



**ANALYSIS OF ROVER SYSTEM ON PRODUCTIVITY AND
RETURN ON INVESTMENT IN AGRICULTURE**

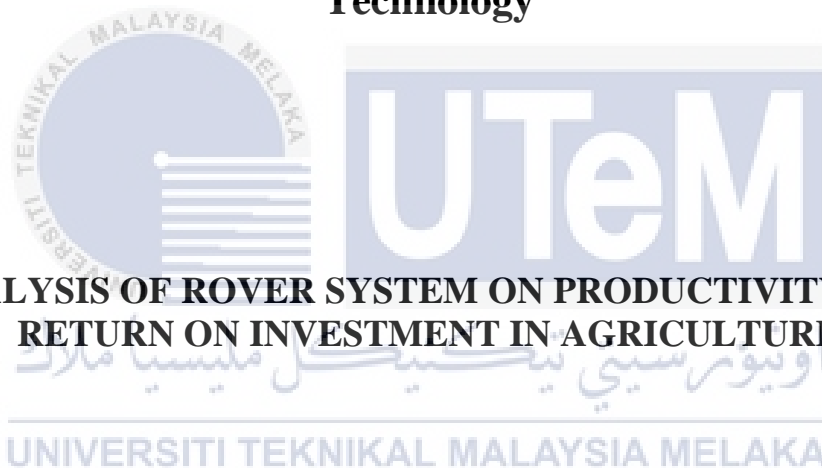


**BACHELOR OF MANUFACTURING ENGINEERING
TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH
HONOURS**

(2022)



**Faculty of Mechanical and Manufacturing Engineering
Technology**



**ANALYSIS OF ROVER SYSTEM ON PRODUCTIVITY AND
RETURN ON INVESTMENT IN AGRICULTURE**

Shurein A/L Arumugam

**Bachelor of Manufacturing Engineering Technology (Process and Technology) with
Honours**

2022

**ANALYSIS OF ROVER SYSTEM ON PRODUCTIVITY AND RETURN ON
INVESTMENT IN AGRICULTURE**

SHUREIN ARUMUGAM

**A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with
Honours**



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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this thesis entitled “ Analysis of Rover System on Productivity and Return on Investment in Agriculture” results from my own research except as cited in the references. Therefore, the thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature

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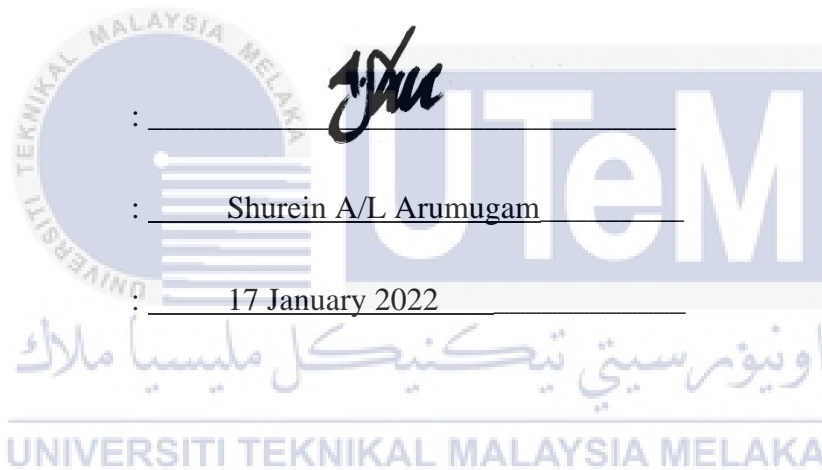
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APPROVAL

I hereby declare that I have read this thesis, and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature

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Supervisor Name

: Nur Aiman Hanis Binti Hasim

Date

: 15 January 2022



DEDICATION

To my beloved family and friends who have been my source of strength and inspiration
and gave me support in terms of moral, spiritual, and emotional.

To my supervisor Madam Nur Aiman Hanis Binti Hasim for guiding and supporting me in
completing this thesis. Also, to my co-supervisor Madam Nur Farah Bazilah Binti Wakhi

Anuar for giving me every possible solution needed.



ABSTRACT

Agricultural sectors are now in the process of facing either an increase or decrease when it comes to the rate of productivity. By simply implementing the rover system can be beneficial in that it affects drastic change in productivity and return on investment. Productivity is a critical issue in the agriculture sector that must be addressed in order to increase key performance indicators such as production and efficiency. Despite the fact that the agricultural system exists in our country, it still has problems with production, which does not meet the expected output. The aim of this research is to identify the factors that affected productivity performance and return on investment. Hence, to apply the Define, Measure, Analyse, Improve, Control (DMAIC) concept in agricultural performance and to recommend a solution to the industry for productivity improvement and performance. There are few tools that are used in order to complete this study. In order to obtain the outcome for this initiative, data were gathered and problems were identified. Data processing can be divided into two categories which are primary data and secondary data. The methods utilised to identify the underlying causes were the Fishbone Diagram and the Why-Why Analysis. Furthermore, the implementation of six sigma tools was approached as the DMAIC method enabled the work to be more effectively completed. The findings of this data were then tabulated using the Why – Why Analysis to identify a root cause remedy. The operating model system provided an efficient way to understand the process of the agricultural system. Then, the application of the Maynard Operation Sequence Technique (MOST) approach was to evaluate the working time and work process of the sectors as the work measurement technique produced sequence model for the complete activity. As such, the changes in the work process brought a valuable change in productivity and benefits in return on investment in such a way. Aside from that, the agricultural sector were to be advised to engage in optimization and improvement activities from minimising or removing factors that affect productivity utilising the MOST methodology. All analysis and root cause identification must be performed before results can be obtained. It has been discovered that a particular error involving human error needs to be removed from the process in order to increase productivity. As a result, a few potential alterations are described and suggested in this study. One of the most effective ways to boost output and save expenses was to deploy a rover system. Robotic rovers save time and money over manual labour, according to the study. Robotic rovers' ROI is 18.45% higher than manual labour.

ABSTRAK

Sektor pertanian kini dalam proses menghadapi peningkatan atau kekurangan dalam tingkat produktiviti. Dengan hanya melaksanakan sistem *rover*, ia dapat memberi manfaat kepada perubahan yang ketara dalam productivity dan *return on investment*. Produktiviti merupakan salah satu isu kritikal dalam sektor pertanian dan harus ditangani untuk meningkatkan prestasi utama seperti kecekapan pengeluaran. Walaupun sistem pertanian wujud di negara kita, ia masih mempunyai masalah dengan pengeluaran yang tidak memenuhi hasil yang diharapkan. Objektif kajian ini adalah untuk mengenal pasti factor-faktor yang mempengaruhi prestasi produktiviti dan *return on investment*. Selain itu, penggunaan kaedah *DMAIC* dalam prestasi pertanian dan mencadangkan penyelesaian kepada sektor pertanian demi meningkatkan produktiviti. Terdapat beberapa kaedah yang digunakan untuk menyelesaikan kajian ini. Demi untuk mendapatkan hasil dari daya usaha ini, data perlu dikumpulkan dan masalah yang wujud perlu diambil kira. Perlaksanaan *Six Sigma Tools* sebagai kaedah *Define, Measure, Analyse, Improve, Control (DMAIC)* telah dijalankan matlamat kajian dengan lebih berkesan. Penemuan data ini kemudian diggunakan secara Mengapa – Mengapa Analisis untuk mengenal pasti kaedah penyebab punca. Operasi sistem model menyediakan cara yang efektif untuk memahami proses sistem pertanian. Penggunaan teknik *MOST* adalah sesuai untuk penilaian masa dan proses kerja dalam kalangan sektor pertanian. Dengan demikian, perubahan dalam proses kerja telah membawa peralihan yang berharga dalam produktiviti dan memberi keuntungan kepada *return on investment*. Hasil didapatkan selepas semua analisis disiapkan and punca utama yang mempengaruhi productivity telah dikenalpasti iaitu kesalahan manusia yang terbabit dalam pengurangan produktiviti. Oleh itu, sektor pertanian disarankan untuk terlibat dalam kegiatan penambahbaikan dan aktiviti peningkatan dengan mengurangkan atau menghapuskan factor yang mempengaruhi produktiviti menggunakan teknik *MOST*. Pelaksanaan *rover system* adalah salah satu penyelesaian untuk meningkatkan productivity serta menjimatkan kos. Analisis yang dilakukan membuktikan bahawa *rover system* lebih menjimatkan masa berbanding dengan kerja buruh dan pulangan pelaburan untuk *rover system* adalah 18.45% lebih berbanding dengan kerja buruh.

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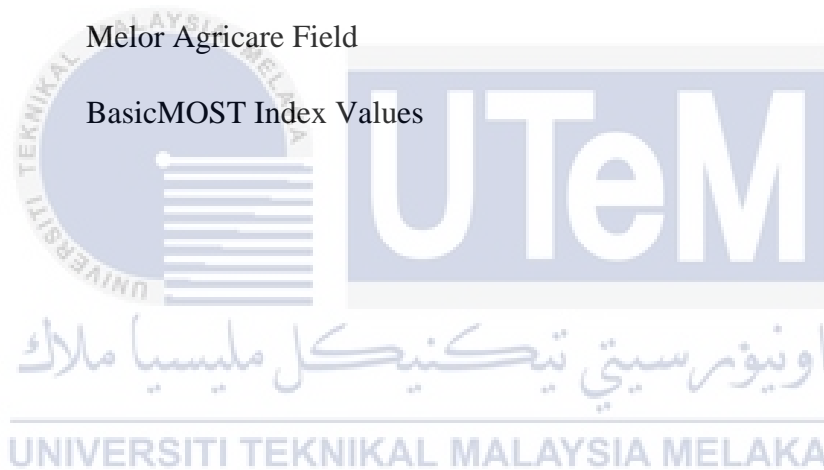


LIST OF ABBREVIATIONS

MOST	-	Maynard Operation Sequence Technique
ROI	-	Return on investment
SPRS	-	Smart Pesticide Rover System
QCC	-	Quality Control Circle
TQM	-	Total Quality Management
PFMEA	-	Process Failure Modes and Effect Analysis
SPC	-	Statistical Process Control
UCL	-	Upper Control Limit
LCL	-	Lower Control Limit
DFSS	-	Design for Six Sigma
RCA	-	Root Cause Analysis
DOE	-	Design of Experiment
DPMO	-	Defect Per Million Opportunity
OLS	-	Ordinary Least Squares
GWR	-	Geographically Weighted Regression
SROI	-	Social Return on investment
AI	-	Artificial Intelligence
NVA	-	Non – Value Added
TDABC	-	Time – Driven Activity – Based Costing

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CHAPTER 1

INTRODUCTION

1.1 Research Background

There are various factors that influence construction labour productivity in Malaysia today. The facility's design determines its complexity and intricacy, which in turn influences labour productivity. A second distinction to make is between factors that influence productivity and those that only influence costs. It is the responsibility of management to provide the necessary tools, equipment, equipment, and information to the workforce in order for them to perform their duties in a workmanlike manner. An additional economic concern arises when productivity increases as a result of a change in job design, resulting in the worker's job being downgraded and his pay being reduced. As a result, the majority of farmers continue to use traditional methods and outdated machinery (William F.Maloney, 1983). As a result, productivity is low. Need agriculture institutional arrangement to farmers to educate them with short term courses or workshops to educate and update the latest methods and machinery in the hope that it will deliver results is quite common in the context of agriculture, as stated by Ch. Chandra Sekhar (2017). Techniques developed in advanced countries were not always directly transferable to less developed countries due to differences in climate and resource endowment. The principal sources of high productivity in modern agriculture are reproducible sources. They consist of specific material inputs as well as the skills and other capabilities required to successfully use such inputs (Vernon W.Ruttan, 2002).

There is never enough time or money to complete all worthwhile tasks. When faced with a plethora of potential projects and limited funding, standard business and economic advice are to invest in projects with the highest rates of return on investment. According to William Murdoch (2007) whereas in conservation applications, Return on Investment (ROI) reflects the changes in the conservation objective per unit cost of the conservation action. Conservation actions might include land purchase, or easements, management of invasive species, fire management, pollution control, lobbying activities, conservation financing aimed at sustainable forestry, and so on. Protected areas are essential in efforts to conserve biodiversity and secure and focus on improving ecosystem services. Protected areas vary in many ways, and countries must ensure that newly established protected areas are ecologically effective. This includes ensuring that protection is targeted to areas where it is most needed and that protected areas are appropriately sized and adequately funded. As a result, any new protected areas must be chosen in a cost-effective and ecologically sound manner. Conservation organisations increasingly rely on return-on-investment (ROI) analyses to balance these demands. P.R. Armsworth et al. (2018) addressed that ROI approaches seek to identify candidate sites for protection that offer the greatest return, when measured in terms of the ecological goals motivating conservation, for every money spent on protection.

Manipulating pest infestations plays a vital role in increasing productivity. Farmers are having a difficult time dealing with pest infestations. The main disadvantage of this method is that the pesticide may come into contact with the farmer during spraying, which may cause skin cancer and asthma attacks. Increased pesticide spraying has the potential to harm consumer health as it enters the food chain. Pesticides are also sometimes sprayed on crops that are not affected, resulting in the same waste. By using the form of SPRS (Smart

Pesticide Rover System), produced a fresh concept of using IoT to monitor crops and to use intelligent farming (Dileep Kotte, 2020).

The primary objective of any work measurement technique is to reduce work content and thus improve process productivity; this is concerned with the intention to spread awareness of a specific work measurement technique known as the 'Maynard Operation Sequence Technique (MOST). The stopwatch method would typically take forever for an Industrial Engineer who would be standing right behind the operator, observing and noting down the various actions. This, in turn, causes a slew of annoyances, deliberate delays, and the addition of non-value activities by the operator. The important challenge is that the worker/union believes the entire estimate is unfair. The MOST technique nearly eliminated the unpleasantness for workers (Vivek A. Deshpande, 2007). A manufacturing company's productivity is hampered by bottlenecks at workstations. As a result, bottleneck workstations and non-value-added activities are essential for achieving the company's goal. As a result, it is essential to identify and eliminate bottlenecks and non-value-added activities. The MOST can be defined as a method of analysing operations or sub-operations that are carried out using various methods, steps, and sequences, etc. In other words, it is a motion time method that aims to define the standard time of performing the work. As a consequence, increasing productivity through the smooth workflow is critical (Md. Sumon Rahman, 2018).

1.2 Problem Statement

In the past years, although the agricultural system exists in our land but yet it is still facing issues when it comes to productivity where the productivity does not reach the desired output. This can be caused by several factors when it comes labour or pesticide. This analysis aims for productivity improvement based on the MOST technique using the DMAIC concept in agriculture performance and calculation of ROI. Hence, the techniques will tend to improve productivity with ROI based on the factors in agriculture. When it comes to controlling the issues in pesticides, the rover system approach will come in handy as not much agricultural field uses this system to increase their productivity and reach the desired output.

This is applied so that the product will meet the desired output. Through ROI we can accumulate the return on investment as this is a field where a wide range of investment can be implemented. If the SPRS is introduced to the field, it aids the economic development of farmers and, by extension, the nation. Using this type of robot, the time spent spraying pesticide liquid is reduced, and it will also assist farmers in reducing their workload in any season or condition (Chaitanya et al., 2020). But in order for it to be successful, the solution has to be tested using the MOST technique as we can differentiate the current working method with the provided solution to produce a proper outcome and eliminate downtime.

1.3 Research Objectives

The main objective of this study is to enhance productivity performance through Rover System implementation in agriculture. The general objectives of this study are :

- a) To identify the factors affected to productivity performance and ROI.
- b) To apply the DMAIC concept in agriculture performance.
- c) To recommend a solution to the industry for productivity improvement and performance.

1.4 Scope of Research

Particularly, this study will focus on the improvement of the production activities by using the tool MOST in the agriculture industry based on DMAIC (Define, Measure, Analysis, Improvement, Control) method. The crucial task of this study is to minimize or eliminate waste and controlling the smoothness performance of productivity through reduction of pesticide burst process time in agriculture. Hence, the application of ROI measures the gain and loss on an investment related to the amount of money invested as this should improve the decision-making process. This method is important to achieve timely delivery to customers also continuous improvement in the company.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To make a long story short, the analysis of agriculture throughout the years has been an unstable record in productivity due to several kinds of factors that affected production. According to Ruttan (2002) in modern agriculture, the primary sources of high productivity are reproducible. They consist of specific material inputs as well as the skills and other capabilities required to successfully use such inputs. However, these modern inputs are rarely ready-made. In general, there is a body of knowledge that has enabled advanced countries to produce for their use factors that are technically superior to those used elsewhere. Time consumption is decreased in spraying the pesticide liquid and it will also assist farmers to lessen the burden and in any season and weather conditions to complete the task. Early detection and avoidance of pests are vital in crop management (Dileep Kotte, 2020). However, Armsworth et al. (2018) stated that conservation organisations are increasingly relying on return-on-investment (ROI) analyses to balance these demands. ROI approaches seek to identify candidate sites for protection that provide the greatest return for every money spent on protection when measured in terms of the ecological goals motivating conservation. Hence, manufacturing has been on a decades-long quest for increased productivity. As a result, a slew of technology advancements and productivity-boosting methods have arisen (Park & Li, 2019). This strategy has aided in the advancement of the operations management discipline by increasing productivity levels in practice (Güldenpfennig & Hansen, 2021).

2.2 Six Sigma

Lean manufacturing is a methodology that assists businesses in continuously eliminating waste (for example, overproduction and waiting time), whereas Six Sigma is used to reduce variation in processes with the ultimate goal of improving quality production and performance. It is one thing to successfully implement quality tools; this is quite another to choose which quality tools will significantly improve the organisation's performance. One of the most difficult aspects of implementing quality tools in the Lean and Six Sigma methodologies is examining which tools are most effective in improving overall operational performance (cost reduction, productivity, and quality). This is because not all high-quality tools are required for a specific project (Cohen et al., 2020).

There are so many solutions to production problems and retrofitting manufacturing technology, such as the Quality Control Circle (QCC), Total Quality Management (TQM), design of experiments, Process Failure Modes and Effects Analysis (PFMEA), and Six Sigma (6 Sigma, 6) method, among others. Six Sigma can effectively enhance the overall capacity of the process with a systemic and comprehensive approach. Based on the ideas of C. Lin (2009) with a systematic DMAIC process and tactic, only Six Sigma can improve product quality comprehensively. It usually starts with key customer needs and internal process needs, then affirms the key quality index and key process index, clarifies the definitions of key input, process, and output indexes, and recognizes the critical factors using a Cause and Effect Diagram and PFMEA.

Six Sigma is a quality-improvement initiative that utilizes a plethora of services in a DMAIC-style process (define, measure, analyse, improve and control). Six Sigma aims to discover and eliminate the root flaws or defects in business processes. Six Sigma focuses on outputs that are critical to customers (L. B. M. Costa et al., 2021). Process yield and process

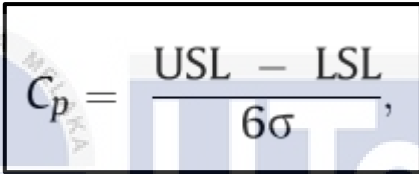
expected losses are two fundamental tools used to study samples consist of quality and performance. Process yield is a traditional evaluation tool that measures the quality of products or processes, Taguchi (1991) developed process expected loss to define the quality of products or processes based on the concept of loss (Wang & Chen, 2020). As identified by A.Swain (2018) Six Sigma is a quality assurance technique that aims for a process to have zero defects. Six Sigma has been characterized as an administrative innovation, a business development technique for increased customer satisfaction and improved organisational efficiency, as well as a culture change initiative that represents a push for productivity and profitability.

2.2.1 Importance of Six Sigma

Six Sigma is a systematic, integrated, and customer-oriented approach aimed at improving process performance and quality, Six Sigma is a systematic and customer-oriented approach to enhance processes, products, or services via statistical techniques, to improve their performance and quality. The Six Sigma application was however intended to increase the supply of the final assembly lines with the product. The application of Six Sigma was thus anticipated to first increase the number of goods produced and reduce the associated cost of quality. Six Sigma's methodology was used only in the productive sector, but it expanded rapidly to different operating fields such as administrative, marketing, engineering, and purchasing after its application had been found able to benefit from deteriorates the performance and reduces expenditures (J. P. Costa et al., 2019). N,Gupta (2021) states that Six Sigma is a disciplined, statistical analytical, and data-driven approach to eliminating weaknesses in a product, process, or service.

Three evaluation cycles should include an expert evaluation with Six Sigma professionals, a technical experiment, and finally a multi-cases study in a company (Kregel

et al., 2021). In other words, Six Sigma is mainly used to detect defects in a corporate field or some other field which will surely come in handy to identify problem areas to achieve the customer's production quality. Čampulová et al (2017) stated that the residual process X's statistical capability is monitored using the Six Sigma framework. The residuals' behavior is evaluated again on disjoint segments of size n, and the competence index Cp is then built for each day based on the estimates of characteristic σ in preliminary segments. The capability index, which is used to establish if the process strays significantly from the prescribed mean or produces outliers due to individual observation variability, is evaluated using the Cp relation as shown in Figure 2.1.



$$C_p = \frac{USL - LSL}{6\sigma}$$

Figure 2.1 Process Capability Index (Čampulová et al., 2017)

2.2.2 Advantages and Disadvantages of Six Sigma

The top management has been attributed to a large portion of Six Sigma's rise. To contribute to a more reasonable understanding of top management, transformational and visionary leadership ideas have been advanced (Swain et al., 2018). Six Sigma will benefit sales and marketing efforts by bringing process discipline and a focus on measuring performance. In targeted product/markets, the Six Sigma strategy adds measurable value to sales and marketing success and facilitates growing market share and top-line revenue. Due to its high focus on trouble detection, process improvement, and consumer focus, Six Sigma is well-suited to contribute to and support these sales and marketing strategies. Since sales and marketing require a disciplined and strategic strategy for value creation and business growth, Six Sigma implementation in sales and marketing will be depending on its ability to

adjust and adapt to organisation objectives. By generating superior value, the Six Sigma approach assists sales and marketing in growing market share and top-line revenue in targeted products/markets (Madhani, 2017). However, Muralidharan (2015) states that Six Sigma has a huge advantage over other key performance measures in that it is customer-driven. It is adaptive rather than reactive in that it intends to establish how to change things long before faults or flaws are exposed.

Six Sigma helps in the effective application of scientific methodologies. It is a prospective strategy in preference to other quality schemes because it focuses on defect elimination rather than defect resolution. For example, a moderate measure that may end in a marginally higher defect rate may be rejected in favor of a higher-cost measure that aids in Six Sigma but it does have a negative impact on profitability. Six Sigma is a quality initiative, not a cost-cutting technique. By removing faulty goods, costly rework, and returned products, systematically improving quality will save money. Cost savings, on the other hand, are a by-product of any quality improvements in the process. Six Sigma programs may or may not result in any cost savings. Improving product quality can result in capital expenditures as well as long-term overhead costs in the form of additional quality staff. Prior to beginning the project, the process was evaluated to improve quality and efficiency metrics and lay the groundwork for using the Six Sigma methodology (Vendrame Takao et al., 2017).

2.2.3 Results of Six Sigma

The proposed method has the advantage of reducing the number of observations needed for manual data control. This is particularly useful for maintaining the consistency of data that is continuously measured with a high temporal resolution. Automatic detection of segments containing outliers will save a lot of time because the specialized operator only

has to deal with the observations that relate to the detected segments (where the observations are in any way inconsistent with the rest of the data) and does not have to worry about the overall data quality (Čampulová et al., 2017). (Vendrame Takao et al., 2017) the project team was able to introduce successful corrective measures to reduce cycle time by quantitatively identifying the problem, measuring direct and indirect processes, and analysing the data with statistical tools. The development of ordinal regression models aided in understanding the significance of some of the quality tools, which we dubbed essential quality tools (Cohen et al., 2020). Wang & Chen (2020) concluded that this approach can be used to create a six-sigma quality evaluation model, and this analysis produces a six-sigma quality evaluation model. When assessing product quality, it can be overcome that the sampled samples in practice do not always have natural distributions, or that the number of small samples limits such product characteristics.

2.3 Six Sigma Tools

To crown it all, "Conformance to requirements or specifications" is the definition of quality. Quality refers to a product's ability to meet the needs of the consumer. Customer satisfaction is the objective of quality. These products and the measurements that are not attached to the product have intrinsic quality values for dimension. To maintain international quality standards, the organisational management of product quality has adopted the ISO 9001 standard. This quality level necessitates practices that enhance the manufacturing process without wasting resources. The price is very huge. In reality, the program is expected to lower costs, especially the cost of quality, allowing the firm to produce more income. Since there are goods that do not adhere to the prescribed standard, the cost of quality appears to hold no product whose quality is below standard or may claim the cost of quality is the cost of the already published. Quality costs are categorized such as preventive costs, which

include elements such as quality manufacturing, quality preparation, quality planning, quality audit, design review, and quality circles, analysis costs, which include elements such as raw materials, packaging, inspection, product acceptance, acceptance, and field-testing process, and operating costs, which include elements such as raw materials, packaging, inspection, product acceptance, acceptance, and field-testing process. Scrap, rework, downtime, reinspection, retesting, and design improvement is examples of internal failure costs, while missed revenue, returns or allowances, warranties, repair, product liability, and complaint modification are examples of external failure costs (Shonhadji, 2017).

Alkasisbeh et al. (2018) demonstrated that to evaluate the key issues that prevailed in projects, Six Sigma methods such as checklists, Pareto diagrams, cause and effect diagrams, and control charts were used. Six Sigma has proven to be an effective success measure and process improver for businesses in a variety of industries. Six Sigma is a method of pinpointing sources of errors using highly detailed data collection and statistical analysis. It aids in the reduction of costs, the improvement of quality by process improvement, and the reduction of production time.

2.3.1 Check Sheet

A check sheet is a simple tool that was once one of six sigma's seven basic tools. The check sheet was made to be as basic as possible. This is due to two factors. First and foremost, it was intended to be a basic data recording tool. Second, the check sheet was designed for people working on the shop floor. These issues would be discovered if checkpoints were used. If the process cannot be reversed at that stage, it continues with an "error carry" scheme. A complication or a bad surgical outcome will be the end result (Acquafresca et al., 2020). They generate a "consistent, accurate, and cost-effective methodology" that can be used in quality assurance auditing for monitoring and following

the steps in a process (Neyestani, 2017). Defect-location check sheets, tally check sheets, and defect-cause check sheets are three of the most common types of check sheets. A tally check sheet is shown in Figure 2.2 that can be used to collect data during the manufacturing process.

Telephone Interruptions						
Reason	Day					Total
	Mon	Tues	Wed	Thurs	Fri	
Wrong number						20
Info request						10
Boss						19
Total	12	6	10	8	13	49

Figure 2.2 Check Sheet (Tally) for Telephone Interruptions (Neyestani, 2017)

2.3.2 Histogram

Histograms, also known as frequency distribution diagrams, are bar graphs that depict the distribution pattern of Amman building problems, which are clustered into convenient class intervals and classified in order of magnitude. There are some drawbacks to simply computing multiple histograms in parallel. To begin with, the number of histograms to compute will usually be tiny. More importantly, since each histogram is focused on all data points, one is still constrained by the memory space of each individual computer (Sainudiin et al., 2020). As identified by Sbert et al. (2021) they've become commonplace in all fields of knowledge, used to visualize the distribution of events, or frequency, between different values of a variable. Each value is represented by a rectangular “bin”, the height of which corresponds to the frequency. If the variable is static, the range is traditionally divided into equal intervals, with a representative value assigned to each section. A frequency histogram is used to represent relative frequencies. A regular histogram is a graph with bars that fits the criteria listed below as shown in Figure 2.3. On the horizontal axis, only one statistical variable's data is displayed. The data is measured at the interval or

ratio level. The variable should ideally be continuous. The class density, or when bin widths or class intervals are equal, which is relative frequency or frequency, is often displayed on the vertical axis (Boels et al., 2019).

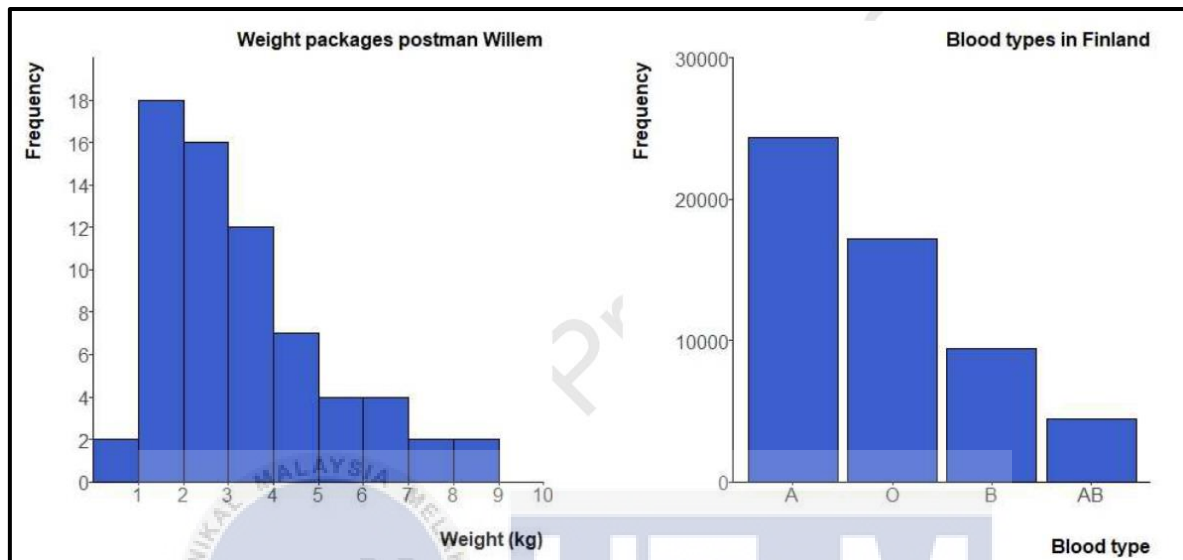


Figure 2.3 Example of a Histogram (Boels et al., 2019)

2.3.3 Pareto Analysis

Based on the ideas of Neyestani (2017), a Pareto chart is a form of the histogram that can be used to effectively identify and prioritize quality issues, conditions, and triggers within a corporation. The aim of a Pareto chart is to determine the various types of "nonconformity" based on data stats, maintenance data, repair data, parts scrap rates and other sources. In addition, a Pareto chart may be used to establish a means for investigating quality management and performance, as well as "material waste, energy conservation, safety concerns, and cost reductions". On its secondary axis, the Pareto diagram keeps a list of the defects' accumulated frequency level occurrences (Memon et al., 2019). This concept is used in SPC and regulatory compliance for a variety of purposes, including prioritizing projects for improvement, optimizing the formation of corrective action teams to fix issues, identifying items for which the most complaints are issued, identifying the essence of

complaints that occur most frequently, and identifying the most likely causes of rejections (Parmar & Awasthi, 2018). Erdil (2019) emphasizes the collection of data as shown in Figure 2.4 can be partitioned into areas to promote a Pareto map (also called segments, bins, or categories). The absolute weight (AW-the number of counts for each category) is labeled on the left-side vertical axis of the Pareto map, the average AW percentage is labeled on the right-side vertical axis of the Pareto chart, and the horizontal axis of the Pareto chart is labeled with the group names of technical requirements. The number of data points in a Pareto chart is defined by the number of people who live in each group, but unlike a bar chart, the Pareto chart is arranged in descending frequency magnitude, and users classify the groups.

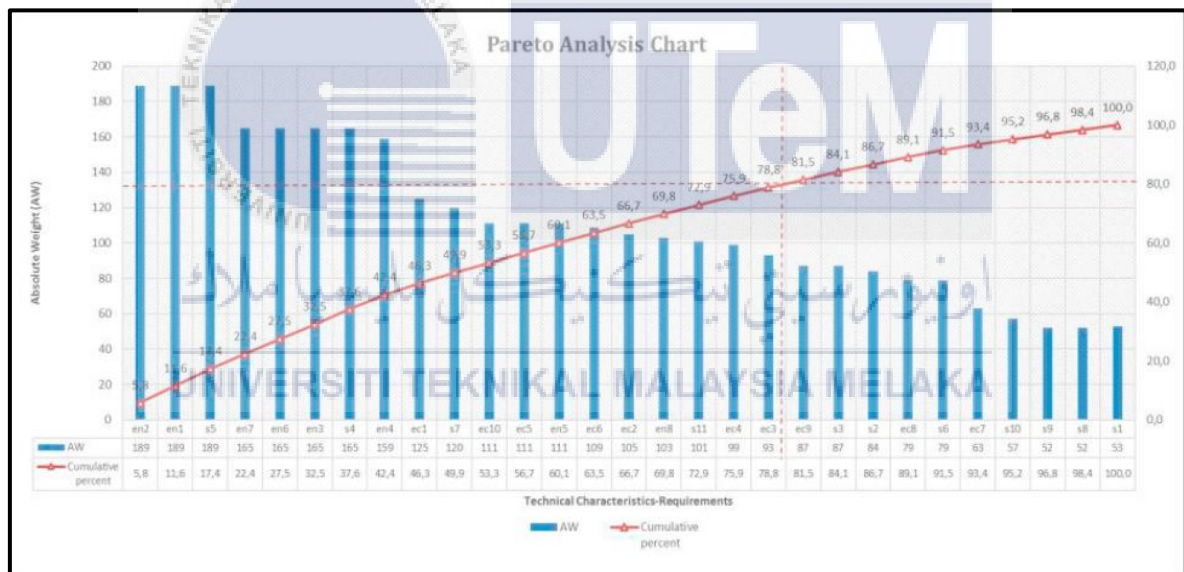


Figure 2.4 Pareto Analysis Chart (Erdil, 2019)

2.3.4 Cause and Effect Diagram

A cause-and-effect diagram is a visual technique for logically analysing potential causes for a particular issue or effect by graphically showing them in increasing detail, implying causal relationships between theories. A fishbone diagram, also known as an Ishikawa diagram, is a basic way. A tree diagram may also be used to portray cause-and-

effect relationships. To convert the root cause analysis into a cause and effect diagram that can be used to define and solve problems (Kuendee, 2017). However, Memon et al. (2019) stated that the cause and effect diagram aids in the discovery of the problem's root causes. Since the form of the diagram resembles the skeleton of a fish, it is also known as the Ishikawa diagram and the fishbone diagram. It is used to classify quality issues based on their significance. By “gathering and organizing the possible causes, reaching a shared definition of the problem, exposing gaps in established information, ranking the most likely causes, and studying each cause,” this diagram will aid in problem-solving efforts. The cause and effect diagram as shown in Figure 2.5 is typically divided into six elements that represent the causes such as setting, materials, system, calculation, individual, and process (Neyestani, 2017).

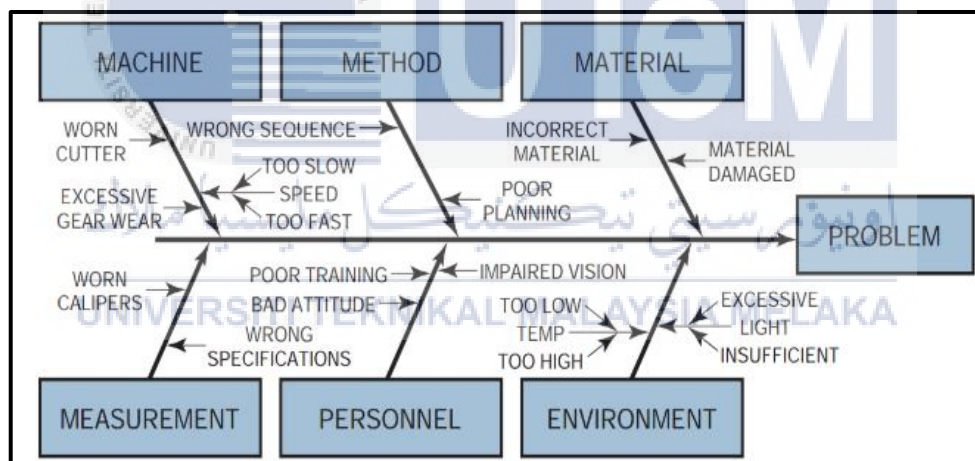


Figure 2.5 Cause and Effect Diagram (Neyestani, 2017)

2.3.5 Control Chart

Neyestani (2017) pointed out that control charts are a type of “run chart” that depicts the amount and type of change in a process over time. It can also draw and explain what is happening during the process. As a result, using a control chart is critical because it allows researchers to observe and monitor processes that are under “statistical control” based on

samplings or samplings that fall between Upper Control Limit (UCL) and Lower Control Limit (LCL). Complementary to this, the main aim of the control chart is to prevent defects in a process. The main goal of a control chart is to avoid process errors. The control chart allows for the diagnosis and correction of many production issues, resulting in significant increases in product quality and a reduction in spoilage and rework. It tells us when to leave a process alone and when to intervene to fix a problem (Parmar & Awasthi, 2018). According to Neyestani (2017) Because “statistical control” does not exist between UCL and LCL, the process is out of control, and control may be used to determine the source of the quality problem, as shown in Figure 2.6, where A point is under control and B point is out of control.

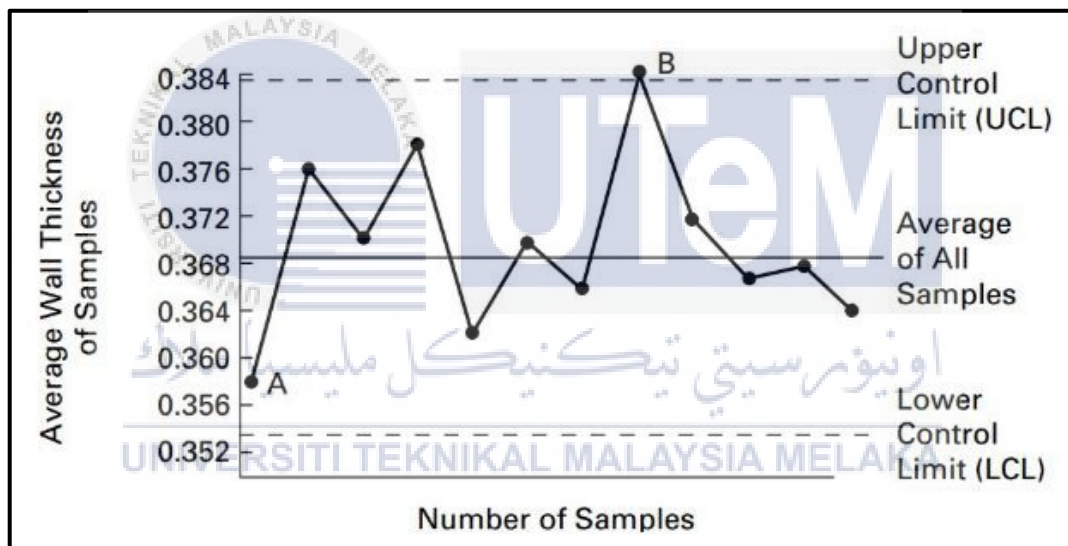


Figure 2.6 The Shewhart Control Chart (Neyestani, 2017)

2.3.6 Advantages and Disadvantages of Six Sigma Tools

The check sheet is a straightforward and efficient method of displaying results. Since it offers a standardized data collection method, it is a successful first step in understanding the essence of the problem. It is very useful in the Define and Measures step of the Lean Six Sigma DMAIC system to help differentiate opinions from evidence. Six Sigma's attributes extend beyond clear problem-solving to include the entire manufacturing process, from raw

materials to finished goods, rather than just the finished goods. When an organisation introduces Six Sigma tools, issues will occur because the company focuses solely on Six Sigma endorsed policies and ignores its own mission statement or policies. Following the initiation of Six Sigma programs, employees at ST recognize that meeting customer needs is more important than meeting departmental targets (Yang et al., 2018).

2.3.7 Application of Six Sigma Tools

DFSS is a strong approach to achieving high standards of quality that falls under the general umbrella of Six Sigma methodology. DFSS can be used for more than just the production of new products or processes, it can also be used to increase quality and service activity by redesigning existing products or processes. In conventional improvement programs, Six Sigma practitioners often use existing manufacturing or service process data to conduct their research, while in the DFSS process, they often use simulations and system design/analysis methods. To achieve the best performance of the design, the tool selection is based on the current situation. In the redesign phases of troubleshooting and service delivery, for example, we can see the gaps between design concepts and tool implementations (Yang et al., 2018).

2.3.8 Results of Six Sigma Tools

Without a doubt, management should consider and employ all of the above quality tools when finding and resolving design flaws during the production of goods and services (Neyestani, 2017). By investigating the causes of process breakdowns and eliminating their root causes, lean six sigma tools help to improve supply chain efficiency. The majority of improvement processes focus on lead time and inventory availability problems (Bavdhankar et al., 2019). However, Alkasisbeh et al. (2018) pointed out that these issues must be detected as soon as possible in order to enhance efficiency. Pareto, cause and effect diagram, checklist

sheet, histogram, and scatter diagram are some of the six sigma methods and techniques used in this study.

2.4 Define, Measure, Analyse, Inspect, Control (DMAIC)

Six Sigma is based on a set of clearly specified measures. In Six Sigma programs, the DMAIC approach specifies strategy and orientation lines. The DMAIC methodology is a systematic and disciplined approach that provides numerous benefits, including the study and analysis of the problem, as well as the exploration for a solution. Initially, the Six Sigma technique was used in the manufacturing sector and manufacturing processes (Kholkar & Sangodker, 2019). Nevertheless, Patil et al. (2020) relate identifying and removing defects, setting performance targets, the consumer value, and achieving strategic objectives are all advantages of the six sigma approach. The DMAIC methodology (Define, Measure, Analyse, Improve, and Control) is used to apply six sigma in a systematic manner.

The initial stage Define (D) describes the problem, the solution variables, and the research objective. The Measure (M) stage depicts the study's materials, concrete mixing procedures, and specimen preparation for measuring the strength of RCA and RCAC. The material and concrete specimen test results are shown and discussed during the Analyse (A) stage. The defects are found in the next step, Improve (I), in order to improve the quality of the RCA. The final stage of the technique is Control (C), where final response variables are observed and good RCA consistency is found across all samples. Iriani et al. (2020) confirmed that the DMAIC approach is a method for identifying and analysing the root causes of a product's impairment in the most efficient way possible.

2.4.1 Importance of DMAIC

Six Sigma's DMAIC (Define, Measurement, Analyse, Develop, Control) methodology has been widely accepted as a game-changing process management technique for human resources that reduces defects and errors in a broad range of business processes. As evidenced by the large number of large organisations that have taken on the task of applying the DMAIC, Six Sigma is becoming increasingly common among organisations from different industries as a collection of resources to generate change (Patil et al., 2020). Certain issues are detected, variables influencing the process are quantified, causes of the problems are evaluated, change is designed and introduced, variables are tracked until the expected sigma level is achieved, and customer satisfaction is optimized using the DMAIC methodology (Abdul & Purwatmini, 2018).

2.4.2 Advantages and Disadvantages of DMAIC

Identifying and removing defects, setting performance targets, the consumer value, and achieving strategic objectives are all advantages of the six sigma approach. The DMAIC methodology (Define, Measure, Analyse, Improve, and Control) is used to apply six sigma in a systematic manner (Patil et al., 2020). Likewise, DMAIC focuses heavily on improving manufacturing processes, resulting in increased profitability for the company. Furthermore, Six Sigma initiatives were found to result in significant cost savings as well as intangible benefits such as improved employee engagement, teamwork, and productivity (Evander Subagyo et al., 2020).

2.4.3 Application of DMAIC

Sodhi (2020) claims that DMAIC (define, evaluate, analyse, improve, and control) is a data-driven quality improvement approach. The letters in the acronym stand for the five

stages of the operation, as well as the resources needed to complete them as shown in Figure 2.7. It is an essential component of a Six Sigma project, but it can also be used as a stand-alone quality assurance technique or as part of other process improvement projects. The DMAIC approach is a five-step approach that is part of the Six Sigma toolkit. Its primary purpose is to eliminate costly variance from manufacturing and business processes (Ali, 2021).

2.4.3.1 Define the Problem

Abdul & Purwatmini (2018) stated that this phase identifies difficulties arising from client needs, followed by a decision on which areas will be improved. The improvement team's concentration, scope, direction, and motivation will be defined by the project charter. To consider input from current and potential customers indicating services that please, delight, and dissatisfy them, use the voice of the customer.

2.4.3.2 Measure Process Performance

The measure stage's major goal is to focus your development efforts by obtaining the appropriate information or data generated during the process. Throughout the process, it's critical to know how much to measure in order to ensure that enough data is obtained while not wasting time gathering excessive amounts. This stage should produce data that pinpoints where the problem occurs and how frequently it occurs, baseline data that illustrates how well the process is working and an understanding of how the present process works, and a more defined problem description (Kholkar & Sangodker, 2019).

2.4.3.3 Analyse the Process

The most significant part of the DMAIC is the analysis stage. This stage's overall purpose is to identify and validate the fundamental cause of our original problem. Proper

solutions will not be created if the analysis process is not completed completely, and the problem will persist. The defined problem statement that was established in the previous stage should be the starting point for the process. The procedure then shifts to possible causes that may be impeding the performance of the regions in the process that are now being investigated. The next step is to employ tools like fishbone diagrams to arrange these potential causes. Finally, we should use the data gathered in the previous stage to quantify a cause-and-effect link using statistical tools (Kholkar & Sangodker, 2019).

2.4.3.4 Improve Process Performance

According to Prabhakaran et al. (2020) this phase focuses on enhancing process performance characteristics by addressing and eliminating underlying causes/defects in order to achieve desired results and objectives. This phase entails the use of scientific methods and approaches to improve profitability and customer happiness in a tangible way. Improvement is carried out at this stage utilising lean methodologies such as the seven wastes and the Design of Experiment (DOE) approach. The seven waste method is required to determine whether there were any unnecessary steps in the process that were lavish from the seven waste method's perspective (Abdul & Purwatmini, 2018).

2.4.3.5 Control the Improved Process

This step is about standardising the improved process and implementing process controls. Statistical process control approaches must be used to document and monitor the process conditions during this phase. It may be essential to revisit one or more of the prior phases depending on the findings of such a follow-up investigation. The goal of the Control phase is to keep the improvements made in the Improve phase going. To ensure continuing and long-term success, keep an eye on the improvements (Prabhakaran et al., 2020).

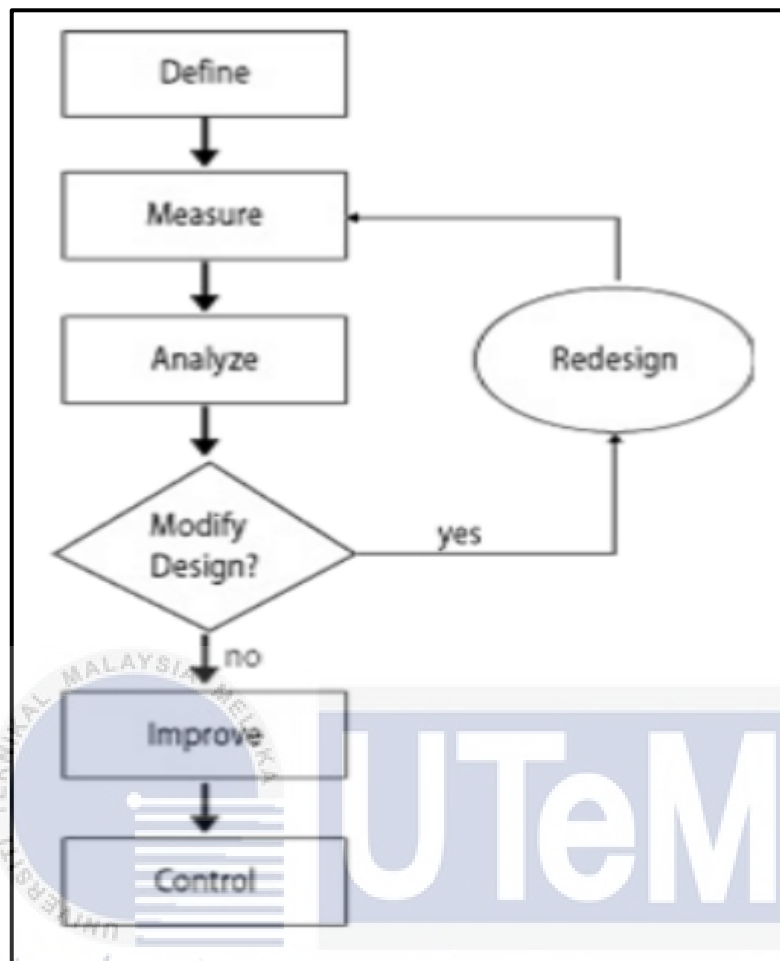


Figure 2.7 DMAIC Approach (Sodhi, 2020)

2.4.4 Results of DMAIC

Maryani et al. (2021) concluded that to make the repair process easier, the DMAIC phase method is used, as well as quality instruments, measurement, and statistical methods at each step. DMAIC is carried out in a systematic manner based on science and facts in order to achieve a six-sigma goal of 3.4 Defect per Million Opportunity (DPMO). Furthermore, six-sigma was an important production management tool that aimed to maintain, improve, and keep product quality. To monitor product quality, save money, reduce product defects and development time, boost market share, and keep customers, the Six-sigma approach employed a variety of statistical methods (Science, 2021). Bhargava &

Gaur (2021) pointed out that Six-Sigma DMAIC is an effective methodology for determining a process's real needs for change. The Six-Sigma DMAIC approach also offers a functional solution for data processing. Six Sigma is a very effective tool for achieving financial targets for the organisation and improving the company's value through process change that is data-oriented, project-centered, disciplined and systematic, and customer-focused. If there are processes that result in negative customer feedback, Six Sigma components should be seen as a way to investigate and correct the problem (Ali, 2021).

The six sigma approach had a positive effect on the overall process and assisted in lowering total scrap generation. It listed the organisation's major issues and the areas that required the most attention (Kholkar & Sangodker, 2019). Evander Subagyo et al. (2020) reported companies would be encouraged to adopt the DMAIC approach and benefit from it if they use non-statistical methods and techniques that are comparatively easier to apply. In addition to the tangible benefits addressed, intriguing insights into the future added value in the value chain were also revealed. The DMAIC method is an efficient way to minimize waste. Different time-related wastes were minimized, resulting in increased process efficiency. These outcomes have a direct impact on cost savings, improved resource use, and reduced staff turnaround time, both of which can contribute to a more positive work environment. The use of DMAIC with well-defined steps assisted in the delimitation of the problem and the direction of a solution (Rosas Hernandez et al., 2021). Any organisation that wants to develop its solid blend nature should use the DMAIC cycle and the proposed enhancement framework. Then, give faculty a brief presentation on current across-the-board value management strategies, which are the foundation of Six Sigma (Kartawidjaja, 2020).

2.5 Productivity Improvement

An increase in productivity leads to more efficient resource use and lower costs and prices for industrial goods and services, which leads to higher demand growth in both domestic and foreign markets. To rate companies or economies, productivity is used as a point of reference or yardstick (Resources et al., 2018). Similarly, Hutton & Eldridge (2019) demonstrated that productivity is an important determinant of economic development and rising living standards. Any manufacturing plan must include competitive capabilities such as efficiency, distribution, versatility, and cost. As an industry that produces agricultural products, the agricultural sector plays an important role in this. The agricultural sector is a rather stagnant industry with little space for creativity and a very rigid input from the factor soil. Innovation and human resources are two characteristics of the manufacturing sector (Gumpert, 2020). While this is the case, Bizimana & Richardson (2019) disputed that the Adoption of modern agricultural technologies results in increased production and food security, as well as improved agricultural growth and poverty reduction. Danger and ambiguity associated with agricultural production and marketing, on the other hand, are one of the obstacles to farmers adopting new agricultural technologies. Financial risk is more closely linked to the inability to meet liabilities with cash created from farm revenues due to a disparity between cash inflows and outflows, debt levels, and other financial resources.

2.5.1 Importance of Productivity Improvement

However, Sivakumar & Feng (2019) wrote that using a consistent conceptual framework, little attention has been paid to understanding how consumers respond to various patterns of product improvements. Consumers are likely to react differently when confronted with various trends (such as the implementation of product improvements). In essence, businesses may vary the extent of changes to their current goods and assign capital to various

growth programs in an unequal manner. Increased economies of scale result in an equal or greater increase in individual industrial production volume due to the relationship between fixed and marginal costs (Gumpert, 2020). Only when there is a genuine shift in people's attitudes toward global business, technology, and organisations will productivity be improved. Only by properly implementing and using technology and human resource development strategies can this transformation be achieved. For productivity gains to last, the changes must become a company-wide culture change rather than just a process change (Series & Science, 2021).

2.5.2 Advantages and Disadvantages of Productivity Improvement

Based on the ideas of Gumpert (2020), The price of manufactured products is being driven down by the lack of agricultural production and the growth of industrial production. Since agricultural products are becoming scarcer, the prices of industrial products are reduced as well. Line balancing, time standardization, improving current layout, and retraining operator ability are only a few of the ways to rebalance the problems and increase efficiency at each workstation (Jemal, 2021). Productivity can be boosted by making the most of available resources. Increased productivity equates to increased profits. As a result, increasing efficiency is important. Various modern productivity optimization methods, such as Total quality control, Total productivity maintenance, Line balancing, Just-in-time, and the 6s method, can help a company increase its productivity (Giripunje, 2020). When it comes to putting the different ideas and enhancements into action, the assembly line's overall equipment effectiveness will improve. As a result, losses are reduced as non-value-added activities are eliminated. The assembly line's efficiency can be improved from here (Giripunje, 2020). The development of the APE index system can serve as a benchmark for evaluating agricultural production in other countries and regions, and the use of OLS and

GWR models in tandem offers a novel approach to identifying influencing factors and analysing their spatial heterogeneity. The findings can aid in identifying the problems and limitations of agricultural production in various regions, allowing for the optimization of agricultural production structure and spatial layout, as well as increased farmer income and economic growth (Ma et al., 2021). While it has resulted in rapid agricultural development, it has also resulted in a slew of issues, including resource depletion, environmental degradation, and food safety concerns. How to coordinate the relationship between the economic benefits of agricultural production and environmental and resource conservation has become a major challenge, especially in the context of economic globalization and sustainable development (Ma et al., 2021). Unpredictable weather (drought, freeze, flood, and wind storm), input quality, pest and disease attacks, price volatility, new technology failure, and changes in government policies are all risk and uncertainty factors in the development and marketing processes (Bizimana & Richardson, 2019).

2.5.3 Application of Productivity Improvement

A cycle time study is a technique that is used to evaluate the parameters that influence productivity (Joseph et al., 2021). By lowering fixed costs, industrial work can be minimized. The labour factor, as well as the technological aspect, have an impact on the overall production quantity of the country. Since the relative output volume declines as a result of these interventions, the agricultural sector becomes more valuable than the industrial sector. This, too, would result in a decrease in agricultural production in absolute terms. Within regions and industries, the labour factor is partly mobile. By lowering fixed costs, industrial work can be minimized. The labour factor as well as the technological aspect have an impact on the overall production quantity of the country (Gumpert, 2020). Regardless of the sector, enhancing human resource efficiency is a top priority for increasing

productivity (Series & Science, 2021). Azid et al. (2020) proposed that a model for process improvement that incorporates motion time study and quality tools. According to the model, the key causes of the bottleneck problem and the solution to output shortages can be established and evaluated simultaneously by combining two approaches to investigating motion time study and quality tools. The first step in increasing efficiency is to determine whether or not there is a well-defined mechanism for evaluating worker output. The standards used to evaluate worker efficiency can be based on production cycle time or the number of products generated in a shift, and they should be chosen according to the industry as shown in Figure 2.8 (Series & Science, 2021). As a result, it is important to explore an agricultural development direction that fits the country's conditions while studying advanced experiences and technologies from developed countries (Ma et al., 2021).

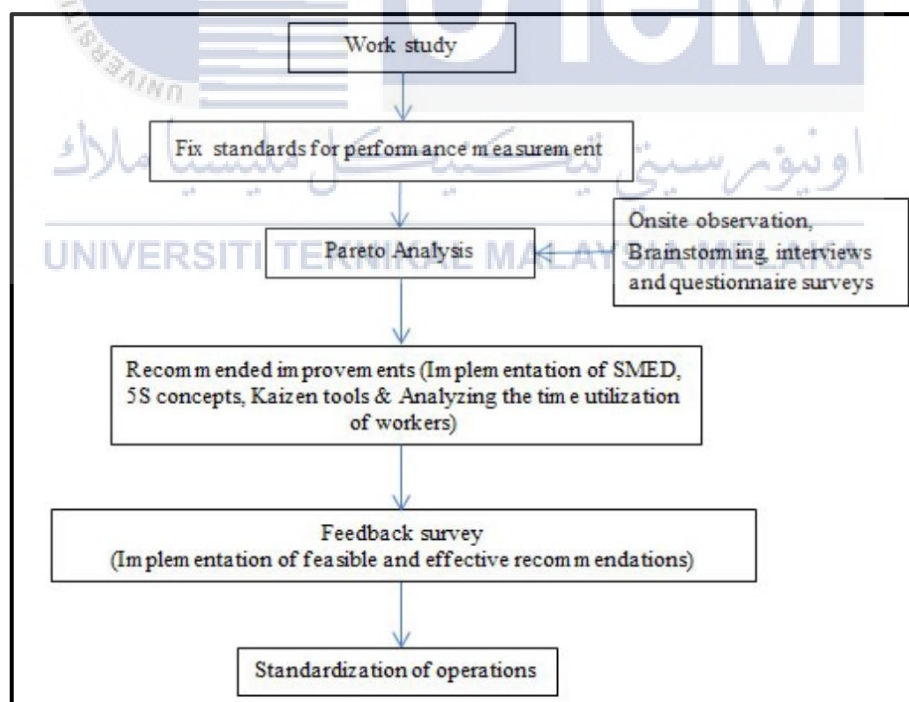


Figure 2.8 Methodology of Productivity Improvement (Series & Science, 2021).

2.5.4 Results of Productivity Improvement

Hutton & Eldridge (2019) contrasts manufacturers should match skills with competitive goals dictated by market requirements to improve firm-level productivity. Falling marginal and fixed costs represent the impact of growing economies of scale. It became clear that the gap between relative incomes is narrowing. The price and quantity of agricultural products remain unchanged (Gumpert, 2020). Jemal (2021) concluded that various productivity factors are impeding or delaying the talege garment industry's productivity growth. As a result, the study aims to reduce the number of operators, operations, and total costs, as well as achieve the overall goal plan. Four alternative scenarios with increased fertilizer rates and irrigation were compared to a baseline scenario with current fertilizer application rates and no or limited irrigation. Households can choose between motor pump, rope and washer pump, and pulley/tank tools, which are all profitable choices but require varying levels of investment costs, depending on irrigation tool affordability and socio-economic status. Solar energy, while being the most costly of all tools, could be the tool of the future due to its environmental cleanliness and low maintenance costs, as compared to motor pumps, which have high maintenance costs and are less environmentally friendly. Increased fertilizer and irrigation use has the potential to increase benefit while also improving family nutrition through development and/or purchase, filling fat and calcium nutrition gaps (Bizimana & Richardson, 2019).

2.6 Return on Investment (ROI)

Although there is no universally accepted scholarly concept of the phenomenon, practitioners typically characterize it as an early-stage investment with the aim of producing both financial and social or environmental benefits (Jain et al., 2017). Nevertheless, Armsworth et al. (2018) reported that protected areas have a wide range of characteristics,

and countries must ensure that newly created protected areas are ecologically efficient, which involves ensuring that protection is focused on the most vulnerable areas. Most necessary, and that protected areas are appropriately sized and equipped financed. Financial funding for the creation of new protected areas, on the other hand, is minimal, and the cost of protecting sites varies greatly. Returns are the gains (net of costs) on traditional financial assets. ROI is closely linked to cost-benefit analysis and cost-effectiveness analysis, two other economic methods for measuring benefits and costs.

This growth is fueled in part by a desire to help limited funds stretch further, an interest in finding the best "bang for the buck," and a need to show the benefits of investment decisions. ROI simplifies details into a single, easy-to-understand metric; this is part of its appeal, but it also means that other critical aspects of projects that aren't included in the ROI equation aren't taken into account (Kousky et al., 2019).

2.6.1 Importance of ROI

The ecological value of maintaining a site is divided by the cost of ensuring the security to calculate the return on investment. There are also alternative methods for measuring progress toward each target. Since ecological processes scale in various ways depending on the size of the population, scale of a protected area, guidelines on how ROI is affected depending on how ecological benefits are measured, the amount of money spent can vary by region. As a result, we put our ROI and protected area size findings to the test across a variety of environmental gain metrics (Armsworth et al., 2018). Based on the ideas of Abrahamsen et al. (2021) security expenses have finally been recognized as investments with a return for the business in the last few decades as risk mitigation has become more widely recognized. The gain (benefit) associated with safety investments is due to the protection of human health and the environment.

2.6.2 Advantages and Disadvantages of ROI

Most natural resource management expenses differ by landscape characteristics, similar to the heterogeneity of ecosystem service benefits on the landscape, and accounting for these costs also improves the efficiency of investments. An ROI study compares the advantages and costs of an investment. In an ROI analysis, the gains are the variations in the desired result due to the investment. Although an ROI study could take into account all of a PES program's benefits and costs, collecting details on each benefit and cost is costly and time-consuming (Jones et al., 2017). Despite the development of the impact investment industry and the surge of interest from professionals, policymakers, and the general public, academics have only begun to scratch the surface of the phenomenon (Jain et al., 2017).

Chalutz Ben-Gal (2019) emphasizes it also includes a step-by-step protocol for managing data and then using the data in the field to achieve a data-driven decision-making process. It also lays out a step-by-step process for managing data and then using the data to derive actionable managerial insights. The lack of analyses is due to a number of challenges, including the difficulty of identifying, quantifying, and monetizing all inputs and returns, difficulties in considering outcomes reported in incommensurable metrics, limitations in separating contribution from attribution, challenges in determining baselines, uncertainty about many benefits and costs, and a lack of consideration of equity issues with respect to many benefits and costs. Return on investment (ROI) is becoming more common as a tool for guiding investment decisions and gaining support for proposed activities. Funders also found that using a mechanism to interact and measure the benefits of their investments using a similar metric has been beneficial. (Kousky et al., 2019).

2.6.3 Application of ROI

Other ecological service benefits, such as tourism, carbon sequestration, scenic beauty, and habitat, can be prioritized in PES programs. Finally, as part of their goals, certain plans will include reduced suppression costs, avoid loss of life or property, and reduced evacuation and fire administrative costs (Jones et al., 2017). Return on investment (ROI) analysis is a method of evaluating and comparing ventures and investments that have been used in the private sector for many years. The application of ROI analysis to a wider range of social and environmental benefits is known as social return on investment, or SROI (Kousky et al., 2019). It may assist in deciding where to spend limited funds by determining the project with the highest return on investment as a percentage of costs. It can be used to assess projects using a profitability measure or to boost them in order to increase net returns. When a private company evaluates its investment, it can use cash flow accounting to weigh only its own costs and returns.

An ROI analysis can be based on a more comprehensive and context-specific logic model. The “costs” in an ROI system are the “inputs” in a logic model that are valued. The “returns” on ROI analysis will be linked to the “outcomes” in some way. A return, for example, may be a direct result (the portion of the outcome due solely to the intervention) or input into a return. A logic model can be useful for isolating the returns directly attributable to the project, program, or initiative under analysis since it defines the assumptions that underpin the project as well as other variables that may affect outcomes (Kousky et al., 2019).

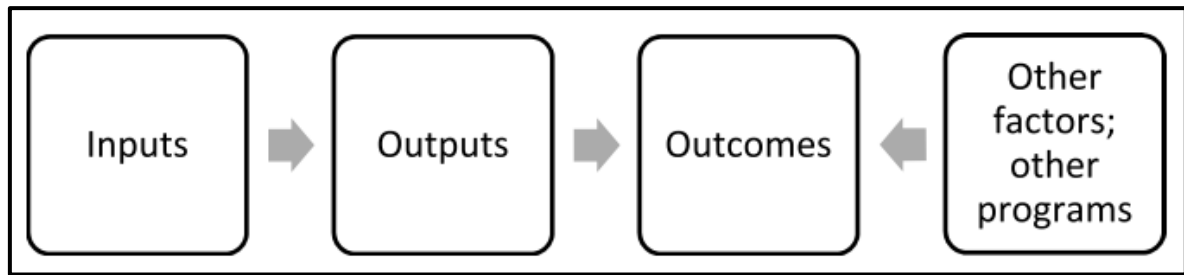


Figure 2.9 Stylized Logic Model (Kousky et al., 2019)

2.6.4 Results of ROI

The estimated expenses on implementing fuel treatments at various scales and locations were used to calculate investment costs. The calculations that go into the ROI analysis are detailed below (Jones et al., 2017). The relationship between the size of a protected area and its return on investment is dependent on the ecological value being considered. Wide protected areas have a higher return on investment in terms of reducing forest fragmentation and increasing connectivity (Armsworth et al., 2018). According to Jeyaraman et al. (2018) leadership consistency, leadership development systems, and current evaluative tools are all related to ROI benchmarks and metrics. The ROI measures and metrics found in this scoping analysis may be used in the future to help design a quick, cost-effective evaluative method to evaluate leadership effects. The minimum reasonable rate of return will always be higher than the return on investment (Zietlow, 2019). Changes in the revenue sharing model are projected to improve profitability as well (Aftab & Naveed, 2020).

2.7 Rover System

Karthik et al. (2018) claim that the use in agriculture, in particular for spraying fertilizers and pesticides, of Unmanaged Ground Vehicles (UGVs) is increasing. Furthermore, as insect, disease, and weed tolerance grows, traditional crop genetic and

protective chemistry technologies from the 'Green Revolution' face increasing pressure. A change has been made to automate and robotize elements of the farming process in order to alleviate the burden of these challenges (Grieve et al., 2019). Plants are watered without knowing their needs, which can dry plants or wastewater. The crops are watered, which leads to water unavailability in critical situations sometimes without knowing the water level in tanks or well (Gobhinath et al., 2019). Artificial intelligence and computer science accomplishments include precision agriculture solutions for seeding, harvesting, weed control, grove management, chemical applications, and other processes (Sandeep et al., 2020). In crops, the disease is described as a change or deficiency in the plant's normal functions, resulting in specific symptoms. Pests are unwanted insects or germs that disrupt human activity by biting, destroying food plants, or making farming more difficult. Early identification and avoidance of pests are critical in crop management. Understanding pests and their habitats are essential for effective pest control (Chaitanya et al., 2020).

2.7.1 Importance of Rover System

With a suitable, ground-based remote control interface the user can achieve controllable movement and variable flow of the enhancer (Karthik et al., 2018). Farmers would have to grow more food with fewer resources over time. They'll have to use less water and fewer additives. Consumers expect nutritious food, while farmers want to optimize growth and cut costs. As a result, farmers are searching for new products, methods, and technologies. During a plant's development cycle, abnormal environmental conditions such as temperature and humidity enable the spread of diseases caused by insects, fungi, weeds, nematodes, and rodents, all of which impede the plant's growth. Some studies are focusing on these pests (Ait Issad et al., 2019). To address these causes of uncertainty, smart agri-systems will need to self-evolve at a faster rate than nature's pests, diseases, and weeds do

in the face of climate change. That is machine learning systems that can detect any emerging resistance to current preventative treatments and alert operators, as well as attempting to mitigate the effects by predicting the trend intolerance changes and randomly changing the timing, position, or concentration of existing therapies to mitigate the effects. Using artificial intelligence to continuously learn and predict the evolutionary processes of pests, diseases, and weeds (Grieve et al., 2019).

2.7.2 Advantages and Disadvantages of Rover System

No such platform was developed, however, despite existing technologies, which aim to deliver chemical rover spraying that can be used for a long time in high-risk areas at a low cost. Pesticides have a variety of beneficial effects. Crop conservation, agricultural commodity preservation, wood products, and vector-borne disease prevention are among them. The Unmanned Chemical Spraying Rover is equipped with a closed chamber that can hold 1.5 litres of pesticides. Pesticides are sprayed precisely from the nozzle at the target with the aid of a mini-pump. This will cut down on the number of pesticides needed to combat pests harmful effects. (Karthik et al., 2018). Indeed, data on weather and soil conditions will alert farmers to the presence of infectious diseases. Farmers may also use the data to protect crops and customize fertilization, resulting in higher yields with less environmental impact (Ait Issad et al., 2019). Manual observation is not a successful way to control stripe rust since it takes two to three weeks from the time it first infects the host plant to the appearance of the distinctive uredinia stripes on leaves. Fungicide applications will be largely unsuccessful by the time disease signs became clearly apparent (Grieve et al., 2019).

Although the crops are properly watered, insufficient nutrition can be provided for the crops, and unidentified diseases can lead to a lower yield. An ideology to properly monitor plant nutrient deficiency and diseases must be proposed to overcome that

(Gobhinath et al., 2019). Sandeep et al. (2020) demonstrated that manual farming consumes additional resources such as water and pesticides, resulting in resource waste. Because of the chemical properties of pesticides and fertilizers, such as skilled, there would be health issues. Farmer deaths due to unsafe chemicals, excessive time-intensive to execute individual methods, and water is wasted, which is extremely helpful in drought-prone areas and could hamper storage. The advantages of useful agricultural robots include minimizing human interference, ensuring proper irrigation, and resource efficiency. These robots are primarily useful in automatic weed control, such as fertilizer application based on soil condition, and soil sensors for drip irrigation in rain-fed areas. The key drawbacks of this approach are that the pesticide can come into contact with the farmer during spraying, potentially causing skin cancer and asthma. When pesticides join the food chain, they can affect consumer health. Pesticides are also sprayed on crops that aren't affected, resulting in the same waste. The ability of this machine to manoeuvre successfully down a farm's lines, spray pesticides effectively, and be controlled from afar by the farmer demonstrates its effectiveness. And this pesticide spraying device uniformly covers the plants with spray in the required dosages. It reduces labour costs, which reduces a farmer's overall costs. A farmer gains a more profitable yield by removing the disease from the crop, resulting in wealth maximization for the farmer (Chaitanya et al., 2020).

2.7.3 Application of Rover System

Farmers will be able to concentrate more on improving overall production yields by using the Unmanned Chemical Spraying Rover to automate sluggish, repetitive, and boring activities as shown in Figure 2.10 (Karthik et al., 2018). The first challenge is to detect disease autonomously in the field at the very beginning of an effective infection case. Two AI opportunities emerge from this networked disease sensor data for gaining additional insights into crop disease growth. To begin, if the micro-assays are organized into arrays,

with each element containing a number of pathogens and host plant-specific replicate assays, machine learning could use the temporal and spatial data patterns from the replicate assays to gauge or model the severity of the disease outbreak from that pathogen, as well as correct and minimize false positives. To learn the complex interactive relationships between the elements of the assay, the AI system will need access to additional on-node environmental sensor meta-data, such as temperature, humidity, and light levels (Grieve et al., 2019).

A rover with an on-the-ground camera that rolls around and collects data can be used to capture the current condition of the crops. Camera images can be processed employing algorithms and the disease can be identified by classifiers based on appropriate measures. In situations like fires or animal entry when crop production reaches full productivity, the entire yield could be spoiled. Therefore, the farmland must be protected. To protect the field against fire accidents and intrusions by animals and birds. The combination of solutions from all the above points could lead to an intelligent agricultural system that reduces human labour. This system can be linked to the Internet, which provides farmers with the means of knowing and controlling their crops from a distance. (Gobhinath et al., 2019). Similarly, Chaitanya et al. (2020) stated that with the aid of live spraying feed, the farmer will be able to monitor the robot wirelessly from afar. This robot is intended to be an all-terrain robot.

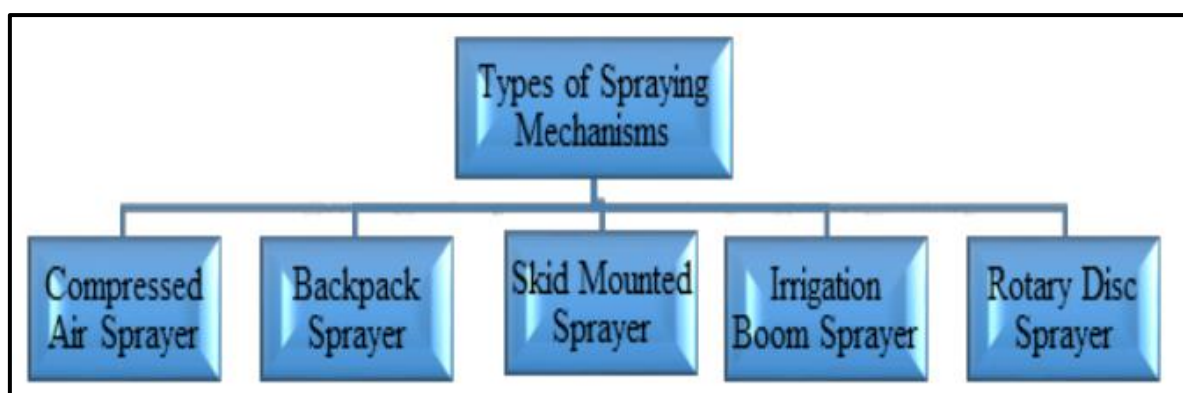


Figure 2.10 Types of Spraying Mechanism (Karthik et al., 2018)

2.7.4 Results of Rover System

Ait Issad et al. (2019) reported that such technologies are insufficient on their own; to provide useful information, they must be combined with data processing resources. The agricultural sector is currently seeing an explosion of information technology, which is primarily focused on the global positioning system and technical developments in sensors and data aggregation. Agricultural companies are now harvesting more than just crops; they are also harvesting ever-increasing quantities of data. The design reduces manual work and errors and increases crop productivity. The crops are treated with optimum water levels and water wastage can be prevented by the method of irrigation as specified in the paper. Detecting nutrition deficits and diseases at an early stage helps the farmer reduce loss in yield and prevents physical damage from protecting the farmland (Gobhinath et al., 2019). The use of machine learning and image processing assisted in the diagnosis of plant diseases. We were able to reduce diseases in the leaf, stem, and plant by effectively spraying pesticides. It would be profitable for the farmer because it can be managed from anywhere without having to work in the field and be exposed to pesticides. His health condition would not affect him. Apart from that, it does not necessitate any monitoring while in use. It only requires recharging the battery and refilling the pesticide dose (Chaitanya et al., 2020).

2.8 Maynard Operation Sequence Technique (MOST)

The MOST can be described as a method of analysing operations or sub-operations in terms of time using a variety of methods, measures, and sequences. To put it another way, it's a fixed motion time method for determining the standard time for completing a task (Rahman, M.S., Karim, R., Mollah, J., Miah, 2018). Ganorkar et al. (2019) Maynard Operation Sequence Technique (MOST) is a fixed motion time that is often used in industrial settings to decide the normal time for a worker to complete a mission. MOST is a more

systematic method of work calculation than traditional methods such as time study, and it is relatively simple to use, reliable, and applicable to manual tasks that are not specifically specified. As a result, it is used to assess each operation and evaluate the standard time associated with it. With the aid of MOST, the time equations are formed. For any organisation, MOST make the process of work measurement efficient and quick. MOST can be used for any form of work that can have micro motions described (Vimal, 2020). The MOST Technique (Maynard Operational Sequence Technique) is a method of analysing all behaviors in a single measurement to determine the risk factors present in the workplace (Ramaganesh et al., 2021).

2.8.1 Importance of MOST

MOST is a technique of measurement that focuses on object movement. It is used to analyse and determine the normal time it takes to perform a specific process or operation. MOST is a powerful analytical tool for measuring every minute a task is spent. The analysis of the work constitutes a practical, efficient and efficient task. Using the MOST technique, process flows, work procedure and plant layout can be easily identified that the cycle time of the work station may be reduced by modifying the work method and replacing the operating tools, as it is mostly in manual work, such as attaching and loosening, difficult for operators to do. Consequently, the company must provide the operator with advanced tools in order to enhance productivity. Not only will the use of these hand tools make the process faster, but it also requires a reduced operator effort. As a result, it's critical for businesses to deliver reliable and timely cost estimates so that they can see where the production process can be improved (Ganorkar et al., 2019).

2.8.2 Advantages and Disadvantages of MOST

MOST has the advantage of being easy to learn and understand as compared to other work measurement techniques. It can also be used directly from memory and only covers three sequence models: general movement, regulated movement, and tool use. Time can be measured ahead of time with this technique, and there is no need for a rating factor. Most significantly, this method will reduce the amount of paperwork and personnel required for the application. As a result, MOST can assist in cost reduction and efficiency enhancement. Due to the lack of pre-defined standard time, working methods, unplanned working distance, and an imbalance in the material flow, non-value-added activities increased and impacted the entire assembly line. As a result, the machine can gain competitive advantages in the undertaken sewing line by properly using and selecting body motion, balancing workflow, and optimizing the operator's layout body motion. As a result, the MOST technique is used to locate bottlenecks and NVA added activities of the production line, as well as set time standards, in order to improve line quality and production rate in the case study (Rahman, M.S., Karim, R., Mollah, J., Miah, 2018). The best thing about this approach is that it eliminates the need for an industrial engineer to stand on the shop floor and take readings for each and every activity, reducing inefficiencies and removing employee awareness while working (Vimal, 2020). The ergonomics intervention's biggest drawback was its awkward and difficult methods of implementation. It can be used in the industrial sectors not only for administrative and corporate techniques but also for human productivity time constraints and methods to use in all industrial sectors' assembly sections (Ramaganesh et al., 2021).

2.8.3 Application of MOST

MOST is a good application of work measurement technology, enabling a wider range of jobs, both repetitive and non-recurring, to be measured quickly and with simplicity

for production, engineering, and administrative service activities. The Maynard operation sequence technique is said to be critical in identifying and eliminating bottleneck workstations and creating a competitive industrial climate. MOST can also help a manufacturing business increase efficiency by reducing non-value-added activities. It is possible to make the best use of all available time and save money by implementing MOST (Rahman, M.S., Karim, R., Mollah, J., Miah, 2018). The MOST analysis is used to assess how long an operation will take. Each operation is divided into sub-activities for MOST research. Each sub-activity is then subdivided further into components. A sequence model is used to organize these components can be shown in Figure 2.11 (Ganorkar et al., 2019). MOST was also used by Selvam et al. (2018) to calculate the cycle time and average time taken by a manual station for spot welding. Various statistical methods may be used to determine the true importance of the procedure in use. The MOST are easier to use and allows for controlled analysis of the fundamental motions of an action. An operation is broken down into different sub-operations for the purpose of measuring acceptable standard time, and each sub-operation is allocated numerical value units in terms of time, which are known as time measurement units. Simple MOST is a strategy for increasing efficiency that focuses on three types of object movements: general movement, directed movement, and tool use. The general move is the unrestricted spatial movement of one or more objects through the air, which is manually operated (Kumar et al., 2020).

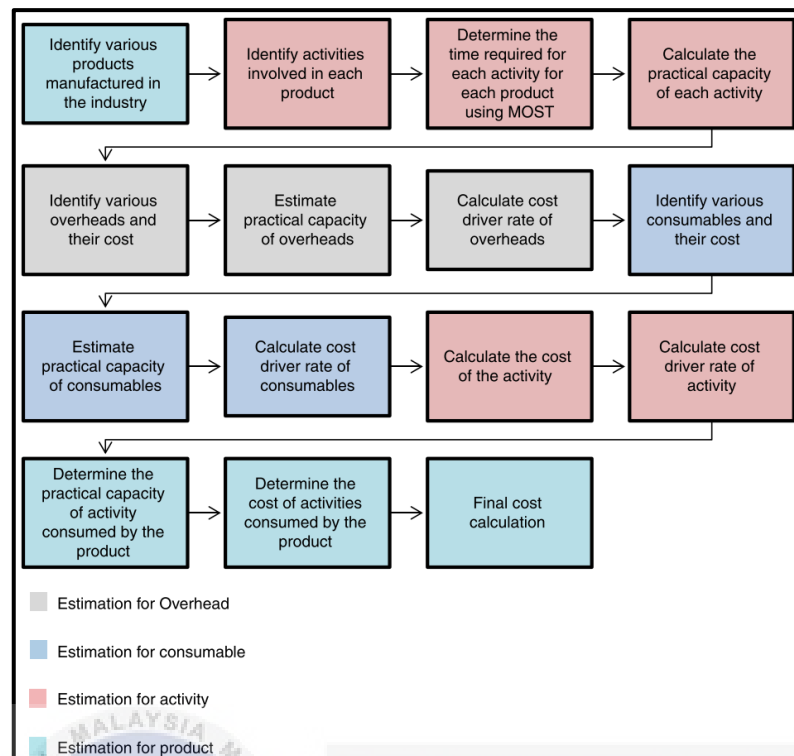


Figure 2.11 Application of MOST Technique (Ganorkar et al., 2019)

2.8.4 Results of MOST

It is clear that a firm must reduce or eliminate unstopable times, improve working practices, standardize time and improve overall capacity planning to sustain itself in this competitive industrial environment, and MOST can play a key role in this respect. Thus, incorporating the MOST to estimate standard times for various elemental tasks involved in various operations, including simple tools and jigs to perform a task in less time with less effort from operators, and manoeuvring the distribution of activities in different workstations to balance production lines will significantly improve an industry's productivity from the ground up. The use of MOST simplifies the work of an industrial engineer by removing the tedious task of interviewing or surveying for the generation of time equations. TDABC with MOST is the name of this process. Since TDABC does not require a large investment in complex data collection systems or organisational restructuring, the risk of implementation can be greatly minimized by using MOST for TDABC costing system implementation.

(Ganorkar et al., 2019). As a result, the MOST research can be said to be an efficient strategy for improving the standard time when compared to the time calculated from the current rows. MOST is a valuable tool for operation managers to make successful process plans because it allows them to remove non-value-added activities and predict the required standard time for each operation (Kumar et al., 2020). This research also revealed that the most important aspect of any organisation is its employees and that improving labour productivity is critical to increasing productivity. The proposed hybrid MOST and ergonomic posture analysis method aids in improving labour productivity (Vimal, 2020).

2.9 Summary

Six Sigma aims to discover and eliminate the root flaws or defects in business processes. Six Sigma focuses on outputs that are critical to customers (L. B. M. Costa et al., 2021). Alkasisbeh et al (2018) demonstrated that to evaluate the key issues that prevailed in projects, Six Sigma methods such as checklists, Pareto diagrams, cause and effect diagrams, and control charts were used. In Six Sigma programs, the DMAIC approach specifies strategy and orientation lines. The DMAIC methodology is a systematic and disciplined approach that provides numerous benefits, including the study and analysis of the problem, as well as the exploration for a solution (Kholkar & Sangodker, 2019). The DMAIC methodology (Define, Measure, Analyse, Improve, and Control) is used to apply six sigma in a systematic manner (Patil et al., 2020).

That aside, an increase in productivity leads to more efficient resource use and lower costs and prices for industrial goods and services, which leads to higher demand growth in both domestic and foreign markets. To rate companies or economies, productivity is used as a point of reference or yardstick (Resources et al., 2018). ROI is closely linked to cost-benefit analysis and cost-effectiveness analysis, two other economic methods for measuring benefits

and costs (Armsworth et al., 2018). A change has been made to automate and robotize elements of the farming process in order to alleviate the burden of these challenges (Grieve et al., 2019). Artificial intelligence and computer science accomplishments include precision agriculture solutions for seeding, harvesting, weed control, grove management, chemical applications, and other processes (Sandeep et al., 2020). MOST is a more systematic method of work calculation than traditional methods such as time study, and it is relatively simple to use, reliable, and applicable to manual tasks that are not specifically specified (Ganorkar et al., 2019).



CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the methodology is a strategy or tool for describing and achieving the study's objectives. Aside from that, the method used to complete each process was well explained in this chapter. Therefore, by having a well-arranged sequence of processes and methods, this project can run smoothly. In addition, each title's theory was interpreted in this chapter. Each title should be specific about how the method will contribute to the project's success. Furthermore, the dominant theory makes it simple to choose an effective approach or tool for this study. Furthermore, methodological flow charts were created to track the sequence of the research from start to finish. The process flowchart helps you work more efficiently by acting as a roadmap for completing the study step by step.

To add to it, each method in the flowchart will be extensively described, using the prior case study as proof, to reinforce their statement and perform efficiently. By referring to the previous case study, it is easier to identify and predict the best methodology or strategy to utilise throughout this research. The data collected in this study will tend to play a role in improving the productivity of this study simply by using several data analysing method such as MOST and six-sigma. The data gathered from the observations will, later on, be analysed in the data analysis and will be used to make the discussion afterwards.

3.2 Design of Studies

Qualitative and quantitative research methodologies are used in the design of research investigations. These methods are utilised to acquire and analyse the data we need to accomplish our study goals, as well. The quantitative approach, on the other hand, is more concerned with numbers, statistics, and data, as I see it. Using literature study methods, it was shown that qualitative research focuses on investigating ideas and personal experiences and developing a theory or hypothesis by describing, categorising and interpreting them. This is a long storey short. However, in a quantitative study, concepts and hypotheses are examined with statistics and statistical analysis, employing a case study technique. Figure 3.1 illustrates how this strategy is used in the research by showing the study designs.

i) **Research approach**

This study employs both a qualitative and a quantitative research strategy.

ii) **Process**

The research procedure is designed to meet the predetermined goals. Finding, verifying, and proposing the research is part of this study design technique.

iii) **Method**

The approach that was used to collect data.

iv) **Source**

The data was collected based on the source for this research.

v) **Size**

The number of journals obtained from other sources, businesses, and the amount of time required to complete this study.

vi) Research Objective

Based on the objectives that have been researched.

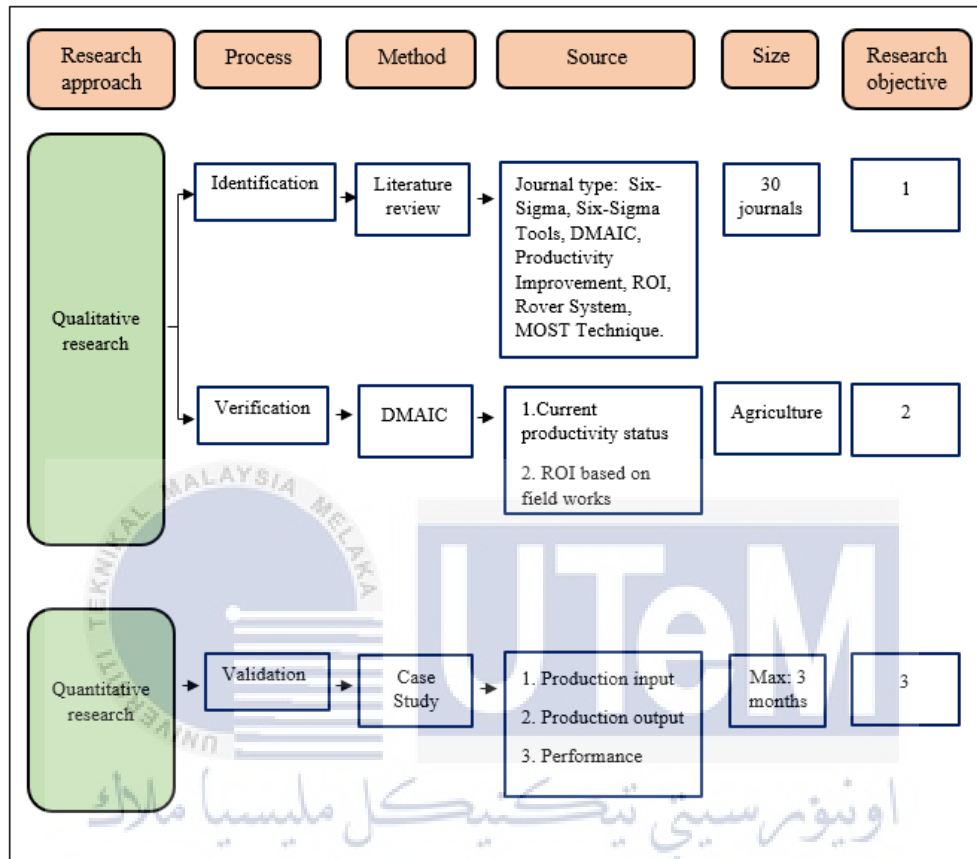


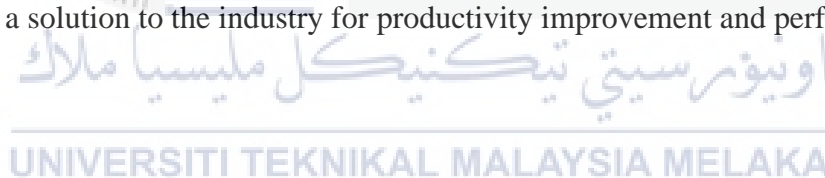
Figure 3.1 Design of Studies

3.3 Flow Chart

The entire research methodology process flow, which encompasses all of the procedures to meet the study aims, is depicted in Figure 3.2. The flowchart's purpose is to establish a framework for the project's activities. This strategy will also highlight how the chosen method and methodology should be used to complete the study's essential task. The flowchart is a step by step task or flows to achieve good or logical results within a predetermined period. Furthermore, it is crucial to identify the root cause of the problem before the objectives are established.

Firstly, the information obtained is encrypted based on the literature review to enhance knowledge regarding the agricultural system and how it works. Secondly, the step identifies research issues and issues to identify the root causes of agricultural productivity issues in the problem identification. In this process, data collection is crucial in order to differentiate from the collected data afterwards. Afterwards, all the data collected will be gathered in order to validate all the details to construct an operation model system. There are several methods that can relate to gathering data such as using check sheets to get data or by taking images of the current progress that exists in the field.

Next, the current productivity based on the gathered data is calculated using the MOST technique and ROI. Once it's done, the MOST technique is then executed to gain productivity if the robot system is implemented. Summing it up, the verification of the result is conducted using DMAIC so that the phases can be categorised. Next, an analysis needs to be conducted to determine whether anything needs to be changed or removed. Finally, recommend a solution to the industry for productivity improvement and performance.



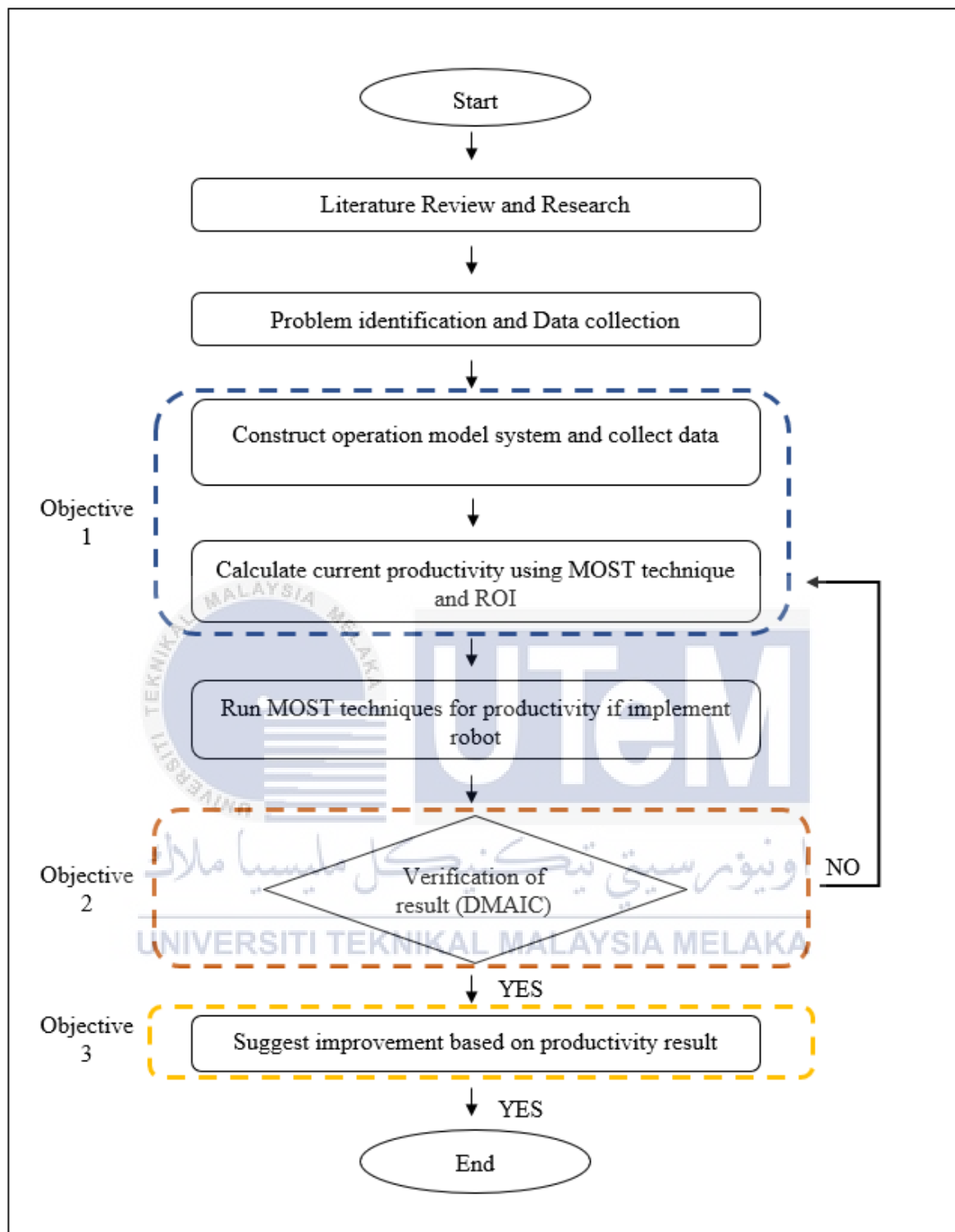


Figure 3.2 Detailed Flow Chart of Research Methodology

3.3.1 Problem Identification and Data Collection

The initial stage in carrying out this study is to identify research difficulties and questions. A research problem is a hypothesis about a worry, a condition that needs to be improved, an issue that must be solved, or a problematic topic that persists in the literature and research philosophy and suggests the necessity for a concerted detailed investigation. Any operational challenges that lead to advancement, as well as theoretical challenges that contribute to a better understanding of the progress. The issue statements developed from the literature review and based on the current situation are now presented. The goal of this study is to find a technique to maintain productivity gains using the MOST methodology and to confirm the optimum productivity and ROI using the analysis of the rover system throughout the case study in the field.

Furthermore, a research question is a statement in the form of a question that aims to go deeper into the study issue through investigation, learning, discovery, or discussion. It will benefit from the knowledge and procedures it will employ to deal with the problem. The research issue is about the elements that influence fieldwork productivity and the methods utilised to solve difficulties.

3.3.1.1 Spreadsheet

Spreadsheets provide a number of advantages, particularly for business users that require complex processing in a format that is simple to use. Microsoft Excel, for example, is a common spreadsheet tool that allows you to easily analyse and visualise data sets. Users can view and share their data sets within presentations using Microsoft Excel tools that can convert data sets into various forms of graphical representations. Furthermore, visualising data in this manner can assist you in interpreting the information and guiding future planning decisions. Spreadsheets assist researchers in collecting, manipulating, evaluating, and

displaying important data pertinent to certain areas of their service. Microsoft Excel as shown in Figure 3.3 may be used for budgeting, accounting, financial statement preparation, and day-to-day tasks like inventory management, therefore the programme may be utilised as a stand-alone solution for most small business finance duties.

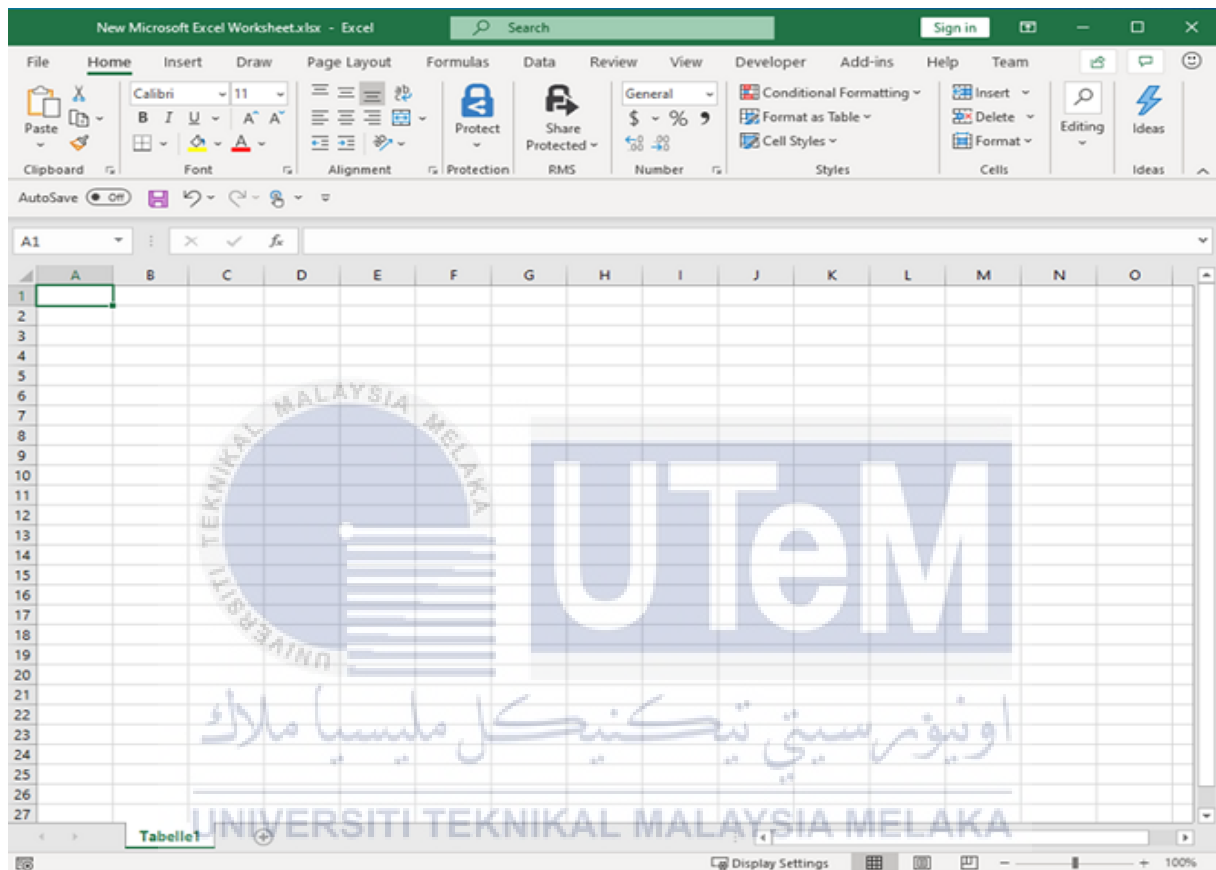


Figure 3.3 Interface of Microsoft Excel

3.3.1.2 Six Sigma Tools

The problem-solving tools used to support Six Sigma and other process improvement activities are referred to as Six Sigma tools. To optimise processes, the Six Sigma expert use both qualitative and quantitative methodologies. Although the tools themselves are not unique, the manner in which they are used and incorporated into a system is. DMAIC is one of the key points in Six Sigma as it categorises into five key elements as shown in Figure

3.4. The key elements are defined, measure, analyse, improve and control. This is a data-driven quality strategy for process improvement. It is an essential component of a Six Sigma project, but it can also be used as a stand-alone quality improvement technique or as part of another process improvement.



Figure 3.4 Implementation of Six Sigma Tools

3.3.1.3 Capture Photos

Capturing the photos of the process is an important role to never be forgotten. This is because it prevents struggling if the process flow of the production has not been started and capturing photos will ease the job. The goal of photographing the production line is to determine the process flow and convey the relevant message in a simple and straightforward manner. Capturing images also aids in the analysis of the production layout and the identification of present production flow flaws.

3.3.1.4 Data Analysis

Data analysis is a tool for gathering, analysing, and evaluating information in order to extract evidence for decision-making. Furthermore, the type of data analysis required depends on the industry and the purpose of the study. Also available are a variety of methods and techniques for conducting data analysis. In addition, various data collection methods are primarily focused on two main research fields, namely quantitative and qualitative research, as described above.

3.3.1.5 Why – Why Analysis

One of the most effective approaches for determining root cause in manufacturing is the why-why strategy. The why-why as shown in Figure 3.5 can be used to identify the fundamental cause of any problem and prevent a process from recurring errors and failures. When using the why-why methodology, it should get to the heart of the problem and then address it, even if the cause of the problem is unexpected. In actuality, what appears to be a technological difficulty turns out to be a human and process one. The why-why method is a useful and alternate technique to problem-solving. The main goal is to figure out why a problem exists by asking a series of "why" questions.

WHY - WHY ANALYSIS		
	<i>Why - Why ? (Fact - Finding)</i>	<i>Answer</i>
Why-1		
Why-2		
Why-3		
Why-4		
Why-5		
ROOT CAUSE →		

Figure 3.5 Why – Why Analysis

3.3.2 Construct Operation Model System and Collect Data

An operating model is a diagram that depicts how a company provides value to both internal and external consumers. Operating models, also known as value-chain maps, are designed to assist employees in seeing and comprehending the function that each component of a business plays in serving the demands of others. The practice of creating abstract models of a system, each of which presents a different view or perspective on that system, is known as system modelling. The term "system modelling" currently refers to the process of graphical notation being used to depict a system. System modelling aids the analyst in comprehending the system's functionality, and models are used to interact with consumers.

During the gathering of requirements data, both new and existing system models are used. Models of existing systems can be used to clarify what the existing system accomplishes and to discuss its strengths and faults. The MOST methodology is then used to separate the positives and drawbacks, resulting in requirements for the new system. Models of the new system are utilised during data gathering in the field to help other systems understand the suggested requirements. Data collection can be classified into two types : (i) Primary Data and (ii) Secondary Data.

i) Primary data

Without the use of previous research, primary data will be acquired straight from a data source. Although it was obtained to address a specific study problem, primary data is also practical, authentic, and objective. The methods used to collect primary data are likely to be determined by the research's goal, as well as the scope and knowledge base gathered.

ii) Secondary data

Someone else has previously compiled secondary data, but it has been made available for others to utilise. When the data is used by a third party, the outcomes are usually secondary. The process of conducting research that necessitates researchers referring to prior studies and adding conclusions to the literature review.

3.3.3 Calculate Current Productivity using MOST and ROI

In this part of the methodology, the step is to calculate the current productivity which is gained from the collection of data. This step is calculated using the MOST technique and ROI in order for it to ease the process of evaluating the data at the end of the case study.

3.3.3.1 Maynard Operation Sequence Technique (MOST)

MOST (Maynard Operation Sequence Technique) is a useful work measuring technique that allows a broader range of work (both repetitive and non-repetitive) to be measured rapidly and accurately for manufacturing, engineering, and administrative service operations. MOST is a sophisticated analytical method for calculating the amount of time spent on a job. It simplifies, manages, and reduces the cost of conducting a work analysis. According to Figure 3.6, this is the basic work measurement when it comes to the MOST approach where it includes index values, time calculation, controlled move, tool use analysis. Roughly 50% of all manual work occurs as a General Move, the percentage runs higher for assembly and material handling and lower for machine shop operations. Based on Figure 3.7, the repeated patterns in the sequence of methods of time measurement (MTM) have been consolidated. The movements of objects follow consistently repeating patterns.

Basic MOST® WORK MEASUREMENT TECHNIQUE		
ACTIVITY	SEQUENCE MODEL	SUB - ACTIVITIES
General Move	A B G A B P A	A – Action Distance
		B – Body Motion
		G – Gain Control
		P – Placement
Controlled Move	A B G M X I A	M – Move Controlled
		X – Process Time
		I – Alignment
Tool Use	A B G A B P _ A B P A	F – Fasten
		L – Loosen
		C – Cut
		S – Surface Treat
		M – Measure
		R – Record
		T – Think

Figure 3.6 Basic MOST Work Measurement

Comparison of MTM-1, MTM-2 and MTM-3			
	MTM-1	MTM-2	MTM-3
Therbligs Utilized	Release	Get	Handle
	Reach		
	Grasp	Put	
	Move		
	Position		
Time to analyze job	250 X Cycle Time	100 X cycle time	35 X Cycle time
Time/Accuracy-100 TMUs	15 min/+21%	6 min/+40%	2 min / +- 7%

Figure 3.7 Comparison of MTM-1, MTM-2 and MTM-3

i. **General Move**

The general move follows a fixed sequence of steps which are when a product reach, either directly or in conjunction with body motions or steps. Next is where gain control of the object and then move the object, as in “reach”. Then, the object is placed in a temporary or final position and finally, its returned to

the workplace. Each parameter is assigned an index value based on the motion needed to perform the activity. Index values are then used to generate the total time required to perform a task.

ii. Controlled Move

The controlled move sequence describes the manual displacement of an object over a “controlled” path. The controlled move follows a fixed sequence of steps which when it reach, either directly or in conjunction with body motions or steps. Then, to gain control of the object. Next is to move the object over a controlled path by simply allowing time for the process to occur. Then the object is aligned after the move process. Finally, it returned to the workplace. The object is restrained by its attachment to another object. It's controlled during the move by the contact it makes with the surface of another object and it must be moved on a controlled path to accomplish the activity. This parameter is used to analyse all manually guided movements or actions of an object over a controlled path.

iii. Tool Use

The tool use sequence is a combination of the general movement and controlled move activities. Tools not listed in the tables that are similar to a tool in the table can use their time values for analysis. Tool use goes through various phases which are first to get the tool (object), then put the tool (object) in place, then use the tool and then put the tool (object) aside and the object is returned. The time values generated by the data card for power tool use must be compared to the times generated by the tools used in the shop and adjusted if necessary.

3.3.3.2 Return on investment (ROI)

On the other hand, return on investment (ROI) is a financial metric that is commonly used to determine the likelihood of generating a profit from a given investment. It's a proportion that compares an investment's profit or loss to its cost. It can be used to assess the probable return on a single investment as well as to compare the returns of multiple investments. It's vital to keep a few things in mind when reading ROI figures. For starters, ROI is usually presented as a percentage because it is easier to comprehend (as opposed to when expressed as a ratio). Second, because investment returns can be positive or negative, the ROI calculation includes the net return in the numerator. ROI is computed by two methods. The first method as shown in Equation 3.1 includes the net return on investment dividing it by the investment cost and multiplying it by 100. The second method is calculated by subtracting the initial investment value from the end investment value (which equals the net return), dividing the new figure (the net return) by the investment cost, and then multiplying it by 100 as shown in Equation 3.1. ROI is a standardised, universal measure of profitability since it is very simple to compute and understand. An investor can distinguish between low-performing and high-performing investments using an ROI calculation. Investors and portfolio managers can use this method to try to optimise their assets.

i. First Method :

$$ROI = \frac{\text{Net Return on Investment}}{\text{Cost of Investment}} \times 100\% \quad (3.1)$$

ii. Second Method :

$$ROI = \frac{\text{Final Value of Investment} - \text{Initial Value of Investment}}{\text{Cost of Investment}} \times 100\% \quad (3.2)$$

3.3.4 Run MOST if Implement Rover System

In this phase, this is probably the most vital role in the case study as this part will decide if the implementation of the rover system will affect productivity either in a positive way or negative way. It is proved in some research that implementing a rover system in the field works to increase the rate of productivity as well as cost-saving. As it proves that implementing the rover system has its perks, later on, the MOST technique will be applied to evaluate the data gained before and after the process. Executing the rover system in the field works may bring beneficial factors, these factors will make a huge difference with the data collected early of the process phase and at the ending of the phase. Then, with the data will the discussion be decided later on in this research.

3.3.5 Minitab

In the field of statistical analysis and process development, As shown in Figure 3.8 Minitab aids industry and organisations in the identification of patterns, the resolution of problems, and the extraction of usable information from data. In addition, Minitab streamlines the data entry process for statistical analysis. Minitab provides a quick and appropriate answer for the level of research that is required by the majority of projects. The information gathered is simplified in order to facilitate data analysis, and the data set can also be altered as a result. It is necessary to conduct a Minitab analysis in order to calculate the mean, standard deviation, variance, kurtosis, N value, first quartile, third quartile, minimum and maximum values, and skewness of the data.

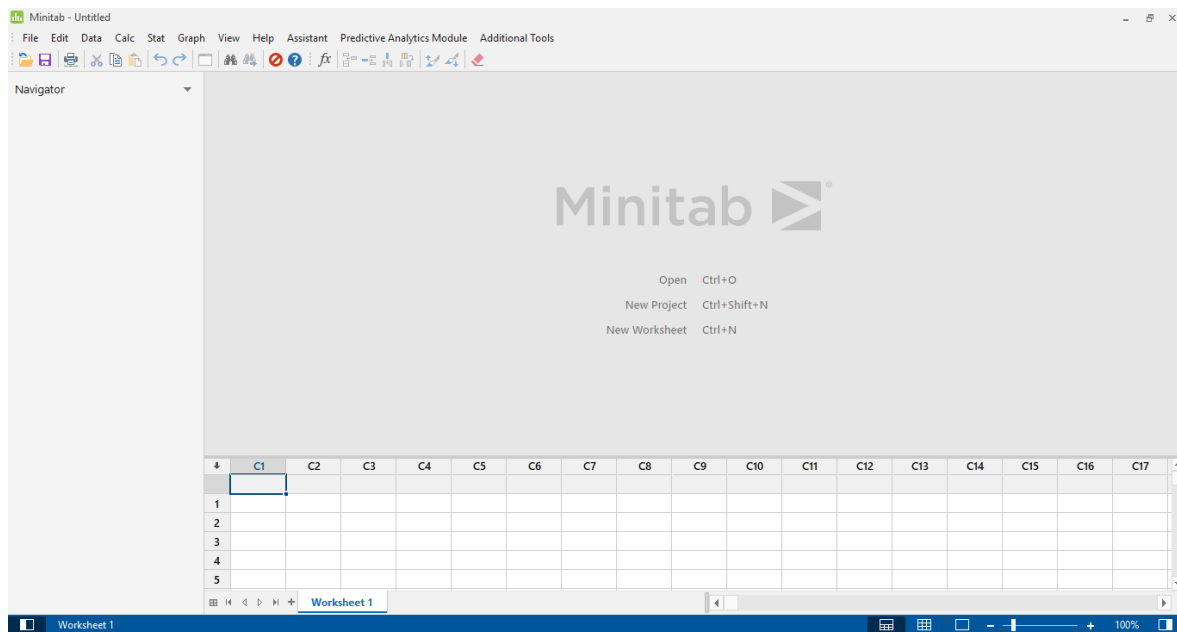


Figure 3.8 Example of Minitab Data Analysis

3.3.6 Suggestion of Improvement

The term "improvement" refers to the process of making something better and more functional. While the Propose Improvement section clarifies all of the improvements that can be done. In addition, this section contains a full description of how to implement the enhancement and the procedures that should be taken into consideration. The Proposal Improvement section clearly outlines all of the recommended modifications that can help boost productivity and performance. The goal of advancing an improvement for industries is to assist them in discovering and introducing new technologies that can help them increase their performance to the next level.

To crown it all, this phase will go through the verification of the result where once the data collected are analysed and predetermined which will bring to the final stage of the process flow. Once the comparison of data is successful and contented, the next aim is to encourage methods that can be done to improve productivity based on the established result. Nonetheless, the industry has the option of adopting the recommended Continuous

Improvement methodology or further testing the techniques before implementing them in their operations.

3.4 Summary

On the whole, the methodology part of this analysis examines the path to attaining the objectives. In a research project, the methodology chapter is crucial since it clarifies the entire project flowchart. This flowchart is quite helpful in a research project since it allows you to undertake a step-by-step analysis and eliminate any false details that should not be included in the project report. The first step is to identify the challenges and concerns that face the industry. The purpose of this study is to discover the elements affecting productivity, therefore building an efficient MOST method based on DMAIC is a scope and objective for us to focus on. Data collection was done using spreadsheets and six sigma tools in order to obtain more data in order to make this study a success.

A flowchart is also a description or flow of objectives that must be accomplished step by step in order to yield meaningful or logical outcomes. Identify the research difficulties and questions first. Second, define the research scope and objectives to concentrate on the study's goal. To gain extra data and make this study effective, data was collected utilising spreadsheets, six sigma tools, and images taken in the study region. Furthermore, in data analysis, why-why analysis is done to interpret the causes of a problem before it is solved. Operating models, also known as value-chain maps, are meant to help employees visualise and understand the role that each part of a company plays in meeting the needs of others. To add to it, the MOST approach is widely used in business fields. The MOST approach is an excellent use of work measuring techniques that allow for a wider range of tasks that benefits the return on investment.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

The issues that influence agricultural productivity will be defined in this chapter. The MOST approach is used to determine the final results. The information is derived from the agricultural sector and is based on the plantation process. After defining the issues, the MOST approach application will be useful in proposing improvements that will help to achieve productivity smoothness between implementing a rover system and a manual labour process. The data gathering for this study, such as primary and secondary data, was then continued in this chapter. The primary data describes the plantation's processes, as well as fertiliser combinations and pesticide reagents. Secondary data refers to information gathered by the agricultural industry. After all of the data has been explained, MOST will be used to conduct the data analysis, which will be followed by a walkthrough of the company's change strategy.

The data is gathered through taking inventory, monitoring, and interviewing relevant workers about the subject at issue. After all of the data has been explained, the data will be analysed, and the company's strategy for change to address the issues hurting their productivity will be implemented. The data analysis can help with the problems that have emerged. Aside from that, deeper inventory concerns were solved using fishbone and why-why analysis. This is why data analysis is used to assist in resolving the issue of this report's output failure. The data collection will be clarified clearly by the caretaker of the field, for

example, the routine for the pesticide spraying process, the time range for the harvesting, field layout, and number of workers.

From this, the application of the MOST takes place to come out with a proper workflow system involving time range. After all data has been thoroughly analysed, the next step is to suggest an improvement that can be made by the agricultural field in order to solve the problem. This improvement proposal may enable them to reduce lost productivity as well as other productivity-related issues.

4.2 Problem Definition

The initial stage in doing this research is to identify the issues in the agricultural sector. In order to increase productivity, we must first identify the most bothersome issues that arise. The problem definition serves as the foundation for the research. The significance of the topic raised in this part will be explored in light of the field's most pressing concern. The agricultural sector faces significant challenges that must be addressed.

In order to ease and conserve the investment, it is necessary to fix the problem that is affecting the productivity during the research phase. Two variables, namely, labour and pesticides, are thought to be the primary causes of this problem. When it comes to labour, each individual has their own timing and mood swings, which determines how they will go about their daily tasks. This plays a significant role in answering the question of why productivity does not remain constant. Other than that, the issue relates performance of labour. As the crop production takes time to be harvested, there are no hurry in harvesting which leads the performance of workers to become slow.

Furthermore, pests also have an major role in affecting the productivity. Pests have occurred, and in addition to causing crop spoilage, pests can considerably increase the price

of producing a harvest. Implementing methods to keep them under control may entail fences, chemical or biological treatments, companion planting, or crop rotation, all of which alter the ratio of inputs to outputs. In addition, Employees play an important role in this process because they are the ones that spray the insecticides on the crops. This is also the location where the herbicides are sprayed using the rover system, which is being implemented. This will result in increased agricultural productivity as a result of this.

4.3 Data Collection

The papers and information gathered from the field will be recorded and suitably measured in this section of the report. In the data collecting process, the manner by which information is gathered is a critical component. The current gathering of data is critical in order to acquire a clear picture of a technique, as well as to comprehend the challenges that are associated with it and to pinpoint the problem. Processes, field plan layout, and schedule data are also contained inside this document.

Additionally, there are two other tools that have been utilised in order to obtain the information. In addition to conducting interviews with the in-charge personnel and some field observations, the tools are being put through their paces. The interview is being conducted in order to obtain as much details as possible about this study. In order to gain a better understanding of the processes involved, it is necessary to observe them in their natural environment for observation purposes. As a result, in order to address the problem, it may be necessary to seek a result through observation.

This agriculture sector is a locally owned and operated business that was created on June 29, 2009. Melor Agricare's headquarters are in Kuala Lumpur, Malaysia, and the company is one of the country's leading agricultural firms, with four sales offices situated throughout the country. Fertigation and conventional agro-systems are areas of expertise for

the organisation. Alor Gajah is the location of the agricultural production field where this sector initially produced and sold chillies to the market. After a number of years, they made the choice to begin producing brinjal as well. Furthermore, this industry is primarily concerned with the manufacturing, distribution, and marketing of chilies. Also available to customers is a partnership with government organisations such as the Standard and Industrial Research Institute of Malaysia (SIRIM), the Malaysian Agricultural Research and Development Institute (MARDI), the Federal Agricultural Marketing Authority, among others, to produce agricultural goods for consumers (FAMA). Primary and secondary data are the two forms of information that can be gathered from sources.

4.3.1 Primary Data

It is necessary to interview the in-charge staff in order to understand the process details, such as manual pesticide spraying methods, layout, and planning. The data is collected through interviews with the in-charge personnel. In addition, data is gathered through viewing the field and taking photographs of the field.

4.3.1.1 Process Flow of Pesticide Spraying

Based on the procedure of pesticide spraying in an agricultural field, the flow chart has been designed. The outcome of the pesticide spraying procedure is depicted in detail in Figure 4.1. First of all, the whole process begins with the preparation of Personal Protective Equipment (PPE) as it is important to be secured with protection when it comes to mixing chemicals to prevent harm. Then, the process of selecting the types of pesticides will take place. It is important to know what types of chemicals are suitable for the types of plants that's about to being sprayed. Next process is where the capacity calculation is needed, from the label attached with the chemical, the amount of pesticide to be applied and the water volume rate to be used will be known as it will ease the mixing process. Each day the mixture

will be different compared to the mixture for the next day so this step of capacity calculation will be carefully noted down to track the daily mixing schedule.

Next, the mixing process takes place after the capacity calculation has been successfully completed. Before beginning the mixing process, a suitable area will be chosen when the mixing process is about to take place, this is to make sure the environment is secure from any harm. When mixing, the water volume rate should always be more compared to the chemical. The mixing process will repeat if the mixture is not at the right amount needed for the field. Water is first poured into the sprayer, then an equipment will be used to measure the amount of chemicals that's needed to be poured into the sprayer as this will be included in the filling process. Then, the sprayer is filled up with clean water. When the mixing is being filled in the sprayer, a gap will be left so that the chemical does not leak. The pesticide containing inside the sprayer is carefully agitated with the water until it is fully dispersed. After this, the pesticide spraying procedure will take place daily with the following flows.

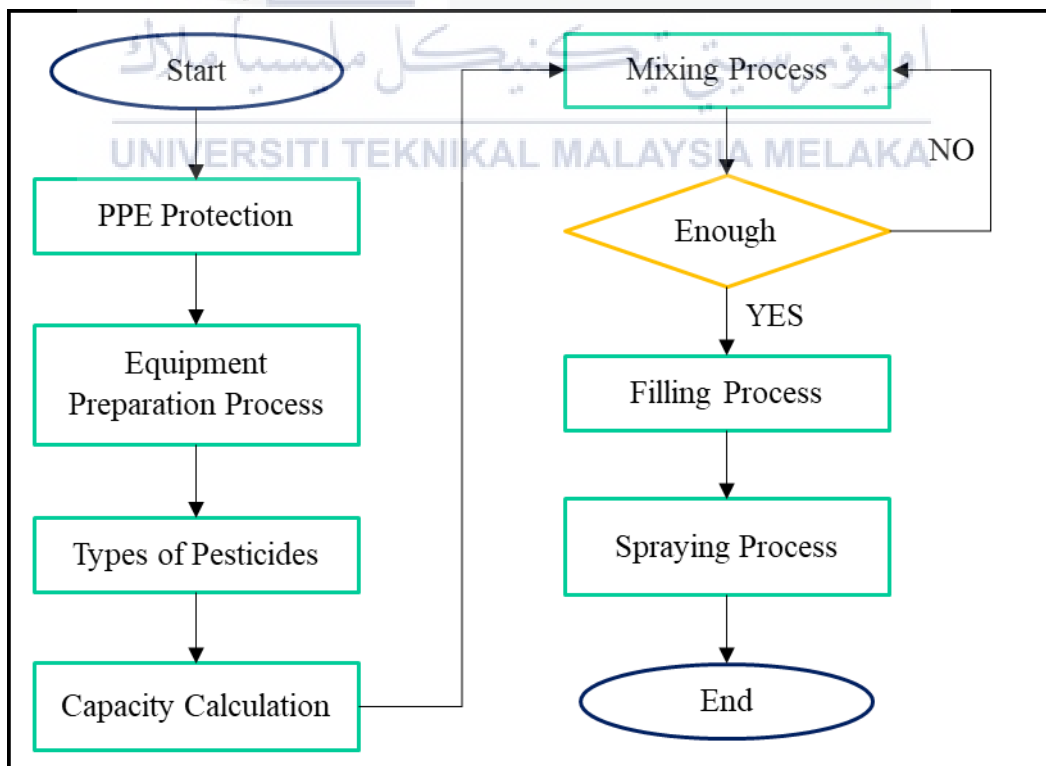


Figure 4.1 Pesticide Spraying Procedure

4.3.1.2 Field Layout

The field pattern for chilli plant production in the agricultural sector is depicted in the following figure, 4.2. The pattern depicts the total number of plants that must be treated with pesticide in order to achieve the desired result. This region has a total of 480 plants that contribute to its output. There are 11 rows with 40 plants in each row, followed by 2 rows with 20 plants in each row, and then a final row with 40 plants in each row. Every plant in every row has a 1.3-foot space between it and the one next to it. It takes 11 rows of plants to cover a total distance of 53 feet, beginning with the first plant and ending with the last plant. Meanwhile, the two rows of plants have a total length of 25 feet from the first plant to the last plant, measured from the first plant to the last plant. The pattern of the pesticide spraying process will follow as indicated as the path pointed through the blue arrow and the path is returned backwards as shown follows the red pointer. These pointers shows how the steps path of spraying process will take place for both manual labour and rover system. The paths will be repeated vice versa for each row where the sprayer will start the journey and follow back the path on the other row and this path step will repeat for the next rows.

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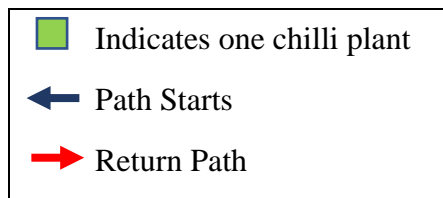
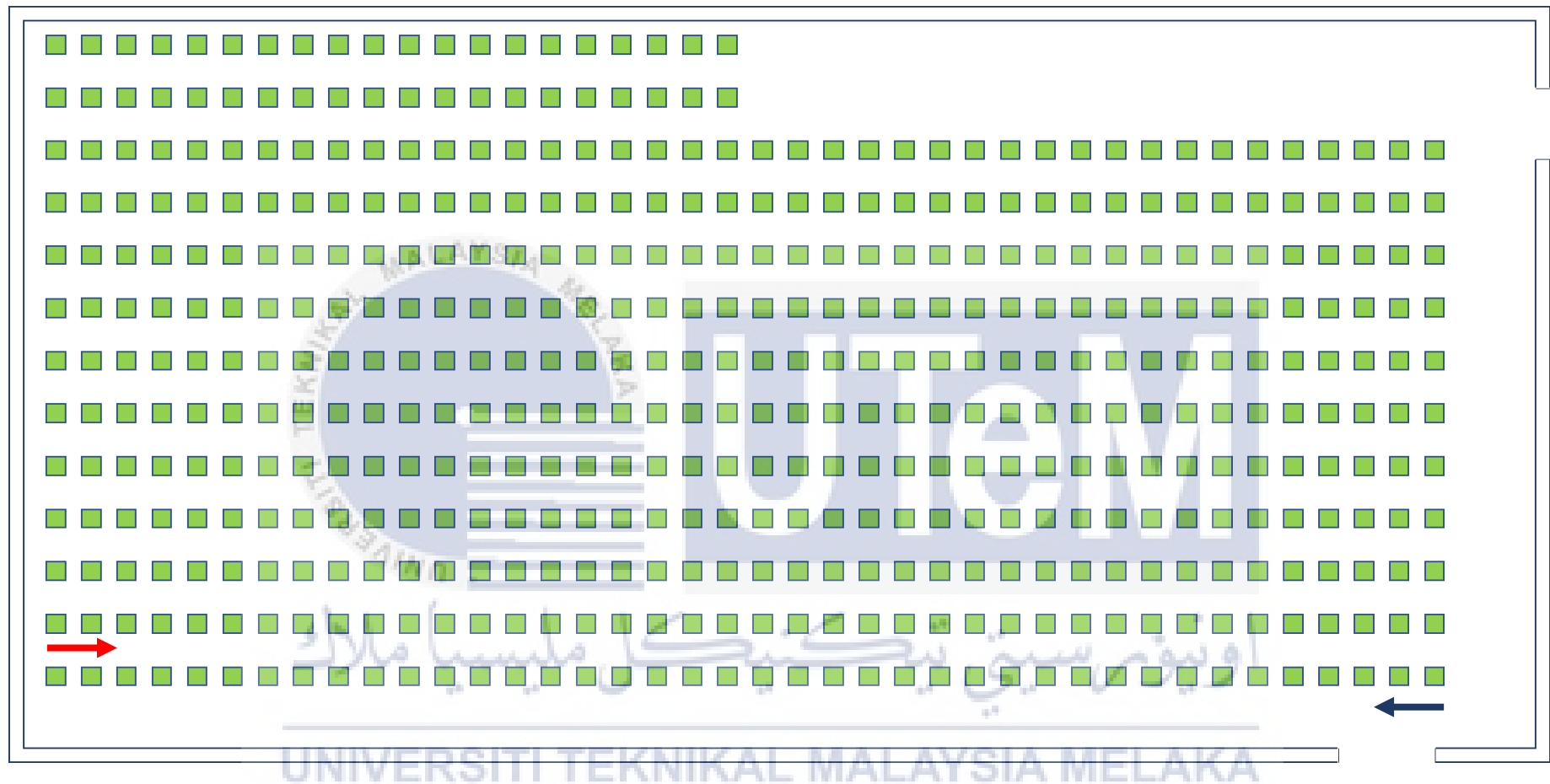


Figure 4.2 Agriculture Field Layout

4.3.1.3 Data Collection Based on Basic Most Analysis

The time measurement unit (TMU) of the time it takes to spray pesticide on the field is the focus of the primary data that has been collected. The information was gathered over the course of four months. Additionally, data is collected based on the sequence models from the Basic MOST approach of the respective movements in accordance with the data collection methods. The Basic MOST analysis sheet for manual labour pesticide operation is shown in Table 4.1, while the Basic MOST analysis sheet for rover system pesticide operation is shown in Table 4.2.

Table 4.1 and 4.2 show the model sequence from pesticide setup through spraying. Each of these models has its own advantages and disadvantages. Every stage of the process flow depends on each sequence. Sequence model A shows the distance to the object, B indicates the necessity for any bodily action, and G signifies acquiring possession of the thing. P is a parameter for where the object is put. This model analyses all humanly guided movements or activities of an object along a regulated path. Whereas X stands for process time and I stands for alignment, both of which are utilised to examine manual actions. The tool use sequence model further shows that U is dependent on the tools used and the motions required for each tool. Tools might stand for Loosen and Surface Treat. The time it takes to manually or mechanically disassemble an object using fingers, hands, or a hand tool. Surface Treat includes activities to clean, coat, or finish an object's surface. Furthermore, the index values stated in both the table 4.1 and table 4.2 shows the steps for each processes taken, this is clearly stated in Appendix G for the Basic MOST Index Values.

Table 4.1 Basic MOST Analysis Based on Manual Labour

MOST ANALYSIS SHEET			
MODEL : Basic Most Analysis		EQUIPMENT LIST :	Pesticide container, water tank, pressure pump, pesticide spray gun
OPERATION : Pesticide Spraying (Manual)			
STEP	METHOD DESCRIPTION	SEQUENCE MODELS	TMU
1	Open pesticide container cap	A6 B3 G1 A6 B3 P1 A1	0.0021 hours
			0.126 minutes
			7.56 seconds
2	Open tank lid	A1 B3 G1 A1 B3 P1 A1	0.0011 hours
			0.066 minutes
			3.96 seconds
3	Pour needed amount of pesticide into tank	A1 B3 G1 M3 X3 I1 A1	0.0013 hours
			0.078 minutes
			4.68 seconds
4	Pour plain water into another tank	A1 B3 G6 M3 X3 I1 A1	0.0018 hours
			0.108 minutes
			6.48 seconds
5	Mix both the tank thoroughly	A3 B3 G1 A1 B0 P1 U16 A1 B3 P1 A1	0.0031 hours
			0.186 minutes
			11.16 seconds
6	Switch on the pressure pump sprayer	A1 B0 G1 A1 B0 P1 A1	0.0005 hours
			0.03 minutes
			1.8 seconds
7	Turn on the nozzle of the pressure pump	A16 B3 G1 A6 B3 P0 U5 A16 B3 P0 A1	0.0054 hours
			0.324 minutes
			19.44 seconds
8	Start spraying and return	A20 B3 G3 M3 X3 I3 A1 (26)	0.0936 hours
			5.616 minutes
			336.96 seconds
9	Turn off pressure pump nozzle	A10 B6 G1 A10 B6 P0 A1	0.0034 hours
			0.204 minutes
			12.24 seconds
		Total	0.1123 hours
			6.738 minutes
			404.28 seconds

Table 4.2 Basic MOST Analysis Based on Rover System

MOST ANALYSIS SHEET			
MODEL : Basic Most Analysis		EQUIPMENT Pesticide container, Rover system	
OPERATION : Pesticide Spraying (Rover System)		LIST :	
STEP	METHOD DESCRIPTION	SEQUENCE MODELS	TMU
1	Open pesticide container cap	A6 B3 G1 A6 B3 P1 A1	0.0021 hours
			0.126 minutes
			7.56 seconds
2	Fill it up with water	A1 B6 G3 M3 X3 I1 A1	0.0018 hours
			0.108 minutes
			6.48 seconds
3	Open rover container lid	A1 B3 G1 A1 B0 P1 L6 A0 B0 P0 A0	0.0013 hours
			0.078 minutes
			4.68 seconds
4	Pour pesticide inside rover container	A1 B3 G3 M1 X3 I3 A1	0.0015 hours
			0.09 minutes
			5.4 seconds
5	Rinse and pour water into rover container	A1 B6 G3 A1 B0 P0 S6 A1 B6 P1 A1	0.0026 hours
			0.156 minutes
			9.36 seconds
6	Close rover container lid	A1 B3 G1 A1 B0 P1 F6 A0 B0 P0 A1	0.0014 hours
			0.084 minutes
			5.04 seconds
		Total	0.0107 hours
			0.642 minutes
			38.52 seconds

4.3.1.4 Calculation for Time Measure Unit (TMU)

The Time Measurement Unit (TMU) is used to calculate the duration of each action performed by the operator (TMU). As a result, there is a distinction made between standard time and actual time. These formulas are being used to calculate the TMU for each sequence models.

➤ Time Measurement Unit (TMU)

$$\begin{aligned} 1 \text{ TMU} &= 0.00001 \text{ hour} \\ &= 0.0006 \text{ minute} \\ &= 0.036 \text{ second} \end{aligned} \tag{4.1}$$

Hence, Basic MOST involves time to perform the activity calculated by adding all index values in the sequence model and multiplying by 10 to convert to TMU.

$$\text{TMU} = \text{SUM OF INDEX VALUES} \times 10$$

4.3.2 Secondary Data

In the context of data, secondary data refers to information gathered by another individual. For example, the data collected by the employees during the chilli crop production process will be used to improve the quality of the crop. When secondary data analysis is used to supplement primary data collection, it can save time by providing more meaningful and higher-quality datasets. This is especially true for quantitative data that would be hard for any individual researcher to acquire separately.

4.3.2.1 Rover System Operation

This section describes the amount of time it will take for the rover system to cover the entire field layout in order to achieve the research objectives, and it is intended to determine whether it is more useful than manual labour operation in order to meet the

objectives. Table 4.3 shows the total time taken for the operation of rover system operates for the whole field layout. In operation, the rover system moves at a pace of one metre per second, has a tank capacity of seventy litres, and has a spraying width ranging from eight metres wide to cover the majority of the plant rows. The rover travels at a pace of sixteen metres per second, covering each of the eleven rows of forty plants, for a total travel time of one hundred seventy-six metres per second, which is the time required to cover the four hundred forty plants. Furthermore, it will take the rover system a total of fourteen metres per second to cover two rows of plants, with twenty plants in each row, on a flat surface.

Table 4.3 Time Taken for Rover System Operation

Plants	Row	Time/row	Total Time
40	11	16 m/s	176 m/s
20	2	7 m/s	14 m/s

4.3.2.2 Return on Investment (ROI)

The return on investment (also known as return on capital) evaluates the profit or loss made on an investment in relation to the amount of money invested. The return on investment (ROI) is usually represented as a percentage and is typically used to compare the profitability of two companies. In this scenario, the incoming cash flow represents the amount of investment that represents the primary cost of investment in the overall project's operation. The entire revenue value is what this is referred to as. The profit made, on the other hand, is referred to as net income. Referring Appendix D and Appendix E, the quantity of cash flow for both manual labour operation and rover system operation is shown, allowing for the demonstration of both of these values. From the calculation below, the Return on Investment between manual labour and rover system is shown proves that operating using

rover system has more profit in return even though the cost of investment is higher compared to manual labour operation. As stated in Appendix D and Appendix E, the net profit, cost of investment has been carefully tabulated and calculated which determines the Return on Investment.

These formulas are being used to determine the Return on Investment (ROI) to generate the company's profitability.

➤ Return on Investment for Manual Labour Operation

$$\begin{aligned} \text{ROI} &= \frac{\text{Net Profit}}{\text{Cost of Investment}} \times 100 \% \\ &= \frac{16851.04}{100136} \times 100\% \\ &= 16.83 \% \end{aligned} \tag{4.2}$$

➤ Return on Investment for Rover System Operation

$$\begin{aligned} \text{ROI} &= \frac{\text{Net Profit}}{\text{Cost of Investment}} \times 100 \% \\ &= \frac{81741}{231680} \times 100 \% \\ &= 35.28 \% \end{aligned} \tag{4.3}$$

4.4 Data Analysis

In this section, the data analysis will describe in detail the issues encountered and the potential reasons of the problems discovered. In addition, the consequences of increasing production will be discussed. When it comes to approaching the results for the desired output, data analysis is the act of systematically applying analytical techniques. The data analysis is further supported by a cause and effect diagram, a why-why analysis, and a graph analysis, amongst other tools.

First and foremost, the cause-and-effect diagram is used to identify issues that have an impact on productivity in the workplace. This methodology is further separated into four

basic reasons, which are represented by the terms method, equipment, environment, and man, in order to uncover as many probable causes and consequences as feasible. Following that, the why-why analysis process is utilised to create a list of essential components as well as particular causes and consequences.

In addition, it is a strategy of questioning that aids in the identification of possible root causes of a problem or situation. This why-why analysis is extremely helpful in identifying the true root cause as well as the action that needs to be taken in order to find the root cause that has been discovered. Finally, graphs can be used to measure and analyse the data that has been collected. Besides that, data analysis is utilised to monitor ways to increase production and make them more efficient rather than wasting time with unneeded activities.

4.4.1 Cause and Effect Diagram

The cause-and-effect diagram is used to uncover fundamental root causes by breaking down ideas into their constituent parts or functional pieces. The cause-and-effect diagram was employed extensively in this study, which was based on the factors studied. Man, equipment, environment, and approach are the variables to consider. Additionally, this diagram will elicit ideas for discovering the root cause of an issue from the viewer. Agriculture field productivity is depicted in diagram 4.3 as a result of a cause-and-effect relationship.

The first aspect to consider is method. When it comes to applying on the field, it is noted that the wrong spraying approach is deficient in this regard. When it comes to agriculture, there are some methods that have been passed down through generations. Sowing, ploughing, irrigating, weeding, threshing, and harvesting are all done with a traditional wooden plough and bullock draught power, which is becoming increasingly popular. As previously said, new technology and machines are commonly used in farming,

and their use can have an impact on certain aspects of production. In addition, there is an issue with unreliable production. Additionally, this is owing to inefficient pesticide spraying schedule, which has a negative impact on productivity.

The second item to consider is technical difficulties with the equipment. As a result, there is a scarcity of equipment available when it is needed. The result of this could be a delay in the schedule for pesticide application. Additionally, when an item of equipment is required to be used, the absence of regular maintenance will cause the item of equipment to malfunction, causing the timetable to be delayed.

The third aspect is the surrounding environment. Temperature, water absorption, soil reactivity, and other environmental factors are all taken into consideration. Certain varieties of plants may be more sensitive to certain sorts of environmental conditions than others. A combination of terrain, climate, soil characteristics, and soil water is required for good crop growth, and a lack of any of these factors will have an adverse effect on the yield of a crop in a particular place.

Last but not least, there are concerns involving men. The problem is that workers' performance is suffering as a result of their mental and physical state. This can be triggered by the state of mind in which the employee is currently in. The mood swings of the employees would not be the same on every single day. Another difficulty that is caused by humans is a scarcity of trained labour. When skilled labour is in short supply, workers are less likely to follow right procedures when it comes to specific ways during work, especially if no proper work instructions have been provided.

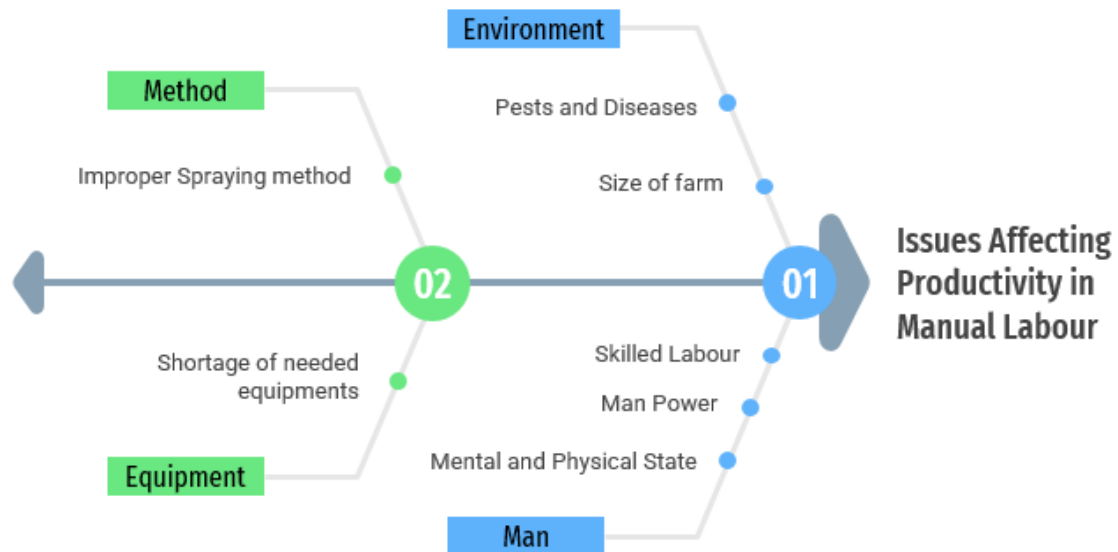


Figure 4.3 Cause and Effect Diagram

4.4.2 Why-Why Analysis

In the agriculture sector, the why-why analysis is used to determine the reasons and underlying causes of a problem or issue. In addition, the why-why analysis is a method of analysing and discovering the underlying causes of an issue or situation. When combined with the Fishbone diagram revolution, this method was developed by Genichi Taguchi to provide an efficient and easy tool for identifying and resolving the fundamental cause of a problem. Then, for each root cause, potential measures that can be taken to lessen the likelihood of the cause's occurrence or outcome are identified and discussed.

According to the why-why analysis provided in the table 4.4, there is one major factor determining production, and that factor is the individual. Lack of dedication is the most serious human resource challenge encountered by the agricultural sector. This process is used when an individual demonstrates a lack of discipline and ethical behaviour, which results in a lack of dedication to their profession. Additionally, financial concerns are included in this list of variables that lead to an individual engaging in money laundering. In

other words, the worker will take a specific amount of crops and lawfully sell them to customers outside of the sector at a fairer price, causing the company to lose a customer and causing production fluctuations.

Worker underperformance is the second issue to contend with. Producing chilli crops is the focus of this agricultural industry. This can be caused by a lack of labour, as there will not be enough workers to cover the entire region, or by a large amount of work that cannot be completed by a single individual. Consequently, only one person will be required to go through the entire procedure, resulting in that individual slowing the pace of work. Furthermore, there is a paucity of prior experience in this field. This occurs as a result of not participating in a training course to go through the job process, which results in the lack of appropriate work experience.

Table 4.4 Why-Why Analysis

Factor	Problem	Why 1	Why 2	Why 3	Root Cause
Man	Poor dedication	Lack of discipline	Lack of ethical behaviour	Financial Issues	Money Laundering
	Lacking performance of worker	Lack of manpower	Too much of work	No experience	Never attend training course

4.4.3 Calculation of Time Taken

To simplify the time required for manual and rover system operation, a database is created that records the amount of time required to spray pesticide on each plant in each row. Following that, the cumulative frequency is calculated in order to produce the graph, which may then be analysed by referring to the table.

Table 4.5 Time Taken for Rover and Manual Operations

PLANTS/ ROW	TIME (min)	
	ROVER	MANUAL
1	0.0167	0.0833
2	0.0167	0.0833
3	0.0167	0.0833
4	0.0167	0.0833
5	0.0167	0.0833
6	0.0167	0.0833
7	0.0167	0.0833
8	0.0167	0.0833
9	0.0167	0.0833
10	0.0167	0.0833
11	0.0167	0.0833
12	0.0167	0.0833
13	0.0167	0.0833
14	0.0167	0.0833
15	0.0167	0.0833
16	0.0167	0.0833
17	0.0167	0.0833
18	0.0167	0.0833
19	0.0167	0.0833
20	0.0167	0.0833
21	0.0167	0.0833
22	0.0167	0.0833
23	0.0167	0.0833
24	0.0167	0.0833
25	0.0167	0.0833
26	0.0167	0.0833
27	0.0167	0.0833
28	0.0167	0.0833
29	0.0167	0.0833
30	0.0167	0.0833
31	0.0167	0.0833
32	0.0167	0.0833
33	0.0167	0.0833
34	0.0167	0.0833
35	0.0167	0.0833
36	0.0167	0.0833
37	0.0167	0.0833
38	0.0167	0.0833
39	0.0167	0.0833
40	0.0167	0.0833

4.4.4 Analyse Collected Data by Using Minitab

Minitab includes all of the tools and resources necessary to assist users of all levels of expertise in data analysis and visualisation, as well as to empower individuals in these areas. Minitab assists manufacturers in identifying ways to increase the efficiency of their products, improve and protect critical quality, and save money.

4.4.4.1 Time Series Graph

This section will cover the data analysis and results findings related to time. Industries must be aware of the productivity rate processes through observation and analysis. The analytical instrument used is the period of time taken in comparison between manual operation and rover system operations. This method will reveal which operation can bring in more productivity in less period of time. Additionally, data analysis is utilised to monitor productivity in order to improve efficiency and avoid performing unnecessary operations.

A time series plot is a graph that depicts data collected from any process over time. The chart can be used to determine the trend of the data over time and whether the data points are randomly distributed or reflect any pattern. A time series visualisation demands that the data be gathered in a particular order or sequence. This means that when data is kept for analysis, the second data point follows the first, the third data point follows the second, and so forth. A time series plot cannot be created if the data is not collected or stored in a time sequence. While it is theoretically conceivable for the interval between data points to be non-constant, this is typically the case, and for the sake of simplicity, let us suppose that the data collecting frequency is constant.

Furthermore, the time series graph of rover operations against manual operations is depicted in figure 4.4. There are two independent variables: the rover and the manual operation, and the dependent variable is the amount of time it will take for both procedures

to be completed across forty plants. When comparing the outcomes of this graph to manual labour tasks, it can be shown that the rover travels faster to complete the pesticide spraying process. The actions that must be accomplished in a single row of plants consisting of forty plants are depicted in this graph.

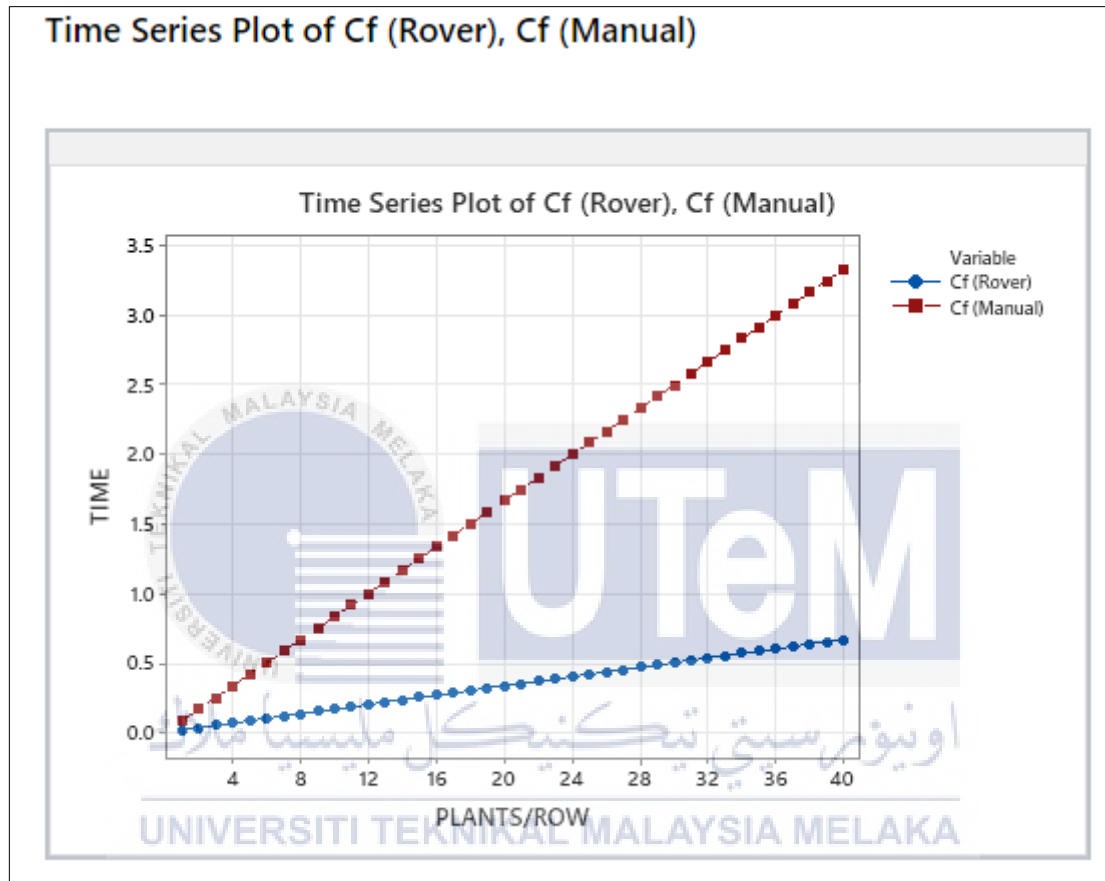


Figure 4.4 Time Series Graph of Rover versus Manual

4.5 Improvement Proposal

The first action that has been suggested is the use of autonomous systems. Using automated machinery to conduct pesticide spraying operations allows operators to spend more time on other tasks, which frees up time for them to devote to other responsibilities. This also saves money because it allows for a reduction in the number of employees. In addition, the operation of the rover system is proposed in order to prevent any harm that

could result in diseases in humans or faults in crop production. Even while the costs may be slightly greater than those associated with physical labour, this enhancement has a substantial impact on increasing productivity and reducing investment costs. As a result, the worker's productivity can be increased by the use of an automated procedure.

4.6 Control the Improvement

Improvements should be planned and implemented, their effectiveness evaluated, and long-term improvements maintained. The adoption of the DMAIC principle in the final phase of the study is the method to control that is required by the industrial sector. In order to ensure that the recommended process modifications are executed consistently and sustainably, this would be the goal of this project. The following are suggestions for improving and maintaining continuous management and improvement in the agricultural sector.

4.7 Summary

This chapter discusses the project's outcomes and discussion, which is the increase in agricultural production as well as the return on investment in the agricultural sector, as well as the implications of the findings. In accordance with the sectors, there were two sorts of data gathered: primary information and secondary information. By interviewing the workers and gaining a grasp of the spraying operation, the fundamental data is gathered. This is done with the MOST technique, which compares both manual and rover spraying procedures. In contrast to this, secondary data is information that is gathered based on the amount of money that will be invested in the human labouring process and in the implementation of rover system operations in order to maximise the return on investment.

Furthermore, identifying the root cause is a prerequisite for implementing or proposing any reforms in the industry. Its purpose is to guarantee that the improvement is

commensurate with the problem that has already happened. For determining the root cause, the cause and effect diagram and the Why - why analysis are employed together. Following the identification of the root problem, certain modifications have been proposed. Then, using the data acquired via the differentiating of time required for both procedures, it was tabulated through the use of a time series graph which results in which process takes longer to complete the process and which process saves time.

Furthermore, based on the findings of the cause-and-effect diagram and the why-why analysis, suggest a way to change the situation. A number of enhancements have also been implemented to increase the productivity of crop output in the agricultural sector.



CHAPTER 5

CONCLUSION

5.1 Conclusion

As a summary, the most efficient technique is an analysis of a task to determine the amount of time it will take the average worker to accomplish the assignment. This method is vital for organizations wanting to boost productivity or remove waste, and it can be applied in any organization. In order to assess the amount of time a task will take, there are several factors to consider. The most common of these factors are the need to complete long-term planning, manage performance, define costs, and determine weekly personnel hours. The Basic MOST System is capable of measuring a wide range of common work measurement conditions across a wide range of industries. It is the most rational and practical tool for measuring labour productivity. As a result, it may contribute to the reduction of the problem of poor-quality performance.

It is possible to meet the first purpose of this study, which is to identify the elements that influence productivity performance and return on investment (ROI), through this research. The criteria are established by the use of primary and secondary data that has been gathered from the agricultural land itself. Furthermore, a cause and effect diagram as well as a why-why analysis were utilized to discover the main cause of the problem and to resolve the issues that were affecting production. It is possible to calculate the cash flow in comparison to manual labour operation and rover system operation by calculating the return on investment (ROI). This technique can be used to estimate the profit that is more predictable and worth the investment. According to the results of the calculation, the cash

flow generated by the rover system operation results in a higher cash flow in the form of a return on investment.

As an additional goal, the DMAIC will be used to identify and analyze the factors that are affecting productivity and how to implement improvements. When applying Basic MOST sequence models, which depict the whole activity of moving one or more objects from one area to another, as well as the activity of utilizing tools or performing administrative activities, the results are as follows, The MOST Work Measurement Technique's main advantage is that it can be utilized for any sort of manual labour task. Technology is progressing slowly but steadily, and it has the potential to influence how labour is performed. For example, the introduction of a rover system is being studied to determine whether it would increase productivity.

Finally, the ultimate goal of this thesis is to provide a method for increasing productivity and monitoring it using the MOST Work Measurement Technique. The purpose of this objective is to make a recommendation to the agricultural industry regarding a solution for high productivity while maintaining efficiency. The proposed upgrade is based on data analysis and the identification of the root cause, from which the implementation of these strategies can be determined. There is a plan in place for the company to be provided with upgrades in order to assist in the resolution of the problem. The company is then approached with the idea of making the modification.

5.2 Contribution

Most Work Measurement Technique application in the agriculture sector makes the most significant contribution by providing a structure to assess various types of work and to monitor the quality performance and productivity of the organization. In the agriculture industry, Basic MOST is an excellent application of work measurement technique since it permits a broader diversity of labour (both repetitive and non-repetitive) in a shorter amount

of time with higher ease and precision. As an added benefit, it can aid in preventing inappropriate implementation, which can result in large financial losses and decreased productivity. Using the MOST Work Measurement Technique, the agriculture industry will gain access to fresh and valuable information that will help them enhance their productivity. In addition, the agricultural sector will adopt the rover system in a manner that will result in effective productivity, and it will reap the benefits of the system in a significant way when it comes to productivity.

5.3 Suggestion for Future Research

As a result, the recommendation for future research is to develop another means of increasing productivity that will incorporate any type of automation system into it. It has been shown that when using a MOST approach, the adoption of MiniMOST and MaxiMOST can increase productivity by improving the precision of work measurement techniques. Furthermore, when applying the technology of implementing a rover system, the specification of the rover system can be in criteria so that it is perfectly suitable for the field layout or will be able to cover a wider range of field layouts can be in criteria so that it is perfectly suitable for the field layout.

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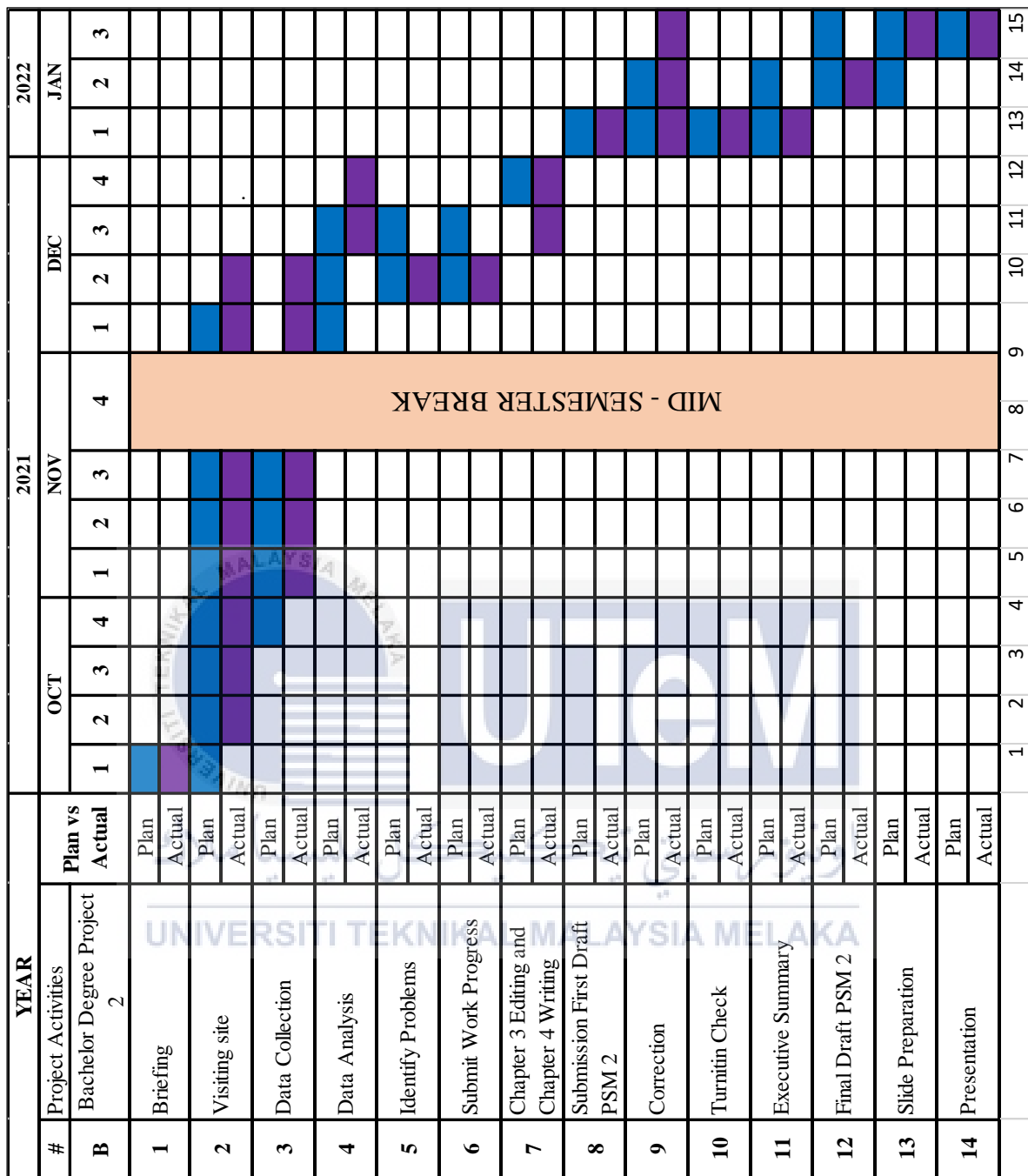
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APPENDICES

APPENDIX A Gantt Chart PSM 1

YEAR			2021																	
#	Project Activities	Plan vs Actual	MAR		APR					MAY			JUN							
A	Bachelor Degree Project 1	Actual	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4			
1	Briefing	Plan																		
		Actual																		
2	Identify Problem	Plan																		
		Actual																		
3	Establish Objective	Plan																		
		Actual																		
4	Chapter 1 Writing	Plan																		
		Actual																		
5	Literature Review	Plan																		
		Actual																		
6	Chapter 2 Writing	Plan																		
		Actual																		
7	Chapter 3 Writing	Plan																		
		Actual																		
8	Title Page	Plan																		
		Actual																		
9	Submission First Draft PSM 1	Plan																		
		Actual																		
10	Turnitin Check	Plan																		
		Actual																		
11	Correction	Plan																		
		Actual																		
12	Final Draft PSM 1	Plan																		
		Actual																		
13	Slide Preparation	Plan																		
		Actual																		
14	Presentation	Plan																		
		Actual																		

APPENDIX B Gantt Chart PSM 2



APPENDIX C Spraying Schedule

Pesticide Spraying Schedule Plot 1 (2120 polybags)

Days after plantation (HST)	am / pm	Active Ingredient	Chemical Volume (mL @ gram)	Solution volume (L)
0	pm	Imidacloprid 18.3% SL	15 mL	40
1	am	Vegetation Foliar	70 g	40
2	am	acetamiprid 20%	15 mL	40
3	pm	malathion 84%	40 mL	40
4	am	Imidacloprid 18.3% SL	15 mL	40
5	pm	pyriproxyfen 10.8%	15 mL	40
6	am	mancozeb 80% + vegetation foliar	100g + 70g	40
7	pm	Imidacloprid 18.3% SL	15 mL	40
8	am	Vegetation Foliar	70 g	40
9	am	acetamiprid 20%	15 mL	40
10	pm	malathion 84%	40 mL	40
11	am	Imidacloprid 18.3% SL	15 mL	40
12	pm	pyriproxyfen 10.8%	15 mL	40
13	am	mancozeb 80% + vegetation foliar	100g + 70g	40
14				
15	am	Imidacloprid 18.3% SL	19 mL	50
16				
17	pm	malathion 84%	50 mL	50
18				
19	am	acetamiprid 20%	18 mL	50
20	am	mancozeb 80% + vegetation foliar	125g + 85g	50
21				

22	am	Imidacloprid 18.3% SL	19 mL	50
23	pm	pyriproxyfen 10.8%	18 mL	50
24				
25	am	acetamiprid 20%	18 mL	50
26				
27	pm	malathion 84%	50 mL	50
28	am	mancozeb 80% + vegetation foliar	125g + 85g	50
29				
30	am	Imidacloprid 18.3% SL	19 mL	50
31				
32	pm	Amitraz 21.6%	60 mL	60
33	am	acetamiprid 20%	23 mL	60
34				
35	am	mancozeb 80% + vegetation foliar	150g + 120g	60
36	am	Imidacloprid 18.3% SL	25 mL	60
37	pm	pyriproxyfen 10.8%	18 mL	50
38				
39				
40	am	acetamiprid 20%	23 mL	60
41				
42				
43	am	Imidacloprid 18.3% SL	25 mL	60
44	pm	Amitraz 21.6%	60 mL	60
45				

46	am	mancozeb 80% + vegetation foliar	200g + 200g	80
47	pm	pyriproxyfen 10.8%	40 mL	80
48				
49	am	Imidacloprid 18.3% SL	40 mL	80
50				
51	am	acetamiprid 20%	40 mL	80
52	pm	Amitraz 21.6%	80 mL	80
53				
54	am	mancozeb 80% + flower foliar	250g + 250g	100
55	pm	pyriproxyfen 10.8%	50 mL	100
56				
57	am	Imidacloprid 18.3% SL	50 mL	100
58				
59				
60	am	acetamiprid 20%	50 mL	100
61	pm	Amitraz 21.6%	100 mL	100
62				
63				
64	am	mancozeb 80% + flower foliar	300g + 300g	120
65	pm	pyriproxyfen 10.8%	60 mL	120
66				
67	am	Imidacloprid 18.3% SL	60 mL	120
68				

69				
70	am	acetamiprid 20%	60 mL	120
71	pm	Amitraz 21.6%	120 mL	120
72				
73				
74	am	mancozeb 80% + vegetation foliar	350g + 350g	140
75	pm	pyriproxyfen 10.8%	70 mL	140
76				
77	am	Imidacloprid 18.3% SL	70 mL	140
78				
79				
80	am	acetamiprid 20%	70 mL	140
81	pm	Amitraz 21.6%	140 mL	140
82				
83				
84	am	mancozeb 80% + flower foliar	350g + 350g	140
85	pm	pyriproxyfen 10.8%	70 mL	140
86				
87	am	Imidacloprid 18.3% SL	70 mL	140
88				
89				
90	am	acetamiprid 20%	70 mL	140
91	pm	Amitraz 21.6%	140 mL	140

92				
93				
94	am	mancozeb 80% + flower foliar	400g + 400g	160
95	pm	pyriproxyfen 10.8%	80 mL	160
96				
97	am	Imidacloprid 18.3% SL	80 mL	160
98				
99				
100	am	acetamiprid 20%	80 mL	160
101	pm	Amitraz 21.6%	160 mL	160
102				
103				
104	am	mancozeb 80% + flower foliar	400g + 400g	160
105	pm	pyriproxyfen 10.8%	80 mL	160
106				
107	am	Imidacloprid 18.3% SL	80 mL	160
108				
109				
110	am	acetamiprid 20%	80 mL	160
111	pm	Amitraz 21.6%	160 mL	160
112				
113				
114	am	mancozeb 80% + flower foliar	450g + 450g	180
115	pm	pyriproxyfen 10.8%	90 mL	180

116				
117	am	Imidacloprid 18.3% SL	90 mL	180
118				
119				
120	am	acetamiprid 20%	90 mL	180
121	pm	Amitraz 21.6%	180 mL	180
122				
123				
124	am	mancozeb 80% + flower foliar	450g + 450g	180
125	pm	pyriproxyfen 10.8%	90 mL	180
126				
127	am	Imidacloprid 18.3% SL	90 mL	180
128				
129				
130	am	acetamiprid 20%	90 mL	180
131	pm	Amitraz 21.6%	180 mL	180
132				
133				
134	am	mancozeb 80% + flower foliar	450g + 450g	180
135	pm	pyriproxyfen 10.8%	90 mL	180
136				
137	am	Imidacloprid 18.3% SL	90 mL	180
138				
139				

140	am	acetamiprid 20%	90 mL	180
141	pm	Amitraz 21.6%	180 mL	180
142				
143				
144	am	mancozeb 80% + flower foliar	500g + 500g	200
145	pm	pyriproxyfen 10.8%	100 mL	200
146				
147	am	Imidacloprid 18.3% SL	100 mL	200
148				
149				
150	am	acetamiprid 20%	100 mL	200
151	pm	Amitraz 21.6%	200 mL	200
152				
153				
154	am	mancozeb 80% + flower foliar	500g + 500g	200
155	pm	pyriproxyfen 10.8%	100 mL	200
156				
157	am	Imidacloprid 18.3% SL	100 mL	200
158				
159				
160	am	acetamiprid 20%	100 mL	200
161	pm	Amitraz 21.6%	200 mL	200

APPENDIX D Return on Investment (ROI) for Manual Labour

CASH FLOW									
CHILLI CROP PROJECT									
Project Name		Chilli Crop							
Project Area		1	acres						
Number of Polybags		2120							
Average yield per bag		3.5	kg						
Estimated Field Cost (RM/kg)		6							
Crop rotation per year		2	times						
Estimated Results		90%							
Project Duration		5	years						
ITEMS		Price / Unit	Quantity	Year					Total
				1	2	3	4	5	
1 INCOMING CASH FLOW									
1	Results (kg)		kg	13356	13356	13356	13356	13356	66780
2	Price (RM/kg)	6	RM	80136	80136	80136	80136	80136	400680
3	Capital	20000	L/sum	20000					20000
	Total Income		RM	100136	80136	80136	80136	80136	420680
2 OUTGOING CASH FLOW									
a)	Development Costs								
	Area Preparation	1500	L/sum	1500	0	0	0	0	1500
	Fence Installation, Drainage	2400	L/sum	2400	0	0	0	0	2400
	Tank House	1500	L/sum	1500	0	0	0	0	1500
	Irrigation System and Fittings	18000	L/sum	18000	0	0	0	0	18000
	Total Development Costs			23400					23400
b)	Cost of Production (Per Year)								
	Input Material								
	Seeds F1 Hybrid (RM/set)	75	8	600	600	600	600	600	3000
	Fertilizer set A @ B (RM/set)	125	40	5000	5000	5000	5000	5000	25000
	Seedling								
	Peatmose Media (RM/beg)	45	8	360	360	360	360	360	1800
	Nursery Tray (RM/unit)	4	50	200	0	0	0	0	200
	Poison								
	Insecticides (RM)	100	20	2000	2000	2000	2000	2000	10000
	Mold Poison (RM)	30	8	240	240	240	240	240	1200
	Other Materials								
	Polybag 16 x 16 (RM/kg)	10	100	1000	0	1000	0	1000	3000
	Cocopeat Media (RM/sack)	10	250	2500	0	2500	0	2500	7500
	Weed Control Mat (RM/roll)	700	3	2100	0	0	0	0	2100
	Farm Tools	900	L/sum	900	0	900	0	900	2700
	Total Production Costs			14900	8200	12600	8200	12600	56500
c)	Operation Costs								
	Wages for per worker	1600	12	19200	19200	19200	19200	19200	96000
	Plucking Wages RM/kg	0.6	13356	8013.6	8013.6	8013.6	8013.6	8013.6	40068
	Electric and Water Bill	150	12	1800	1800	1800	1800	1800	9000
	Petrol (Shipping Cost)	300	12	3600	3600	3600	3600	3600	18000
	Product Marketing Expenses	200	12	2400	2400	2400	2400	2400	12000
	Others	200	12	2400	2400	2400	2400	2400	12000
	Total Operation Costing			37413.6	37413.6	37413.6	37413.6	37413.6	187068
3 Cost of Production									
a)	Total Cost a+b+c			75713.6	45613.6	50013.6	45613.6	50013.6	266968
	Contingent Cost Percentage	10%		7571.36	4561.36	5001.36	4561.36	5001.36	26696.8
	Total Production Costs			83284.96	50174.96	55014.96	50174.96	55014.96	293664.8
4 NET INCOME (5 YEARS)									
5	NET INCOME PER ANNUM (RM)			16851.04	29961.04	25121.04	29961.04	25121.04	
6	NET INCOME PER MONTH (RM)		12	1404.253	2496.753	2093.42	2496.753	2093.42	
7	COST BENEFIT RATIO			1.4					
8	CAPITAL RETURN			1 YEARS					

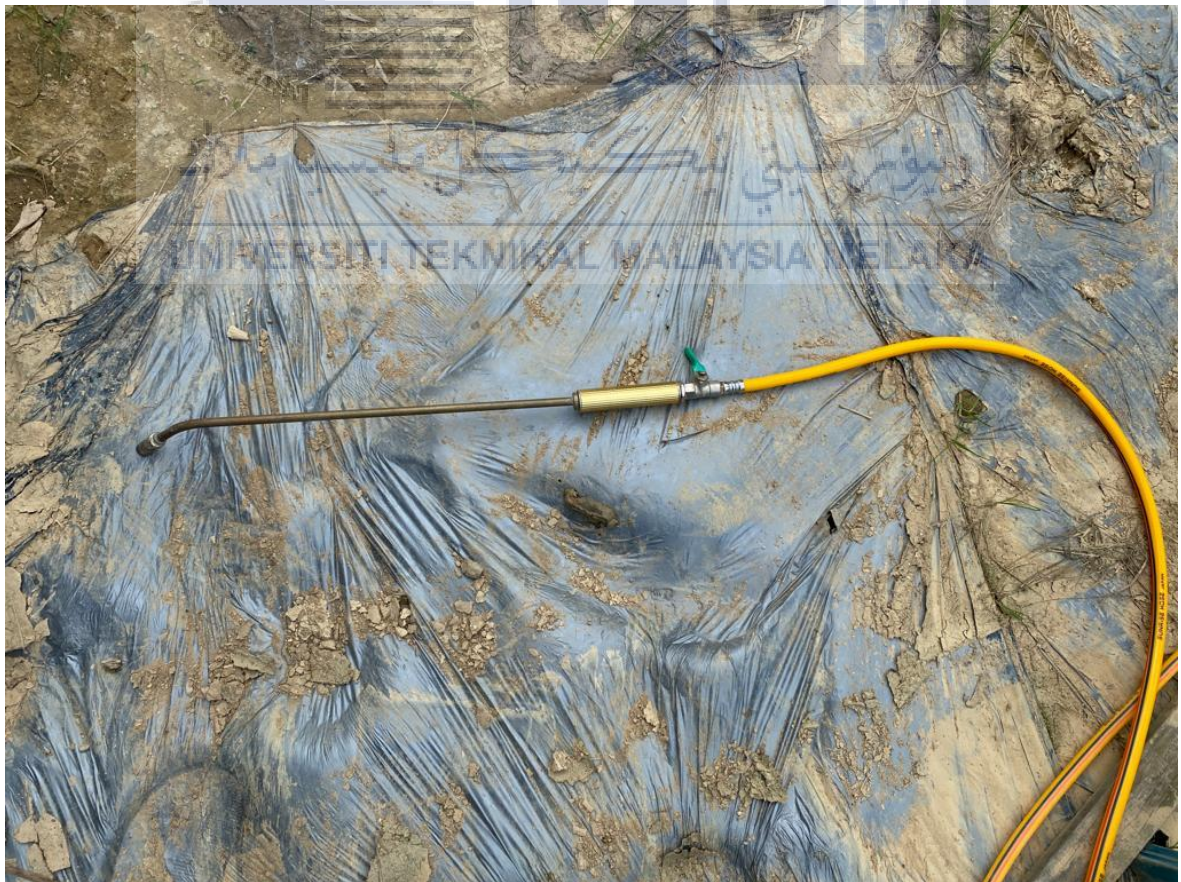
APPENDIX E Return on Investment (ROI) for Rover System

CASH FLOW									
CHILLI CROP PROJECT									
Project Name	Chilli Crop								
Project Area	1	acres							
Number of polybags	4200								
Average yield per bag	3.5	kg							
Estimated Field Cost (RM/kg)	8								
Crop Rotation per Year	2	times							
Estimated Results	90%								
Project Duration	5	years							
ITEMS	Price / Unit	Quantity	Years					Total	
			1	2	3	4	5		
1 INCOMING CASH FLOW									
1 Results (2 musim) (kg)		kg	26460	26460	26460	26460	26460	132300	
2 Price (RM/kg)	8	RM	211680	211680	211680	211680	211680	1058400	
3 Capital	20000	L/sum	20000					20000	
Total Income		RM	231680	211680	211680	211680	211680	1078400	
2 OUTGOING CASH FLOW									
a) <u>Development Costs</u>									
Area Preparation	1500	L/sum	1500	0	0	0	0	1500	
Fence Installation, drainage	2400	L/sum	2400	0	0	0	0	2400	
Tank House	1500	L/sum	1500	0	0	0	0	1500	
Irrigation System and Fittings	40000	L/sum	40000	0	0	0	0	40000	
Total Development Costs			45400					45400	
b) <u>Cost of Production (Per Year)</u>									
<u>Input Material</u>									
Seeds F1 Hybrid (RM/set)	75	8	600	600	600	600	600	3000	
Fertilizer set A @ B (RM/set)	200	80	16000	16000	16000	16000	16000	80000	
<u>Seedling</u>									
Peatmose Media (RM/beg)	45	8	360	360	360	360	360	1800	
Nursery Tray (RM/unit)	4	50	200	0	0	0	0	200	
<u>Poison</u>									
Insecticides (RM)	100	40	4000	4000	4000	4000	4000	20000	
Mold Poison (RM)	30	16	480	480	480	480	480	2400	
<u>Other Materials</u>									
Polybag 16 x 16 (RM/kg)	10	200	2000	0	2000	0	2000	6000	
Cocopeat Media (RM/sack)	10	500	5000	0	5000	0	5000	15000	
Weed Control Mat (RM/roll)	700	12	8400	0	8400	0	0	16800	
Farm Tools	900	L/sum	900	0	900	0	900	2700	
Total Production Costs			37940	21440	37740	21440	29340	147900	
c) <u>Operation Costs</u>									
Wages for per worker	1800	12	21600	21600	21600	21600	21600	108000	
Plucking Wages RM/kg	0.8	26460	21168	21168	21168	21168	21168	105840	
Electric and Water Bill	150	12	1800	1800	1800	1800	1800	9000	
Petrol (Shipping Cost)	300	12	3600	3600	3600	3600	3600	18000	
Product Marketing Expenses	200	12	2400	2400	2400	2400	2400	12000	
Others	200	12	2400	2400	2400	2400	2400	12000	
Total Operation Costing			52968	52968	52968	52968	52968	264840	
3 Cost of Production									
a) <u>Total Cost a+b+c</u>			136308	74408	90708	74408	82308	458140	
<u>Contingent Cost Percentage</u>	10%		13630.8	7440.8	9070.8	7440.8	8230.8	45814	
Total Production Costs			149938.8	81848.8	99778.8	81848.8	90538.8	503954	
4 NET INCOME (5 TAHUN)								574446	
5 NET INCOME PER ANNUM (RM)			81741.2	129831.2	111901.2	129831.2	121141.2		
6 NET INCOME PER MONTH (RM)		12	6811.767	10819.27	9325.1	10819.27	10095.1		
7 COST-BENEFIT RATIO			2.1						
8 CAPITAL RETURN			1 YEAR						

APPENDIX F Melor Agricare Field







APPENDIX G Basic MOST Index Values

INDEX	A ACTION DISTANCE	B BODY MOTION	C GAIN CONTROL	P PLACE	INDEX	M MOVE CONTROLLED	X PROCESS TIME	I ALIGN	INC		
0	≤ 2 IN ≤ 5 CM			HOLD TOSS, STRIKE	0	PUSH/PULL/PIVOT CRANK (REVS.)	SECONDS MINUTES HOURS	OBJECT			
1	WITHIN REACH		LIGHT OBJECT GRIP LIGHT OBJECTS SIMO	LAY ASIDE, PLACE LOOSE FIT (LF)	1	≤ 12 INCHES (30 CM) BUTTON/SWITCH/KNOB	0.5	0.01	0.0001	TO ONE POINT	
3	1-2 STEPS	BEND AND ARISE 50% OCC	NON-SIMO HEAVY OR BULKY BLIND OR OBSTRUCTED DISENCAE INTERLOCKED COLLECT	ADJUSTMENTS LIGHT PRESSURE JOCOLE, IF WITH INTERMEDIATE MOVES	3	> 12 INCHES (30 CM) RESISTANCE SEAT OR UNSEAT HIGH CONTROL 2 STAGES ≤ 12 INCHES (30 CM)	1	1.5	0.02	0.0004	TO TWO POINTS < 4 INCHES (10 CM)
6	3-4 STEPS	BEND AND ARISE	Very heavy & difficult grasp	CARE OR PRECISION HEAVY PRESSURE BLIND OR OBSTRUCTED SEARCH & SELECT	6	2 STAGES > 12 INCHES (30 CM)	3	2.5	0.04	0.0007	TO TWO POINTS > 4 INCHES (10 CM)
10	5-7 STEPS	SIT OR STAND			10	3-4 STAGES	6	4.5	0.07	0.0012	
16	8-10 STEPS	THROUGH DOOR CLIMB ON OR OFF			16		11	7.0	0.11	0.0019	PRECISION

TOOL USE (FASTEN/LOOSEN)											
ABG ABP U ABP A											
INDEX	FINGER ACTION	WRIST ACTIONS				ARM ACTION				POWER TOOL	INDEX
		SPINS	TURN	PEP- SITION	CRANK	TAP	TURN	PEP- SITION	CRANK		
	FINGERS SCREW- DRIVER	HAND SCREW- DRIVER RATCHET T- WRENCH	WRENCH ALLEN KEY	WRENCH ALLEN KEY RATCHET	HAND HAMMER	RATCHET T- WRENCH	WRENCH ALLEN KEY	WRENCH ALLEN KEY RATCHET	HAND HAMMER	POWER WRENCH SCREW DIA INCHES	
1	1	-	-	-	1	-	-	-	-	0.25" 6mm	1
3	2	1	1	1	3	1	1	-	1	1.0" 24mm	3
6	3	3	2	3	6	2	-	1	3		6
10	8	5	3	5	10	4	2	2	5		10
16	16	9	5	8	16	6	3	3	8		16
24	25	13	8	11	23	9	4	5	12		24
32	35	17	10	15	30	12	6	6	16		32
42	47	23	13	20	39	15	8	8	21		42
54	61	29	17	25	50	20	10	11	27		54

EXTENDED VALUES										
ACTION DISTANCE				PROCESS TIME (X)						
INDEX	STEPS	DISTANCE (FT)	DISTANCE (M)	INDEX	SECONDS	MINUTES	HOURS			
24	11-15	38	12	1	0.5	.01	.0001			
32	16-20	50	15	3	1.5	.02	.0004			
42	21-26	65	20	6	2.5	.04	.0007			
54	27-33	83	25	10	4.5	.07	.0012			
67	34-40	100	30	16	7.0	.11	.0019			
81	41-49	123	38	24	9.5	.16	.0027			
96	50-57	143	44	32	13.0	.21	.0036			
113	58-67	168	51	42	17.0	.28	.0047			
131	68-78	195	59	54	21.5	.36	.0060			
152	79-90	225	69	67	26.0	.44	.0073			
173	91-102	255	78	81	31.5	.52	.0088			
196	103-115	288	88	96	37.5	.62	.0104			
220	116-128	320	98	113	43.5	.72	.0121			
245	129-142	355	108	131	50.5	.84	.0141			
270	143-158	395	120	152	58.0	.97	.0162			
300	159-174	435	133	173	66.0	1.10	.0184			
330	175-191	478	146	196	74.5	1.24	.0207			
				220	83.5	1.39	.0232			
				245	92.5	1.54	.0257			
				270	102.0	1.70	.0284			
				300	113.0	1.88	.0314			
				330	124.0	2.06	.0344			

TOOL USE															
ABG ABP U ABP A															
INDEX	C			S			M		R		I				
	CRIP ETC	CUTOFF	CUT	SURF CLEAN	BRUSH CLEAN	WIPE	MEASURE	WRITE	MARK						
	PLIERS	SCISSORS	KNIFE	NOZZLE	BRUSH	CLOTH	MEASURING DEVICE	PENCIL	MARKER						
		(WIRE)	CUTS	STROKES	SOFT 0.1 M ³	SOFT 0.1 M ³	SOFT 0.1 M ³	IN (CM)	FT (M)	DIGITS	WORDS	DIGITS	POINTS	DIGITS SINGLE WORDS	TEXT OF WORDS
1	CRIP		1	-	-	-	-	1	-	CHECK MARK	1	1	3	1	
3	1 TWIST	SOFT	2	1	-	-	0.5	2	-	1 SCRIBE LINE	3	3	8	3	
6	2 TWISTS BEND LOOP	MEDIUM	4		1 POINT OR CAVITY	1 SMALL OBJECT	-	4	1	2	5 TOUCH FOR HEAT	-	5	15	
10		HARD	7	3	-	-	1	6	-	3	9 FEEL FOR DEFECT	12	20		
16	COTTER- PIN		11	4	3	2	2	9	2	5	SIGNATURE DATE		38		
24			15	6	4	3	-	13	3	7			54		
32			20	9	7	5	5	18	4	10			72		
42			27	11	10	7	7	23	5	13			94		
54			33					29	7	16			119		

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: ANALYSIS OF ROVER SYSTEM ON PRODUCTIVITY AND RETURN ON INVESTMENT IN AGRICULTURE

SESI PENGAJIAN: 2020/21 Semester 1

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