cars) to transport technicians to the facility site	Lack in electrical equipment that are shipped to the facility site		

The eight wastes that are existing in the process of connecting a new electricity service are summarized as follow:

- **Defects**: defects may occur during the inserting application step, whereas wrong or missing information may occur while receiving and reviewing the required documents, estimation of equipment more than or less than what needed may occur, mistake may occur while preparing the order list of estimated equipment, the employee may forget to inform the applicant because the informing step is manual by mobile SMS, inaccurate classification of the order list may occur because it is a manual classification, in addition to documents may be missed because it is converted manually between departments.
- **Excessive Processing**: The application goes through unnecessary steps.
- **Waiting time**: High workloads in the estimation division delay the step of electrical equipment estimation, financial Manager and technical manager are busy with other work that delays issuing the financial approval, high workloads in the installation division delay the installation step.
- **Non-utilized talent**: lack of employees, lack of drivers, lack of technicians.
- **Transportation**: Lack of transportation (cars) to transport estimators to the site of facility, lack of transportation whereas one truck distributes all the daily needed equipment to all facilities sites.
- **Inventory**: Lack of inventory management whereas always there is a lack of equipment especially lack of columns.

5.4 Quick Wins

Quick Wins help to find opportunities for fast improvement and potential solutions in process steps, it stands for four criteria which are: the fast improvement takes less than one week, costs less than 1000 NIS, is reversible (returning to the original situation before improvement), and it is within team's scope to authorize. Table 5-2 identifies the quick wins for the process of connecting a new electricity service.

Table 5-2: Quick wins of the process of connecting a new electricity service.

No.	Quality concern or waste	Potential solution	Take less than one week	Costs less than 1000 NIS	Is reversible	Within team's scope to authorize
1	Not all the procedures were written and documented.	Update the documented procedures	✓	✓	✓	✓
2	Wrong or missing information may occur while receiving and reviewing the required documents / Defects	Prepare and adopt a checklist to be followed while receiving and reviewing the required documents	✓	✓	✓	✓
3	The application goes through unnecessary steps / Excessive Processing	- Eliminate the two steps (the step of Receiving the needed documents from the applicant and the step of inserting application) and transform them to become one step with the receiving and reviewing the required documents step - Eliminate the step of technical approval by the technical department manager	✓ ✓	✓ ✓	✓ ✓	X X
4	Estimation of equipment more than or less than what needed may occur / Defects	Train the estimator	✓	✓	✓	✓
5	High workloads in the estimation division delay the step of electrical equipment estimation / Waiting	- Hiring employees and estimators (for both office works and site visit works). - Hiring drivers specified for estimation division tasks	X X	X X	X X	X X
6	Lack of transportation (cars) to transport estimators to the site of facility / Transportation	Purchase additional cars	X	X	✓	X
7	Mistake may occur while preparing the order list of estimated equipment / Defects	Train the employee	✓	✓	✓	✓

8	Financial Manager is busy with other work that delays issuing the financial approval / Waiting	Appointing a deputy for the task of financial approval	✓	✓	✓	X
9	The employee may forget to inform the applicant because the informing step is manual by mobile SMS / Defects	Transfer the step of informing the applicant into automated step linked with the financial approval	X	✓	✓	X
10	Inaccurate classification of the order list may occur because it is manual classification / Defects	Transfer the step of classifying the order list into automated step	X	✓	✓	X
11	Lack of transportation whereas one truck distributes all the daily needed equipment to all facilities sites / Transportation	Purchase additional trucks	X	X	X	X
12	Always there is a lack of equipment especially lack of columns / Inventory	Adopt a new purchase policy in the company to increase the amount of equipment in the warehouses	X	X	X	X
13	High workloads of the installation division delay the installation step / Waiting	- Hiring more technicians - Purchase additional transportation	X X	X X	X X	X X
14	Need for an integrated system to convert the documents between departments for the process of connecting a new electricity service	Build an integrated system to facilitate the tracking of process steps and reduce the manual steps	X	X	✓	X

The quick Wins illustrated the quick solutions that can be implemented as follow:

- Update the documented procedures.
- Prepare and adopt a checklist to be followed while receiving and reviewing the required documents.
- Eliminate the two steps (the step of Receiving the needed documents from the applicant and the step of inserting application) and transform them to become one step with the receiving and reviewing the required documents step.
- Eliminate the step of technical approval by the technical department manager.
- Train the estimator.
- Train the employee in the estimation division.
- Appoint a deputy for the task of financial approval.

On the other hand, there are solutions that can't be implemented as Quick Wins which are:

- Hiring employees and estimators (for both office works and site visit works) in the estimation division.
- Hiring drivers specified for estimation division tasks.
- Purchasing additional cars to transport estimators.
- Transferring the step of informing the applicant that his/her financial claim is ready to be paid into automated step linked with the financial approval.
- Transferring the step of classifying the order list into automated step.
- Purchasing additional trucks to distribute all the daily needed equipment to all facilities sites.

- Adopting a new purchase policy in the company to increase the inventory in the warehouses (make inventory management).
- Hiring more technicians in the installation division.
- Purchasing additional cars specified to transport technicians to the facilities sites.
- Building an integrated system to facilitate the tracking of process steps and to reduce the manual steps.

5.5 Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a vital lean tool and it is defined as “the process of visually mapping the flow of information and material as they are and preparing a future state map with better methods and performance” (Jones and Womack ,2000). VSM helps to demonstrate exactly how the process operates with detailed timing of step-by-step activities. Hence, VSM enables to determine the average cycle time of the process, lead time, delay time, and the value-added percentage, meanwhile, to maximize the efficiency of the process via eliminating the sources of waste.

VSM of the process of connecting a new electricity service has been created as shown in Figure 5-2 by obtaining a data for thirty applications from the beginning of January 2019 until the end of February 2020. In VSM the average duration of the round, down time, average cycle time, and average delay time between steps have been calculated. In addition to calculating the lead time and the value -added percentage for the process.

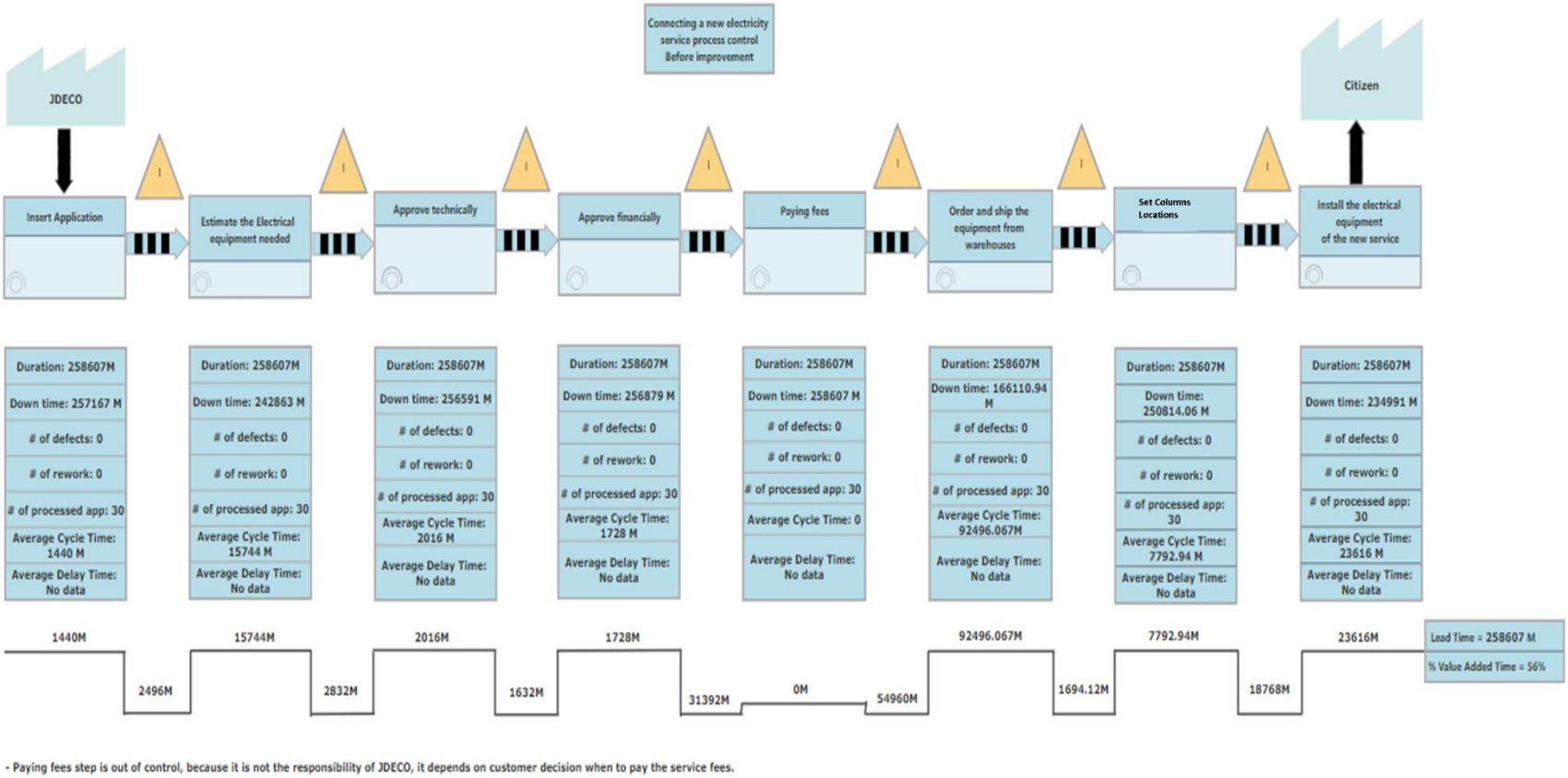

Figure 5-2: Value Stream Mapping (VSM) of connecting a new electricity service process.

JDECO's staff work 7.5 hours/day from 7:30am to 3:00pm, so they work 450 min/day.

The VSM revealed the following results:

- The lead time of the process was 575 days.
- The average Cycle Time of the process was 322 days.
- The Percentage Value Added Time (%VAT) of the process was 56%.
- Three steps from the whole process steps formed bottlenecks that resulted in delaying the process implementation.
- The steps that are forming the bottlenecks of the process are as follow:
    1- Ordering and shipping the equipment from JDECO warehouses step with average cycle time 205.5 days.
    2- Installation of the electrical equipment of the new service step with average cycle time 52.5 days.
    3- Estimation of equipment step with average cycle time 35 days.
- The paying fees step is out of control because it is not the responsibility of JDECO, it depends on the customer decision when to pay the service fees.

5.6 Control Chart

Control Chart is one of the most powerful techniques in statistical process control to determine if the process is stable or not. The Control Chart aims to identify the central line which determines the current average time needed to perform the process of connecting a new electricity service in addition to identifying the upper control limit and lower control limit. The Control Chart has been created by using Minitab software. The data were plotted in Minitab software for the thirty applications.

After creating the VSM, the following control charts were created:

1- Control Chart for the whole process steps was created, as shown in Figure 5-3.

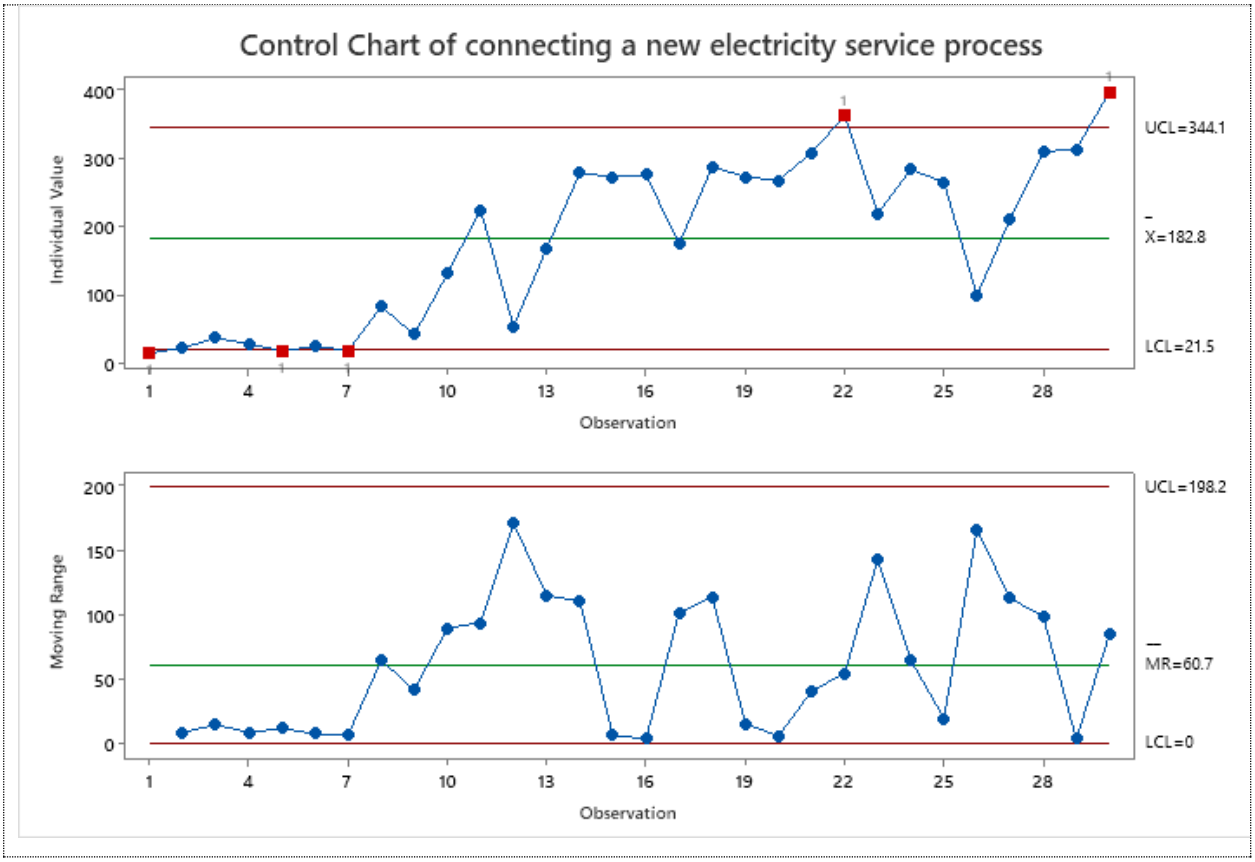

Figure 5-3: Control Chart for the whole process steps.

The Control Chart concludes that:

- The central line of the process is 182 days, which gives that the actual current average time to complete the process is 182 days.
- The upper control limit is 344 days.
- The lower control limit is 21.5 days.
- The process is unstable; it has assignable causes whereas it has points outside the control limits.

Based on the above, the Control Chart indicates that the process has variation, this leads to the need for process improvement to reduce the variation.

2- Control Charts for the three steps that are forming bottlenecks in the process.

The three Control Charts were created for the following three steps as follow:

- Control Chart for ordering and shipping the equipment from JDECO warehouses step.
- Control Chart for installation of electrical equipment of the new service step.
- Control Chart for estimation of equipment step.

They are shown in Figure 5-4, Figure 5-5, and Figure 5-6 respectively:

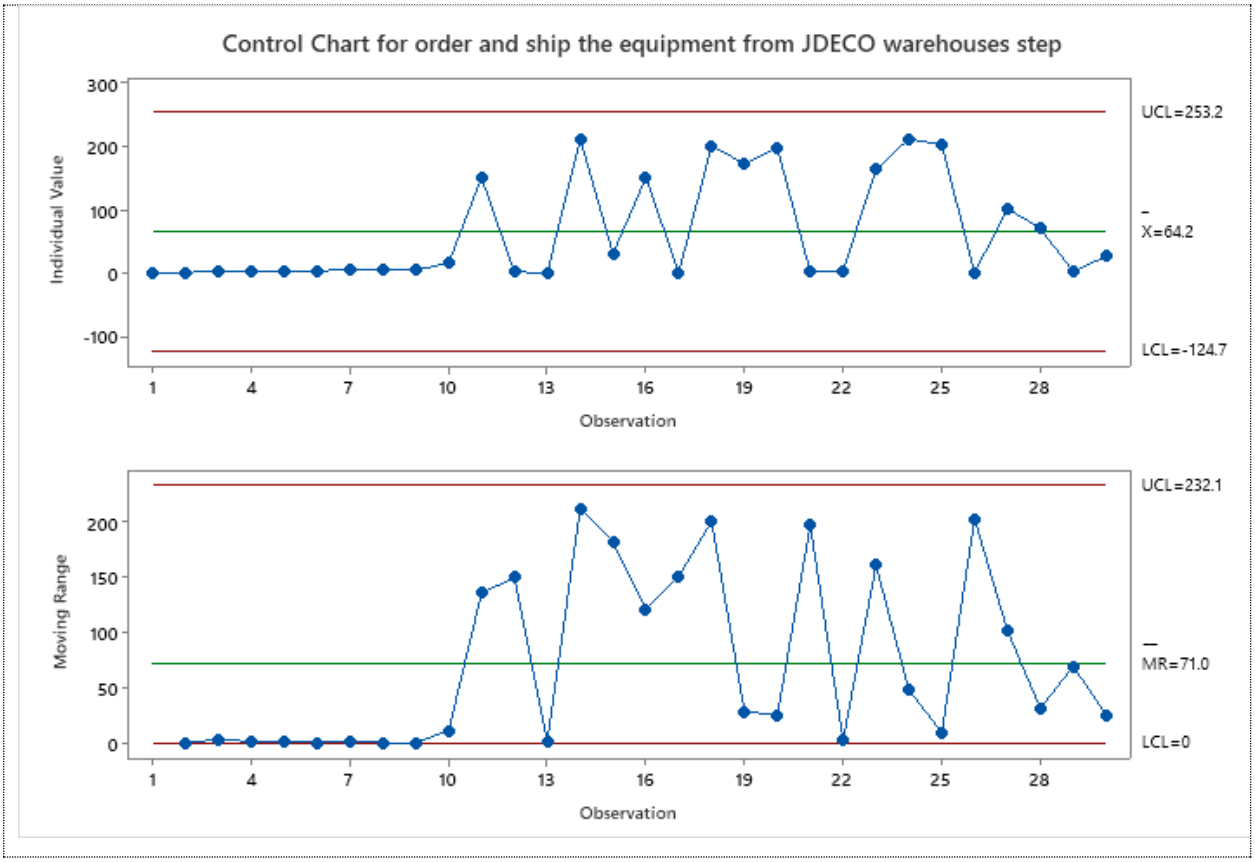

Figure 5-4: Control Chart for order and ship the equipment from JDECO warehouses step.

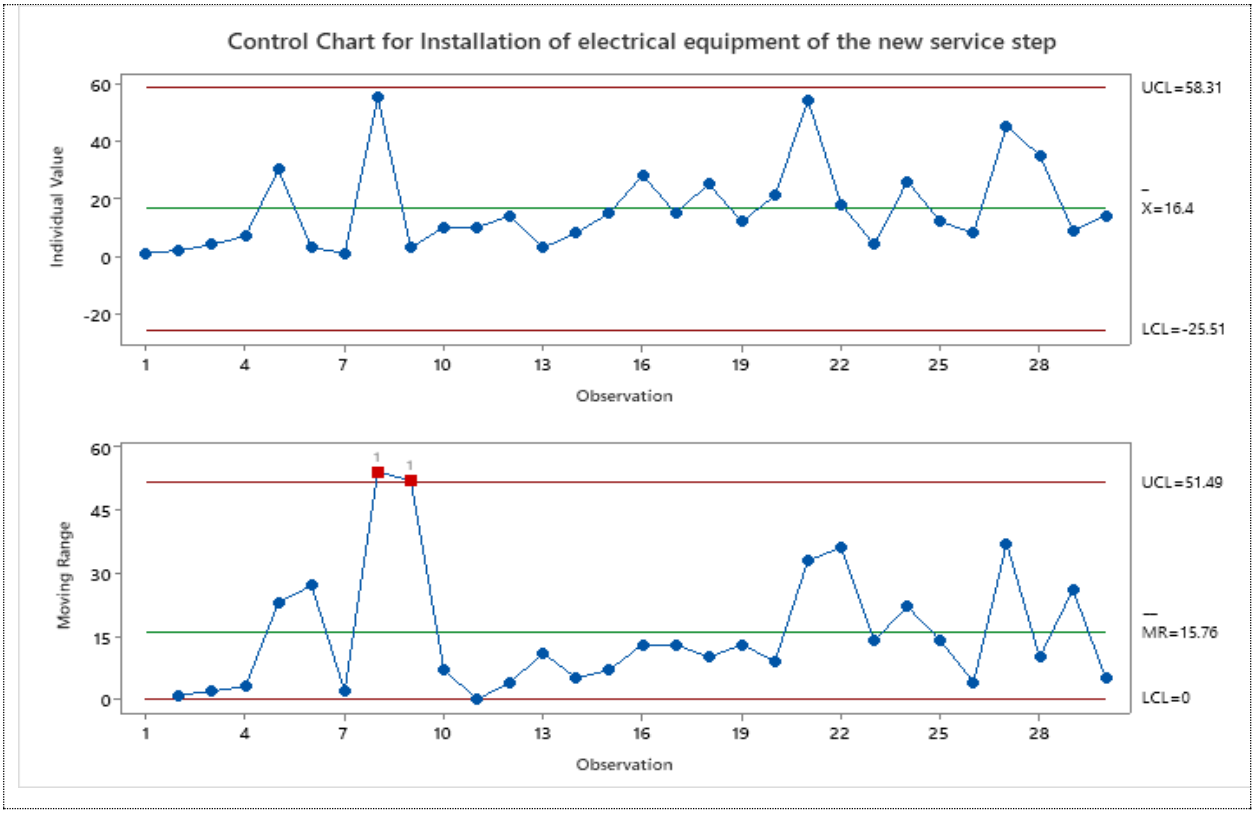

Figure 5-5: Control Chart for Installation of electrical equipment of the new service step.

Figure 5-6: Control Chart for estimation of equipment step.

The Control Charts for the three steps that are forming bottlenecks in the process illustrates the following:

1- With regard to the ordering and shipping equipment from JDECO warehouses step, the Control Chart in Figure 5-4 shows that:
   - The central line of the step is 64.2 days, which gives that the actual current average time to complete the step is 64.2 days.
   - The upper control limit is 253.2 days.
   - The lower control limit has a negative value, and it is an acceptable value because of the high variation in the process.
   - The step has a variation.

2- With regard to the installation of electrical equipment of the new service step, the Control Chart in Figure 5-5 shows that:
   - The central line of the step is 16.4 days, which gives that the actual current average time to complete the step is 16.4 days.
   - The upper control limit is 58.31 days.
   - The lower control limit has a negative value, and it is an acceptable value because of the high variation in the process.
   - The step has a variation.

3- With regard to the estimation of equipment step, the Control Chart in Figure 5-6 shows that:
   - The central line of the step is 10.93 days, which gives that the actual current average time to complete the step is 10.93 days.

- The upper control limit is 29.83 days.
- The lower control limit has a negative value, and it is an acceptable value because of the high variation in the process.
- The step has a variation.
- The step is unstable; it has assignable cause whereas it has a point outside the control limits.

5.7 Measuring the Current Process Capability (Cp)

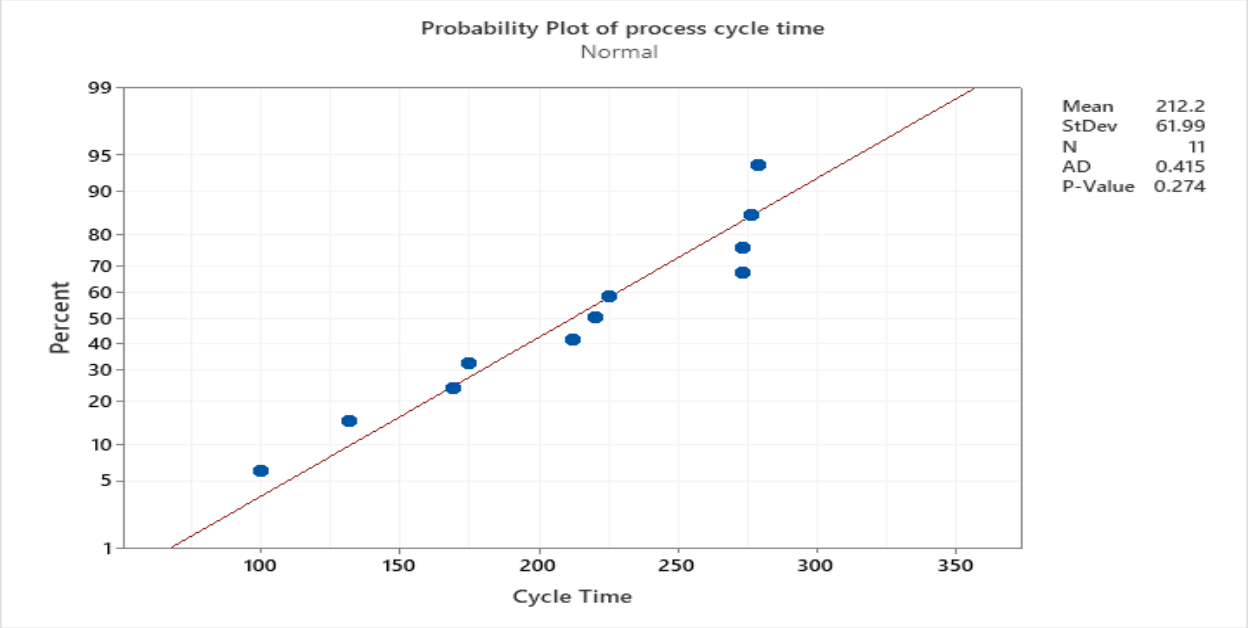

Figure 5-7: Normality test of process cycle time.

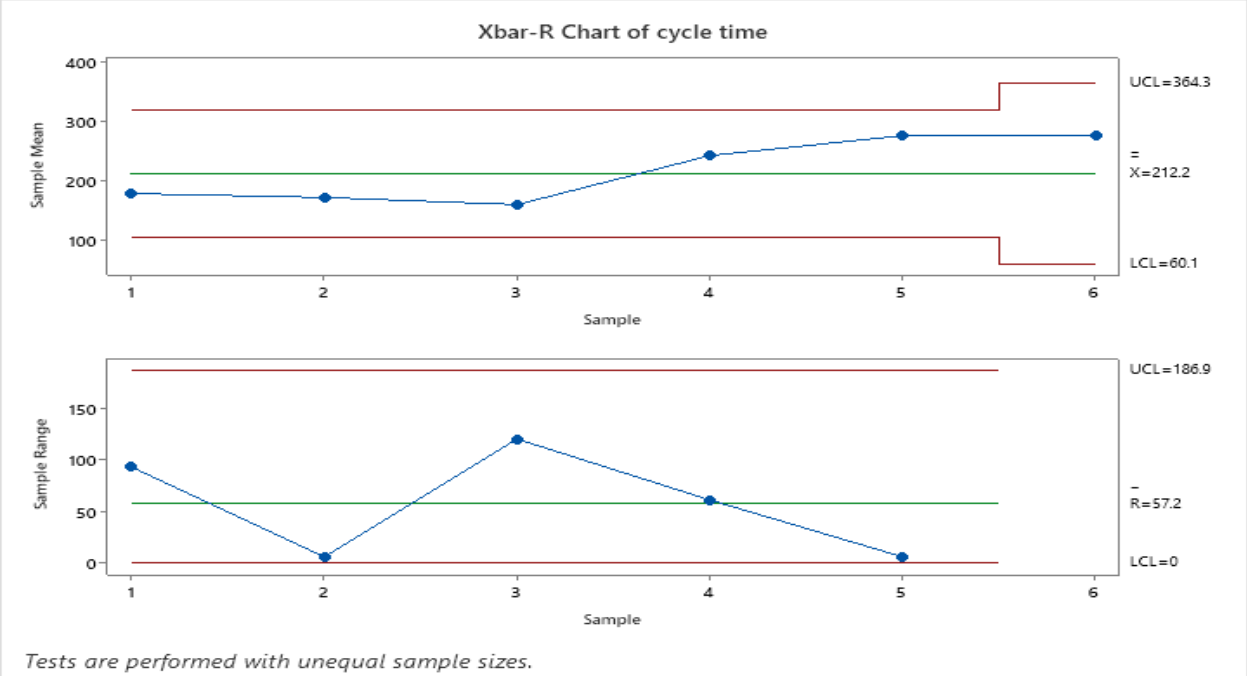

Figure 5-8: Xbar-R Chart of the averages cycle time (n = 2 per subgroup).

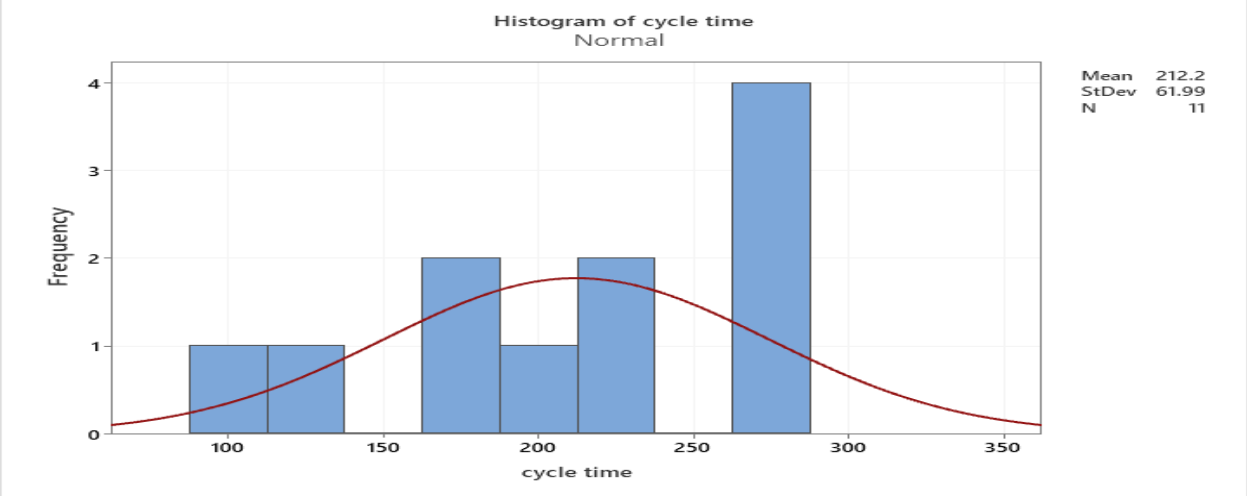

Figure 5-9: Histogram of cycle time.

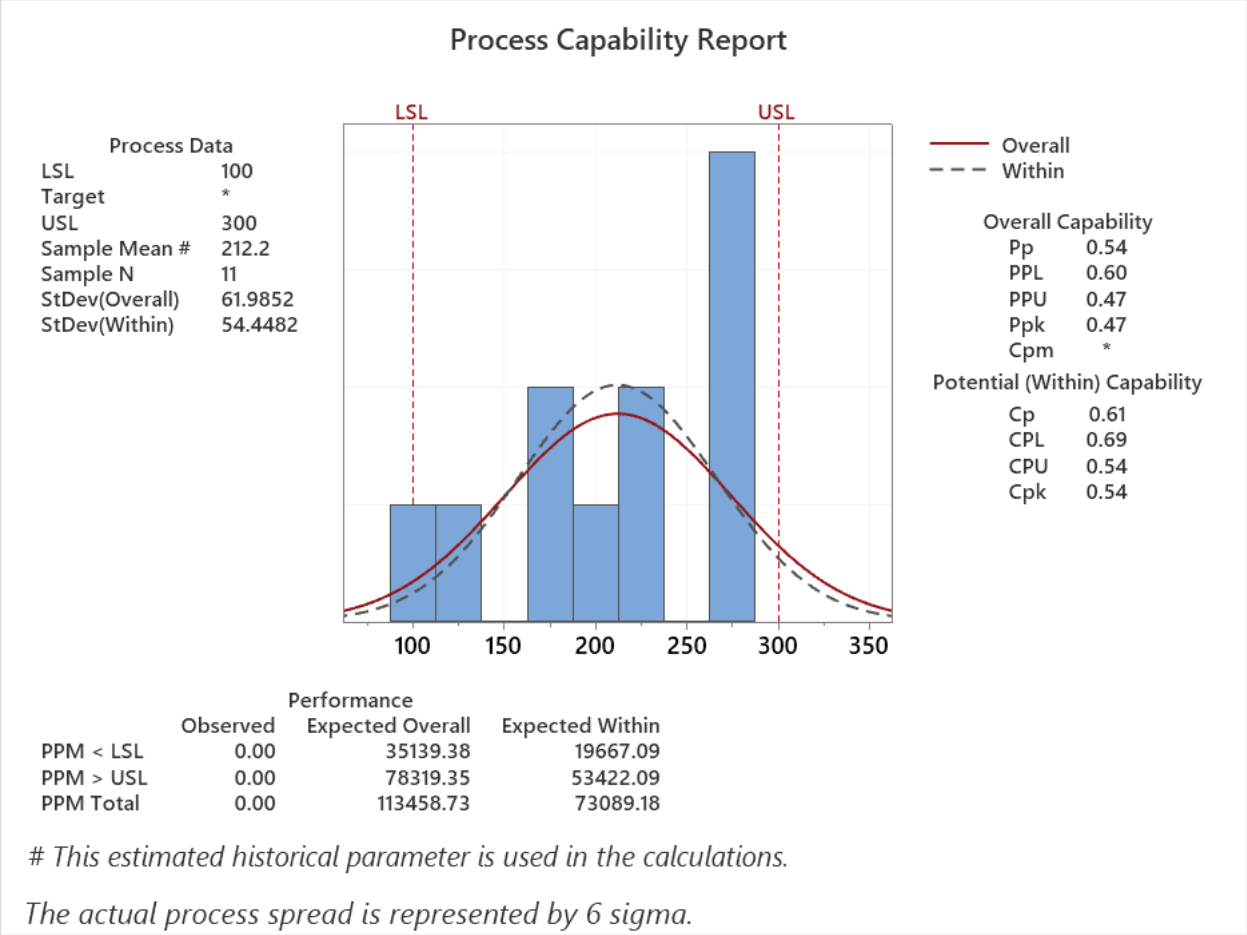

Figure 5-10: Process capability analysis of cycle times.

The probability plot in Figure 5-7 indicates that the cycle times are normally distributed. The Xbar-R chart was created as shown in Figure 5-8, the chart indicates that the process is in statistical control. Once the stability has been determined, the histogram was created as shown in Figure 5-9, the histogram shows the distribution of the actual cycle times, the specification limits of the current process are estimated between 100 to 300 days. The Process Capability (Cp) is 0.61 as measured in Figure 5-10, the Cp indicates that the process is not capable to meet the requirements. The estimated performance of the process is 113458.73 defects per million (PPM). Based on the PPM, the estimated sigma level of the current process is 2.78.

5.8 Voice of Customer (VOC)

Voice of Customer (VOC) is very essential for the team project to understand what customers exactly want before starting to improve the process. By listening to the VOC, the elements that are critical to quality for the customer can be easily understood.

VOC was used to determine customer needs and requirements from the process of connecting a new electricity service. By returning to the customer complaints system in JDECO, the data were obtained at the period of beginning of January 2019 to the end of September 2020. The total number of customer complaints at the mentioned period were 137 complaints, 88 customer complaints from the total number were related to the process of connecting a new electricity service which constitutes 63%, as shown in Table 5-3.

The nature of customer complaints was categorized into five categories as follow:

- Delay in installation of new electricity service.
- Delay in columns installation.
- Objection on survey work.
- Defects in calculating the fees of the new service.
- Defects in the installation of the new electricity service.

Table 5-3: Customer complaints of connecting a new electricity service process.

Nature of complaint	Number of complaints	% Of complaints
Delay in installation of new electricity service	37	27%
Objection on survey work	7	5%
Defects in calculating the fees of the new service	3	2%
Delay in columns installation	28	20%
Defects in installation of new electricity service	13	9%
Total	**88**	**63%**

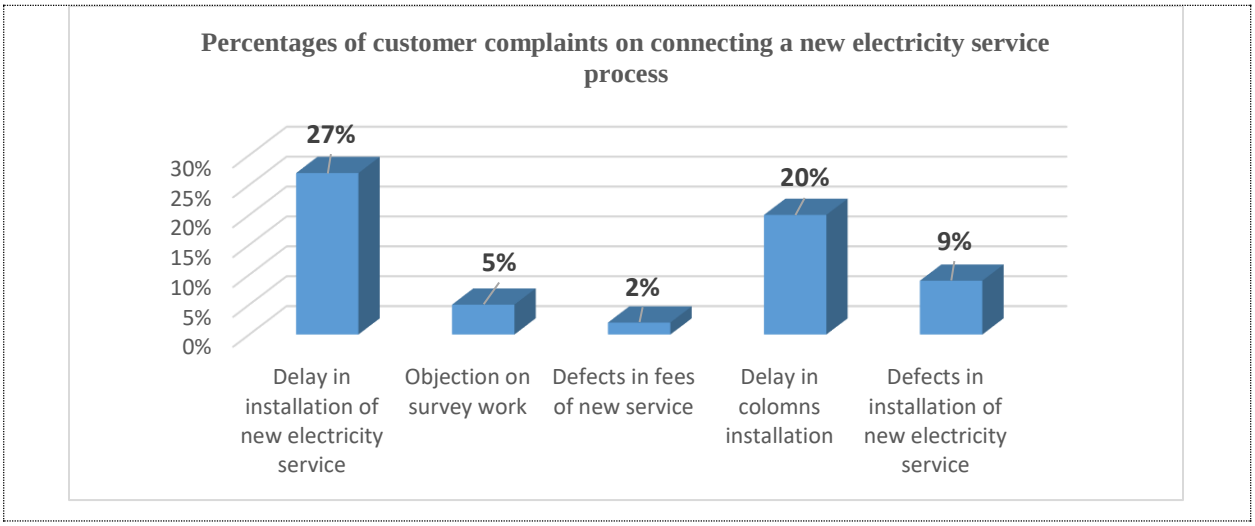

Figure 5-11: Percentages of customer complaints on connecting a new electricity service process.

Figure 5-7 illustrates the following:

- The highest percentages of customer complaints distributed on the delay in installation of the new electricity service, and the delay in columns installation, with percentages of 27% and 20% respectively.
- The total percentage of customer complaints that is related to delays in performing the process constitutes 47%.

This led to conclude that the most important critical to quality (CTQ) factor is the cycle time.

5.9 Measure Phase Tollgates

1- Data collection plan:

A plan for collecting the needed data was applied by determining the data sources and the data type. Where there were data needed for VOC identification which were obtained from customers' complaints system, and data for building the VSM and control charts which were obtained from the Billing system.

2- Performance indicators identifications:

The process cycle time, and the customer complaints were measured as Key Performance Indicators (KPIs).

3- Baseline performance measurements:

The current process performance was measured by measuring the process capability (Cp), and the process sigma level.

5.10 Chapter Summary

Measure phase in DMAIC approach was applied to understand and analyse the current process performance, in addition, areas in which improvements needed were identified. The as-is situation of the process was understood by applying the Measure phase tools: Flow chart, Eight wastes, Quick wins, Value Stream Mapping (VSM), Voice of Customer (VOC), and Control charts. Each tool illustrated significant results.

In this phase, bottlenecks of the process were identified as follow: order and ship the equipment from JDECO warehouses step, installation of electrical equipment of the new service step, and estimation of equipment step. Control Chart was applied, and it showed that the process is unstable, it has several variations.

The problems, defects, and wastes were identified in the process steps in this phase; besides, VOC was determined whereas the most important critical to quality (CTQ) factor is the time.

Chapter Six

Analyze Phase

6. Analyze Phase

6.1 Introduction

The main goals of this phase are to analyze the problems and process inefficiencies, identify the root causes for both the variation and waste, and to define the improvement opportunities. The process was analyzed through a brainstorming with JDECO managers and employees to identify the potential causes. The effective tool that was used to analyze the root causes was the Cause-and-Effect Diagram (Fishbone Diagram).

6.2 Cause and Effect Diagram

To understand the customer dissatisfaction of connecting a new electricity service process, the Cause-and-Effect analysis were conducted to analyze the root causes of the problem that JDECO is facing in regard to the longtime of performing the process. The Cause-and-Effect analysis is an efficient tool to identify the factors that are causing the problem, moreover it illustrates the reasons for the problem that is being faced.

The Cause-and-Effect Diagram was created as shown in Figure 6-1.

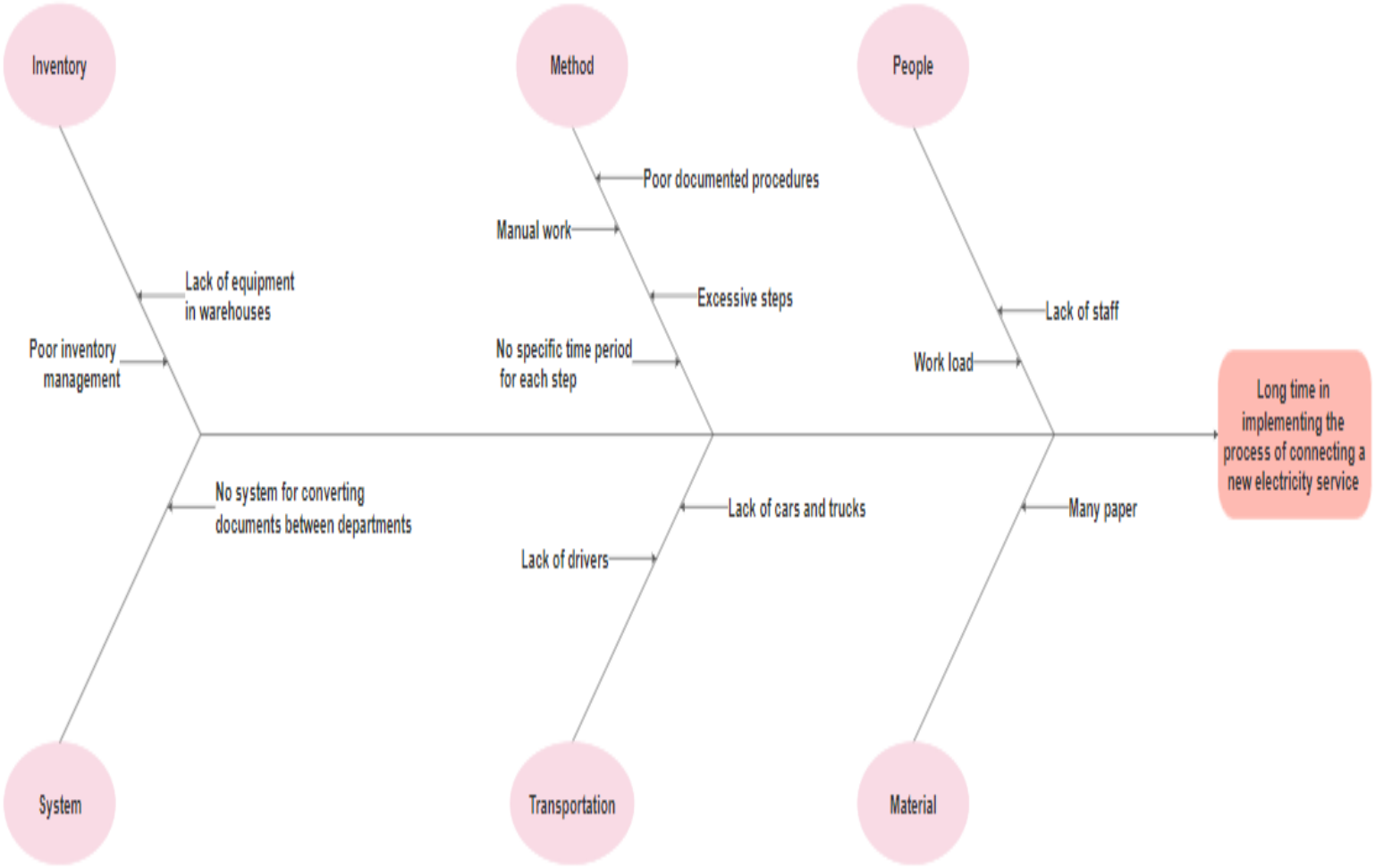

Figure 6-1: Cause and Effect Diagram for the process of connecting a new electricity service.

6.3 Delays in Implementing the Process of Connecting a New Electricity Service

The Cause-and-Effect analysis found that there are six main causes for the delay in implementing the process of connecting a new electricity service as shown in Figure 6-1. These were deduced from the interviews that were conducted with employees, technicians, and managers in the company. Each one of these causes has sub-causes which are the actual reasons for the delays in the process. The main causes with their root causes were summarized as follow:

1- **People**: People is a factor that plays a main cause that causes the delay in the process, it has sub causes as follow:

   a- **Lack of staff:** Employees and technicians play a significant factor in delaying the implementation of the process of connecting a new electricity service as an insufficient resource. As deduced from the interviews that there is a lack of the company staff that creates delay in performing the process. The lack of the staff affected the two steps that form bottlenecks in the process which are estimation step of equipment needed to the new service, and the installation step of equipment in the facility of the new service. These two steps to be implemented at the right time need to increase the staff in the company.

   b- **Work load:** The employees and technicians are facing a work load; therefore, it takes a long time to do their work in order to estimate the equipment and to install the equipment of the new service.

2- **Method:**

a- **Poor documented procedures:** Not all the process procedures were written and documented, even though the procedures must include all the detailed process steps written and documented.

Therefore, the quality management department should have a regular program of reviewing and updating the process procedures.

b- **Manual work:** There is a lot of manual work between departments, where all the documents and files that are related to the application and the process were converted manually between departments. During analyzing the root causes of the delay in the process, there was a root cause that has been observed due to lost documents in the survey division related to the process implementation, this led to creating a delay in completing the work at the right time.

To reduce the manual work and to keep the documents from loss, it is necessary to develop a system to convert the documents between divisions and departments through it.

c- **Excessive steps:** The application goes through unnecessary steps. It is needed to eliminate the two steps (the step of receiving the needed documents from the applicant and the step of inserting application) and transform them to become one step with the receiving and reviewing the required documents step. In addition, the process has an excessive step with regard to the technical approval, it is needed to eliminate the step of technical approval that is conducted by the technical department manager.

d- **No specific time period for each step:** there is a lack of determining the key performance indicators (KPI's) that measure the process performance, where there

was no specific time period determined to measure whether the process steps are performed at the specific time or no. Based on that, it is necessary to create a new flowchart for the process with specified time for each step.

3- **Material:**

a- **Many papers:** due to the manual work in the divisions that are responsible for performing the process activities, there are a large number of papers used. This is considered a waste in resources which increases the operational costs, and costs the company lot of money. In order to reduce the number of papers used, it is necessary to develop a system to convert the documents between divisions and departments through it.

4- **Transportation:**

a- **Lack of cars and trucks:** for implementing the process of connecting a new electricity service, the availability of enough cars and trucks are necessary. Where the cars for transporting the technicians and equipment are necessary during implementing the two steps: estimation of equipment step, and installation of electrical equipment step, where these two steps have a work on site. On the other hand, trucks are needed to implement the ship equipment step, to ship the equipment from JDECO warehouses to the site of work. Based on the previous, the mentioned three steps were the bottlenecks in the process, the lack of cars and trucks was a significant factor that resulted in delaying the completion of the three steps, this led to delay in the process to be completed.

So, it is necessary to purchase additional cars specified to transport technicians to the facilities sites, and purchase additional truck to ship the equipment from warehouses to the work site.

b- **Lack of drivers:** once increasing the number of cars and trucks, it is needed to hire new drivers in the company.

5- **Inventory:**

a- **Lack of equipment in warehouses:** this creates an increase in the waiting time for the availability of equipment specially the columns to complete the process.

b- **Poor inventory management:** it was found that there was a poor inventory management in JDECO warehouses affected negatively the availability of equipment needed to install the new service. It is necessary to the company to adopt a new purchase policy to increase the inventory specially the columns.

6- **System:**

a- **No system to convert documents between departments as an electronic version:** the lack of system in JDECO affected the work negatively, where it was resulted in doing the work manually. Hence, the availability of a developed system is very important to convert the documents between departments as an electronic version, and to keep the documents from loss, in addition to reduce the number of papers used.

It is necessary for JDECO to develop this system.

6.4 Analyze Phase Tollgates

1- Potential root cause:

The main causes for the delay in implementing the process of connecting a new electricity service were identified by conducting interviews with JDECO's employees.

2- Narrow root cause:

The sub causes for each main cause were identified bay creating the cause-and-effect diagram.

3- Critical root cause:

The critical root causes were identified which resulted in causing the process bottlenecks steps based on the VSM results.

6.5 Chapter Summary

The problems and process inefficiencies, the root causes for both the variation and waste were identified in the Analyze phase, in addition the improvement opportunities were defined. By creating the Cause-and-Effect Diagram, the main causes that caused the problems in the process were analyzed, there were six main causes: people, method, material, transportation, inventory, system. Each main cause included root causes that led to delays in the process of connecting a new electricity service, in this chapter the root causes were illustrated and discussed in detail. Based on the root cause analysis the improvement opportunities were defined, where to be implemented in the Improve phase.

Chapter Seven

Improve and Control Phases of DMAIC and Discussion of Results

7. Improve and Control Phases of DMAIC and Discussion of Results

7.1 Introduction

This chapter presents the research findings that have been reached in the previous chapters as a result of the root cause analysis. It discusses the outcomes and it leads to provide solutions and recommendations to be implemented.

The DMAIC approach is very effective methodology within LSS that illustrated the wastes and variations in the process. The analysis that was conducted in the previous chapters showed that there are several inefficiencies in the process of connecting a new electricity service. This allows to determine the improvement opportunities where to be implemented to improve the process performance.

The analysis shows that the customers are not satisfied due to the delay in implementing the process of connecting a new electricity service, there were customer complaints on the long cycle time of performing the process. The analysis indicated the bottlenecks in the process that there was a delay in shipping the equipment from JDECO warehouses, in addition to the delay in installing the equipment in the facility, moreover the delay in estimating the equipment needed to perform the new electricity service. This clearly states that the delays were due to the lack in the resources in JDECO (staff, transportation, equipment), besides the lack of system to convert the documents between departments as an electronic version to keep the documents from loss, in addition to reduce the number of papers used.

The delays in performing the process affect the number of new customers' services that are connected on JDECO grid, where one of the main goals of JDECO to increase the number of customers who are connected on JDECO grid to supply electricity for them. Hence this will affect JDECO revenues to be decreased.

7.2 Improve Phase

The goal of the Improve phase is to identify the potential solutions to the problem that was discussed in the research, to implement the improvements, to measure the new performance, and document the new process.

Based on the outcomes of the research and identifying the wastes, variations, and inefficiencies in the process steps that JDECO is facing, it is recommended for JDECO to implement the following solutions:

1- JDECO should adopt a new purchase policy in the company to increase the inventory in the warehouses and to make a proper inventory management, where JDECO should increase the safety stock to have extra equipment carried for uncertainties in supply and demand. JDECO must study the trend of equipment needs for applying the process of connecting a new electricity service, where the type of equipment that the warehouses have a lack in it should be determined to cover this shortage by purchasing enough quantity for the future needs. This will lead that JDECO can estimate the needed budget to be allocated. The availability of the needed equipment will reduce the delay time of shipping the equipment step.

2- JDECO should study the workload and current staff work capacity.

3- Purchase additional trucks to ship the equipment from warehouses to the site of work at the right time. Hence the availability of enough transportation speeds up the distribution step of the equipment.

4- Hiring more technicians in the installation division to perform the tasks of installing the equipment of the new service at the right time. Where hiring more technicians will reduce the delay time of the installation step and increase the number of new services provided.

5- Purchasing additional cars specified to transport technicians to the facilities sites to install the new service.

6- Hiring employees and estimators (for both office works and site visit works) in the estimation division.

7- Purchasing additional cars to transport the estimators to the work site. Increasing the resources (staff and cars) in the estimation division will reduce the delay time of performing the estimation step.

8- Hiring drivers specified for both estimation division tasks and installation division tasks.

9- Building a system to convert the documents between departments as an electronic version, this will keep the documents from loss, in addition to reduce the number of papers used. Hence this will reduce the operational costs in JDECO.

10- Transferring the step of informing the applicant that his/her financial claim is ready to be paid from manual step into automated step linked with the financial approval. This step will ensure that the applicant has been informed as soon as possible, so this step

will reduce the delay time of the process and speeds up the starting of steps that are depending on the paying for the new service fees.

11- Specifying the time period for each step of the process. This will be ensured by creating a new flowchart for the process with specified time for each step. This will lead to put Key Performance Indicators (KPI's) of the process and this gives the ability for the company to monitor and control the process performance.

12- Applying the LSS methodology to improve other processes.

7.3 Discussion of Results

The DMAIC approach in LSS methodology has been applied in this research. The following tools were used: Problem Context Diagram (PCD), Project Charter, SIPOC, Flow Chart, Eight Wastes, Quick wins, Value Stream Mapping (VSM), Control Chart, Voice of Customer (VOC), Cause and Effect Diagram (Fishbone Diagram). These tools were used to identify the process problems, and the root causes of these problems were analyzed.

The process is not capable with low sigma level of 2.78, the problems in the process led to having unsatisfied customers as revealed in the customer complaints analysis. Where the analysis to determine the voice of customer (VOC) showed that the highly percentage of complaints were on the delay in installation of new electricity service, and the delay in columns installation, with percentages of 27% and 20%, respectively.

The problems in the process were first defined in the Define phase by applying the SIPOC to understand the process steps, process measures, goal performance, sources of variation

and wastes, impact on performance. On the other hand, the Project Charter has been developed; hence the problem, scope, and objectives were determined.

In this research, three main bottlenecks in the process were discovered that are forming the main problems:

- Delays in order and ship the equipment from JDECO warehouses step, with average cycle time 205.5 days.
- Delays in installation of electrical equipment of the new service step, with average cycle time 52.5 days.
- Delays in estimation of equipment step, with average cycle time 35 days.

In the Measure phase, the process current performance was understood and analyzed by the tools of Flow Chart, Eight wastes, Quick wins, VSM, Control Chart. The three bottlenecks that were mentioned above determined by using the VSM tool, moreover, the lead time of the process was 575 days, the average cycle time was 322 days, and the Percentage Value Added Time (%VAT) was 56% which is low, this means that there is a lot of time wasted.

Furthermore, the Control Chart of the whole process was applied, it showed that the actual current average time to complete the process is 182 days which is a long time. Moreover, the Control Charts of the three bottlenecks steps (Delays in order and ship the equipment from JDECO warehouses step, Delays in installation of electrical equipment of the new service step, Delays in estimation of equipment step) showed that the cycle times of these steps are 64.2 days, 16.4 days, 10.93 days respectively.

The Cause-and-Effect Diagram in the Analyze phase was applied and the root causes of the problems were determined in details. The root causes were summarized as follows:

1- People
    a- Lack of staff
    b- Work load
2- Method
    a- Poor documented procedures
    b- Manual work
    c- Excessive steps
    d- No specific time period for each step
3- Material
    a- Many papers used
4- Transportation
    a- Lack of cars and trucks
    b- Lack of drivers
5- Inventory
    a- Lack of equipment in warehouses
    b- Poor inventory management
6- System
    a- No system to convert documents between departments as an electronic version.

Based on the above, the potential solutions were identified to solve the problems that were addressed in the research to achieve the improvements.

7.4 Discussion of Results with JDECO Management

Since the problems in the process have been identified, and the root causes have been determined, measures should be taken to eliminate the wastes and inefficiencies to improve the process performance to make it more efficient. The top management in JDECO should be serious in implementing the measures (solutions) that are recommended in section 7.2 to improve the performance of the process and to increase the efficiency of it, hence these improvements lead to increase the revenues of the company.

Meeting was conducted with the top management of JDECO to explain all the analysis results, the management have shown their commitment to apply the changes and solutions that are recommended.

The reason that the outcomes of this research are not implemented immediately refers to that the potential solutions highly cost the company, in addition the potential solutions take time to be implemented. The management promised to do their efforts to allocate budget to implement the recommended solutions.

JDECO employees who are working in the departments that are responsible for performing the process started to scan and keep any document related to the process application in order to keep the documents from loss until the needed system has been built.

It was suggested to the manager of Ramallah branch to achieve a rotation step of the employees, where employees from certain divisions who are not related to performing the process are assigned tasks with the divisions that are responsible for performing the process of connecting a new electricity service to increase the staff number, but this idea was highly

difficult to be achieved as the manager replied because all the divisions are loaded with their tasks.

Since the research outcomes showed the actual averages of the cycle times for the bottlenecks steps (order and ship the equipment from JDECO warehouses step, installation of electrical equipment of the new service step, estimation of equipment step) with values 64.2 days, 16.4 days, 10.93 days respectively, these results were discussed with JDECO management, and based on that they agreed to take the needed actions to reduce these cycle times to 50%. These actions include supporting the responsible departments of performing the process with the necessary resources that include additional staff, additional transportation, and increasing the amount of equipment needed to cover the future needs.

Once the company applies the recommended solutions as stated in section 7.2, they will be the first Palestinian electricity distribution company which applies LSS methodology. Besides, JDECO can apply LSS methodology to other processes within the company to improve their performance and quality. On the other hand, this will be a success story and a great step by JDECO that will motivate the other Palestinian electricity distribution companies to apply LSS methodology within their processes.

Once it is proven that JDECO has applied the recommended solutions and the process becomes more efficient, there should be controls placed to assure that these improvements are kept. Such controls have been stated in section 7.5 since these controls have to be managed by JDECO management.

7.5 Controlling Developments (Control Phase)

The Control Phase is the final phase of the DMAIC LSS methodology, it aims to maintain the conducted improvements, where there are plans placed to assure that these improvements are well maintained. In addition, the Control Phase gives a plan to reveal if there were any future deviations from the improvements happened.

Since the developments and the recommended changes will be made by JDECO management, controlling these changes is very necessary by JDECO management to be kept as work standards to assure that there is no deviation from these standards.

7.5.1 Monitoring Controls

There are several tools that should be used by the management of JDECO to observe if there are any changes within the process that was improved. These tools should be as follows:

1- **Feedback Surveys**: JDECO should conduct feedback surveys, where these surveys were designed to be provided to the customers to collect their feedback about the improved process of connecting a new electricity service to see if they are satisfied about providing the new service.

   The feedback surveys allow JDECO to see if the customers are satisfied about the time of performing the process, in addition, to see if the customers can advise of any new changes that should be made within the process steps.

The survey was designed as shown in Appendix A.

This feedback system should be reviewed on a weekly basis where there should be an assigned team to review the input of this system and create reports about the customers' feedback and provide them to the higher management. Based on the feedback system inputs, the higher management should take the necessary actions.

2- Out of Control Action Plan (OCAP)

An Out-of-Control Action Plan (OCAP) is created to follow up the controls that are in place, where it provides an action plan for when there are deviations from the standards returns the process more efficient. Table 7-1 shows the created Out of Control Action Plan (OCAP) that JDECO should follow for the developed process.

Table 7-1: The Out-of-Control Action Plan (OCAP).

Deficiency Description	Process Step	Responsibility	Specification limits Requirement	Response Plan/ Actions to be taken	Resources
Delays in order and ship the equipment from JDECO warehouses	Order and ship the equipment from JDECO warehouses	JDECO warehouses	Must be provided within 32 days	1- Allocate budget for purchasing the needed equipment to cover the future needs. 2- Weekly performance report provided to the higher management.	Financial resources
Delays in installation of electrical equipment of the new service	Installation of electrical equipment of the new service	Technical department/ Installation division	Must be installed within 8 days	Weekly performance report provided to the higher management	1- Staff 2- Transportation
Delays in estimation of equipment	Estimation of equipment	Technical department/ Estimation division	Must be estimated within 5 days	Weekly performance report provided to the higher management	1- Staff 2- Transportation

JDECO should apply the LSS analysis every two years to measure the performance of the process, and to assess if there are any inefficiencies and wastes occur within those two years. This will allow JDECO to sustain a scientific approach for analyzing the processes.

7.6 The Future Work in JDECO

As stated before, it is difficult to conduct the potential solutions recommended because these solutions highly cost the company and takes time. But JDECO management advised that they will allocate the needed budget to implement the solutions.

Based on the research recommendations, JDECO management will start seriously work on the following key points:

First, JDECO management will create and implement a new flowchart for the process of connecting a new electricity service with determining the improved time for each step. These specific times will be documented in the process procedures, in addition to determining the Key Performance Indicators (KPI's) to monitor and control the process performance.

Secondly, JDECO management will start to develop an efficient system to document the related applications documents during converting them between departments to be worked.

Thirdly, JDECO will start studying the demand of equipment needs for performing the process of connecting a new electricity service in order to develop a new purchasing policy, where the type of equipment that the warehouses have a lack in it should be determined to cover this shortage by purchasing enough quantity for the future needs.

Finally, JDECO will start to study the workload, current staff work capacity, and current transportations in order to identify the new resources that are needed.

7.7 Research Outcomes

The outcomes of this research are as follow:

- All of JDECO processes were studied, and the data from customer complaints system have been analyzed. The process that has the highest work load, the highest delay, and the highest customer complaints is the connecting a new electricity service process.
- The process of connecting a new electricity service consists of eight steps to be implemented. the following three steps which are order and ship the equipment from JDECO warehouses, install of electrical equipment of the new service, and estimation the electrical equipment form the bottlenecks of the process.
- The LSS methodology and tools were applied, and this resulted in identifying the root causes for the problems and the wastes in the process.
- A set of recommendations and potential solutions were given as a result from this research. These solutions would assist the company to overcome the root causes and the wastes in the process.

7.8 Improve Phase Tollgates

1- Generate possible solutions:

Potential solutions were generated and recommended that JDECO should apply them to reduce the problems and reduce the delay in performing the process.

2- Implement solutions:

It was difficult to implement the generated potential solutions because of the financial and time limitation challenges and barriers.

7.9 Control Phase Tollgates

1- Monitor and control plan:

The Out-of-Control Action Plan (OCAP) that JDECO should follow for the developed process was developed which includes specification limits requirements that act as Key Performance Indicators (KPIs) to measure the process performance. This monitor and control plan should be applied after the potential solutions are implemented.

2- Response plan:

The response plan was included in the OCAP which included the actions that should be taken, and the reports that should be submitted to the top managements to address the problems that may occur in the process.

3- Continual control plan:

A continual improvement plan is needed to be created to continue making improvements to the process in the future, this will be after implementing the potential solutions, and after monitoring and controlling the process. Based on the evaluation of the results of LSS implementation, it is necessary to create the continual improvement plan.

Chapter Eight

Conclusions, Recommendations, and Future work

8. Conclusions, Recommendations, and Future work

8.1 Conclusions

In conclusion, the application of LSS at Jerusalem District Electricity Company (JDECO) using the DMAIC approach was a powerful problem-solving methodology to achieve the process improvement. This was by applying the efficient tools of the DMAIC approach.

In this research, the process of connecting a new electricity service which is a major process within JDECO was studied in details. Where the primary interviews with the quality department manager and his staff, and the primary customer complaints data that were analyzed lead to decide that this process has a priority to be investigated. the process included lots of non-value-added steps that caused customers of JDECO to be dissatisfied, and future work with the long cycle time it takes to provide electricity.

The research aimed to apply the LSS to improve the process; reduce the non-value-added steps in the process; reduce the time of connecting a new electricity service for customers; reduce the number of customer complaints associated with connecting a new electricity service; and increase the customer satisfaction.

The research followed the quantitative and qualitative methodology to achieve the research objectives and to answer the research question. The research followed the action research method where this method is considered an approach to problem solving. Different sources were used to obtain the data needed for the research, these sources were as the following:

interviews, records from the billing system in JDECO, and the customer complaints system. The interviews were conducted with eleven persons included the managers and employees from the four departments which are responsible for implementing the process of providing electricity to the customers: quality management department, customers services department, financial department, technical department. Eleven questions were asked for each person during the interviews. On the other hand, the data that were obtained from the billing system were during the period from the beginning of year 2019 to the end of February 2020. In addition, the data which were obtained from the customer complaints system were during the period from the beginning of 2019 until September 2020. The Minitab software program was used to analyze the data which were obtained from the Billing system. While, the Microsoft Excel program was used to analyze the data which were obtained from the customer complaints system.

The research used the following tools of the DMAIC approach: Problem Context Diagram (PCD), Project Charter, SIPOC, Flow Chart, Eight Wastes, Quick wins, Value Stream Mapping (VSM), Control Chart, Voice of Customer (VOC), Cause and Effect Diagram (Fishbone Diagram), and Out of Control Action Plan (OCAP).

In Define phase, the problems in the process were first defined by applying the SIPOC to understand the high level of the process steps, process measures, goal performance, sources of variation and wastes, impact on performance, and the target was determined that was to reduce the average time of the process to 50% (to be less than 91 days). On the other hand, the Project Charter has been developed; hence the problem, scope, and objectives were determined.

In Measure phase, the flow chart of the current process was created. In addition, the Value Stream Mapping (VSM) was created with detailed timing of step-by-step activities in the current process, The VSM revealed the steps that formed the bottlenecks of the process which were as follow: order and ship the equipment from JDECO warehouses step with average cycle time 205.5 days, installation of the electrical equipment of the new service step with average cycle time 52.5 days, and estimation of the equipment needed for connecting the new electricity service with average cycle time 35 days. Besides, The Percentage Value Added Time (%VAT) of the process was 56%. Furthermore, the control chart in the Measure phase determined the actual current average time to complete the process which was 182 days. Moreover, the Voice of Customer (VOC) analysis illustrated that 47% of customer complaints were related to the delays in performing the process. The current process performance analysis revealed that the process is not capable with low sigma level 2.78.

In Analyze phase, the Cause and Effect analysis were conducted, hence the root causes of the problem that JDECO is facing in regard to the longtime of performing the process were identified. The root causes were summarized as the following: lack of resources (staff, transportation), lot of manual work, lack of equipment in the warehouses, poor inventory management, no system to convert documents between departments as an electronic version. Based on the root causes analysis, set of potential solutions in the measure phase were set that JDECO should apply them to improve the process.

The research resulted in providing a set of recommendations (practical solutions) that should be applied to solve the problems and to achieve the process improvement. But there were challenges to apply the solutions which included the financial barriers, and the time

limitation. The top management of JDECO promised that they will implement these solutions once they allocate the needed budget to achieve the process improvement.

Since the time of connecting a new electricity service, and the number of customer complaints are considered an important Key Performance Indicators (KPI's) to measure the electricity distribution companies' performance in the Palestinian electric power sector, the application of LSS to improve the processes in these companies leads to improve the performance of the Palestinian electric power sector.

8.2 Recommendations

The research has the following recommendations:

1- JDECO should develop a new purchase policy to increase the inventory in the warehouses to cover the shortage of equipment specially the shortage of columns.
2- Developing a proper inventory management system.
3- Studying the workload and current staff work capacity.
4- Hiring more technicians in the installation division to perform the tasks of installing the equipment of the new service at the right time.
5- Hiring employees and estimators (for both office works and site visit works) in the estimation division.
6- Go to outsourcing to provide additional trucks to ship the equipment from warehouses to the work site.
7- Go to outsourcing to provide additional cars to transport the technicians to the work site.

8- Developing a plan for training the employees about the implementation of LSS within the company processes.

9- Developing a system to convert the documents between departments as an electronic version, this will keep the documents from loss, in addition to reduce the number of papers used. Hence this will reduce the operational costs in JDECO.

10- Creating a new flowchart for the process with specified time period for each step.

11- Generating weekly reports submitted to the top management about the process performance.

12- Transferring the step of informing the applicant that his/her financial claim is ready to be paid from manual step into automated step linked with the financial approval.

8.3 Research Contributions

Since the literature review revealed that there were limited previous researches were applied related to the application of LSS methodology to improve the processes within the electricity distribution companies. So, the research's main contributions to practice can be summarized as follow: the application of LSS for the first time in the Palestinian electric power sector has been added to the literature. Moreover, this research contributes to the introduction of LSS methodology in the Palestinian electric power sector as a knowledge contribution and culture change. In addition, the research contributes to strengthen the LSS practices by applying its tools, this leads to the development, improvement, and upgrading of the quality of services provided to customers by the electricity distribution companies in the Palestinian electric power sector.

8.4 Future Research Work

LSS can be implemented to improve all processes in JDECO, such as the billing issuing process, the maintenance process, the warehouses management process. Moreover, LSS can be implemented in the other electricity distribution companies to improve their processes.

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Appendices

Appendix A: Questionnaire about the Process of Connecting a New Electricity Service.

استبيان حول عملية ربط خدمة كهرباء جديدة

يهدف هذا الاستبيان الى تقييم عملية ربط خدمة كهرباء جديدة في شركة كهرباء محافظة القدس.

العمر : ..... الجنس : □ ذكر □ أنثى المهنة .....

القسم الأول:

يتكون هذا القسم من 12 سؤال، يرجى الإجابة عنها جميعها بوضع اشارة X تحت الإجابة التي تمثل أفضل وصف، بحيث أن درجة الموافقة مقسمة الى خمسة درجات من " أوافق بشدة" إلى " غير موافق بشدة" .

	البند	الإجابة				
		أوافق بشدة	أوافق	محايد	غير موافق	غير موافق بشدة
1	يتعامل الموظفين مع المواطنين بكفاءة ومهنية					
2	سهولة الحصول على المعلومات لتقديم الطلب					
3	متطلبات تقديم الطلب واضحة					
4	الدقة في تنفيذ الخدمة					
5	السرعة في انجاز الخدمة					
6	سرعة حضور الموظفين لإجراء عملية التقدير للمعدات المطلوبة لتركيب الخدمة					
7	رسوم دفع تركيب الخدمة					
8	توفر المعدات اللازمة لتركيب الخدمة					
9	السرعة في الاتصال على المواطن للحضور لدفع رسوم الخدمة					
10	السرعة في الرد في حال قيامك بالاستفسار عن وقت تنفيذ الخدمة					
11	طريقة تقديم الشكاوى					
12	سرعة الرد على الشكاوى					

القسم الثاني: اختر/ اختاري الإجابة المناسبة بوضع ○ حول الخيار المناسب:

السؤال	الإجابة			
العامل الأهم بالنسبة لي في عملية الحصول على خدمة كهرباء جديدة	الوقت	االسعر	الدقة	غيرذلك
حسب تقديرك، الفترة المناسبة لتركيب الخدمة	خلال 4 أشهر	خلال 3 أشهر	خلال شهرين	خلال شهر
هل واجهتك أية مشاكل خلال الحصول على ربط خدمة كهرباء جديدة	نعم		لا	
اذا كانت الإجابة نعم، اذكرها:				

الملخص

تعتبر لين ستة سيجما منهجية فعالة لتحسين أداء العملية، وتم تطبيقها في قطاع الخدمات كاستراتيجية ادارة لتحقيق تميز العملية. وعلاوة على ذلك، تطبيق لين ستة سيجما يقود لتحسين جودة الخدمة وزيادة رضا الزبون.

تكمن أهمية هذه الدراسة في تحسين عملية رئيسية في شركة كهرباء محافظة القدس – فرع رام الله – وهي عملية ربط خدمة كهرباء جديدة للزبائن. العملية الحالية تحتوي على خطوات لا تحقق قيمة مضافة وذات دورة زمنية طويلة لتقديم خدمة الكهرباء والتي تسببت في عدم رضا الزبائن. وعلاوة على ذلك، لا يوجد دراسات سابقة شبيهة لهذه الدراسة تم تطبيقها في فلسطين، مما يؤكد وجود فجوة يجب سدها من خلال تطبيق ستة سيجما داخل شركات توزيع الكهرباء.

تحقيقاً لهذه الغاية، تهدف هذه الدراسة لتطبيق منهجية لين ستة سيجما لتحسين عملية ربط خدمة كهرباء جديدة من قبل شركة كهرباء القدس للزبائن. وأكثر تحديدا، تم تطبيق منهجية DMAIC الخاصة ب لين ستة سيجما. تم استخدام العديد من أدوات اللين مثل PCD, Project charter, SIPOC, Flow charts, Eight wastes, Quick wins, Value Stream Mapping (VSM), Control charts, Voice of customers (VOC), Cause and effect diagram.

البيانات ذات الصلة والمعلومات تم جمعها من ثلاثة مصادر أساسية: مقابلات مع موظفين الشركة من مستويات مختلفة، سجلات من نظام الفوترة Billing System والتي تم تحليلها باستخدام برنامج Minitab 19، ونظام شكاوى الجمهور حيث تم تحليلها باستخدام برنامج Excel.

خلصت نتائج البحث لقياس الأداء الحالي للعملية، مشاكل العملية، والأسباب الجذرية للمشاكل، هذه المشاكل تمت مناقشتها مع ادارة الشركة. وبناءا على ذلك، نتج عن البحث تقديم مجموعة من التوصيات والحلول العملية التي يجب أن تطبقها الشركة لتحسين العملية. ولكن كانت هناك تحديات لتطبيق الحلول الموصى بها خلال هذا البحث والتي تضمنت العوائق المالية والقيود الزمنية.