MAYNARD OPERATIONAL SEQUENCE TECHNIQUE WEB DESIGN FOR MANUFACTURING LABOR UTILIZATION STUDY

HADIRAH BINTI AHMAD SAFRI
B092010125

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Hadirah Binti Ahmad Safri

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HADIRAH BINTI AHMAD SAFRI

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56, PERSIARAN SUNGAI CHEMOR 3A

TAMAN BUNGA RAYA

31200 CHEMOR, PERAK

Cop Rasmi: TS. DR. ROHANA BINTI ABDULLAH
PENSYARAH KANAN
JABATAN TEKNOLOGI KEJURUTERAAN PEMBUATAN
FAKULTI TEKNOLOGI DAN KEJURUTERAAN INDUSTRI DAN PEMBUATAN
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Signature :

TS. DR. ROHANA BINTI ABDULLAH
PENSYARAH KANAN
JABATAN TEKNOLOGI KEJURUTERAAN PEMBUATAN
FAKULTI TEKNOLOGI DAN KEJURUTERAAN INDUSTRI DAN PEMBUATAN
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Supervisor Name : Ts. Dr. Rohana Binti Abdullah

Date : 7/2/2024

DEDICATION

This expression of gratitude is extended to my treasured parents, siblings, and friends who have consistently provided me with spiritual and emotional support. Not forgetting my supervisor, Ts. Dr. Rohana Binti Abdullah, whose encouragement and direction inspired me to successfully complete this thesis.

ABSTRACT

Manufacturing industries plays a crucial role in production chains, but inefficiencies such as worker waste result in lower productivity. The Manual Maynard Operational Sequence Technique (MOST) is a proven method used in manufacturing industries to compute and determine productivity. The conventional method of calculating is slow and open to mistakes, impeding enhancements in efficiency. The objective of this project is to create a website that utilises the MOST (Maynard Operation Sequence Technique) to enhance the productivity of SME Aerospace's assembly department. Because of the improvement that is going to be developed, a company will be able to expand its capabilities, which will help it to remain one step ahead of its rivals. Following that, the website will be built utilising the Waterfall method, which employs JavaScript, HTML, and CSS. This is because they are the component that suitable the new developer to develop a website. The website aims to optimise the majority of calculations, minimise processing time, enhance worker comprehension of productivity enhancement techniques, and to eliminate the need for an Excel template. The testing was conducted to determine whether the website can be deployed effectively and optimise the time required. As a result, MOST Calculator website and Excel template has identical result. The website only takes 1 day to enter all the data and get the result, while Excel takes longer and were prone to errors. Efficiency, user-friendliness, and visual analysis are website benefits. This website has the ability to significantly enhance organisational efficiency and effectiveness by reducing calculation time and streamlining access to MOST with minimal expenditures on capital.

ABSTRAK

Industri pembuatan memainkan peranan penting dalam rantaian pengeluaran, tetapi ketidakcekapan seperti sisa pekerja mengakibatkan produktiviti yang lebih rendah. Manual Maynard Operational Sequence Technique (MOST) ialah kaedah terbukti yang digunakan dalam industri pembuatan untuk mengira dan menentukan produktiviti. Kaedah pengiraan konvensional adalah perlahan dan terbuka kepada kesilapan, menghalang peningkatan kecekapan. Objektif projek ini adalah untuk mencipta laman web yang menggunakan MOST (Maynard Operational Sequence Technique) untuk meningkatkan produktiviti jabatan pemasangan SME Aerospace. Oleh kerana penambahbaikan yang akan dibangunkan, syarikat akan dapat mengembangkan keupayaannya, yang juga akan membantunya untuk kekal selangkah di hadapan pesaingnya. Selepas itu, laman web akan dibina menggunakan kaedah Waterfall, yang menggunakan JavaScript, HTML dan CSS. Ini kerana mereka adalah komponen yang sesuai dengan pembangun baharu untuk membangunkan laman web. Laman web ini bertujuan untuk mengoptimumkan sebahagian besar pengiraan, meminimumkan masa pemprosesan, meningkatkan pemahaman pekerja tentang teknik peningkatan produktiviti dan untuk menghapuskan keperluan untuk templat Excel. Ujian telah dijalankan untuk menentukan sama ada tapak web boleh digunakan dengan berkesan dan mengoptimumkan masa yang diperlukan. Justeru, laman web Kalkulator MOST dan templat Excel mempunyai hasil yang sama. Tapak web hanya mengambil masa 1 hari untuk memasukkan semua data dan mendapatkan hasilnya, manakala Excel mengambil masa yang lebih lama dan terdedah kepada ralat. Kecekapan, kemesraan pengguna dan analisis visual ialah faedah tapak web. Laman web ini mempunyai keupayaan untuk meningkatkan kecekapan dan keberkesanan organisasi dengan ketara dengan mengurangkan masa pengiraan dan menyelaraskan akses kepada MOST dengan perbelanjaan minimum ke atas modal.

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LIST OF ABBREVIATIONS

MOST	-	Maynard Operation Sequence Technique
MTM	-	Methods Time Measurement
MODAPTS	-	Modular Arrangement of Predetermined Time Standards
TMU	-	Time Measuring Unit
AI	-	Artificial Intelligence
IOT	-	Internet of Thing
PLC	-	Programmable Logic Controller
NVA	-	Non-Value Added
PMTS	-	Predetermine Motion Time System
JS	-	JavaScript
HTML	-	Hypertext Markup Language
CSS	-	Cascading Style Sheets
CPS	-	Cyber Physical Systems
CPPS	-	Cyber Physical Production Systems
SLDC	-	Software Development Life Cycle
PSM	-	Projek Sarjana Muda
FYP	-	Final Year Project
OTIDS	-	Operation, Transportation, Inspection, Delay and Storage

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CHAPTER 1

INTRODUCTION

1.1 Background

In today's highly competitive industrial climate, manufacturing is an essential component of the production chain that extends from raw materials to a final product. This chain has been in existence since the 19th century and is a major contributor to employment around the world. Nevertheless, in the sphere of manufacturing, there are required to be eight different forms of waste produced together with the product. The most major loss that occurred as a direct result of inefficiencies was not a monetary one; rather, it was a waste of the effort that was put in by individuals. Because of this, the implementation of efficiency improvements is currently taking place.

Previous study that been conducted by student, the measurement for productivity is measured using Maynard Operational Sequence Technique template. The template uses an Excel sheet, to execute the result it takes much longer time to be displayed. Human error might have happened somehow. due to a lack of experience with time study measurement methods other than the stopwatch research. To change work methods drastically, this is essential. The production line will suffer if workers' waste isn't addressed. Unwanted worker movements may increase inefficiencies.

Microsoft Excel is a powerful tool for analyzing data and doing numbers, but there are a few things to think about if you want to use it to figure out the MOST. Excel needs manual updates when data changes. If you add or remove data from your dataset, you will need to change the formulas and ranges used in your "MOST" calculations by hand. Especially if you have a lot of data, this can take a lot of time and lead to mistakes. Excel can be slow and uses a lot of resources when you do complex calculations on big datasets. Excel may take a long time to respond or stop working when it has to do a lot of math or handle a lot of data. This can slow you down and make your work less efficient. Excel makes it hard to work together, especially when several people need to view or change the same file at the same time. Sharing Excel files through email or cloud storage can cause problems and conflicts with version control. Excel calculations can go wrong because of things like wrong cell references, wrong formulas, or accidentally overwriting data. Data verification and mistake prevention can take a lot of time, especially if the spreadsheet is complicated or has a lot of formulas.

In this project, I want to make a website that can calculate most datasets. This is because it's becoming more common to use online calculators or websites to calculate large amounts of data. This is because online calculators and websites can handle large datasets more efficiently than desktop applications like Excel. They often use the tools of cloud computing to do calculations quickly and handle large amounts of data without slowing down. Online calculators and websites are easy to use because they can be viewed from anywhere with an internet connection. Users can do calculations on any device they want, including computers, laptops, tablets, and even smartphones, without having to run any special software. These trends will also make our work easier because we will only have to type in the data and not worry about the method.

Testing the website to see if it can increase productivity calculations in the manufacturing industry is the purpose of this study. This testing uses data from assembly line in the Assembly 6C Overwing Beam section of an aerospace manufacturing organization (SME Aerospace Sdn. Bhd.). The findings of this study will be used to inform future research. A website that can compute the productivity of operators is one of the most essential things that this research study has to offer the organization. This website is a user-friendly strategy for enhancing the effectiveness and overall efficiency of the organization.

1.2 Problem Statement

Recently, there has been a rise in the amount of attention given by businesses to the goals of attaining leaner manufacturing and boosting efficiency. According to research by Kaka et al. (2019), the one and only factor that determines whether or not an organization is successful in a dynamic market is whether or not it is able to produce more successfully than its rivals. Productivity might be increased if troublesome assembly locations were identified and addressed.

For the selected working area at SME Aerospace, there are some issues with the time consuming to process the operator or worker productivity is too long. There are also problems with the utilization of the workforce. This is because workers don't get enough practice with MOST calculations, and it's possible that some of them don't even know which formula to use. This is a crucial objective that must be accomplished before proceeding with the process of bringing about significant shifts in the way work is carried out. If the organization does not take action to solve the waste that may be caused by the workers themselves, the organization will suffer a loss since the production line is being disrupted. This will happen due to the late identifying the unwanted movement or activity made by the workers.

It is necessary to do a thorough study to differentiate between the value-added and non-value-added jobs performed by workers by putting into action MOST in a way that is significantly more efficient, such as by developing a website. This crucial information will be utilized to identify an accurate and more straightforward way for workers to comprehend how to improve the labor productivity for SME Aerospace at the assembly line which is the Assembly 6C Overwing Beam section.

1.3 Research Objective

The primary objective of this study is to improve way to calculate labor efficiency in the assembly department to have an effective required level of manpower. In regard to the primary objective, there are several specific objectives that need to be accomplished in this study.

i. To study the current ways or process to calculate Maynard Operational Sequence Technique.

ii. To develop a website using a current trend system. This aims to provide a more efficient and user-friendly method of calculating MOST and to eliminate the need for an Excel template.

iii. To test the improvement with the aim to achieve higher labor productivity.

1.4 Scope of Research

This research will concentrate on testing the improvement for increase the productivity of individual operation of labors which the factor that can affect the effectiveness of the production system. Their performance is evaluated using a website based on the MOST template. Therefore, the result will be displayed on the website. This improvement being made due to manually calculating MOST takes a significantly longer amount of time and this research purposedly is to reduce the time consumed.

1.5 Summary

This chapter concludes with the background of this paper. This chapter also provides a problem statement. The chapter also provides an overview of the research objectives, which include studying the current methods of calculating MOST and developing a web-based calculator for MOST. Finally, the research scope has been stated.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Modern company has become increasingly diversified and intensely competitive in order to maintain its own market share in the world of modern technology. Furthermore, it has become even harder to monitor consumer behaviors as they make fragile decisions as a result of competitors' introduction of alternative products. As a result, everyone who is interested in business is looking for ways to take advantage of consumer requirements under the intense pressure of meeting demand from clients. However, failure to meet customer demand is not very uncommon in the manufacturing industries. This can occur for a variety of reasons, including issues with resource allocation and utilization. When allocating resources, the amount of people needed to complete a work can be assessed from two angles: sometimes there is insufficient manpower to achieve the desired level of production, and other times there is an excess of manpower. Another issue is resource utilization, which is heavily influenced by how work is done and by the tools that are utilized. In both situations, the allocation and utilization of resources have a direct or indirect impact on a company's capacity to make a profit because the manufacturer must pay higher wages for overtime work or steep fines for late delivery. As a result, action must be made to maintain a company's market competitiveness while also attempting to increase profitability through increased productivity (Tuan et al., 2014).

2.2 Productivity

To measure the firm's efficiency, productivity is an important factor which is calculated by converting inputs to total outputs. The output (OT) by any manufacturing system is usually expressed in units of physical volume, such as pieces, tons, and any other measurable units. These physical units must be weighted in some manner so they can be added together. Good productivity means how much input is converted to output (Rawat et al., 2018). Productivity improvement is one of the core strategies towards manufacturing Excellence and it is also necessary to achieve good financial and operational performance. It enhances customer satisfaction and reduces the time and cost to develop, produce and deliver products and service. Productivity has a positive and significant relationship to performance measurement for process utilization, process output, product costs, and work-in-process inventory levels and on-time delivery. Improvement can be in the form of elimination, correction (repair) of ineffective processing, simplifying the process, optimizing the system, reducing variation, maximizing throughput, reducing cost, improving quality or responsiveness and reducing set-up time (Naveen et al., 2015).

Productivity is simply a term for measuring efficiency. In economic terms, it means measuring the output that results from the inputs provided. Productivity is technically defined as output per unit of input, labor, or capital. According to Bhatti and Qureshi (2017) in Pourmola et al. (2019), productivity is typically regarded as a performance indicator that includes efficiency and effectiveness. It is an attempt to achieve the highest level of performance with the fewest resources.

Furthermore, implementing continuous productivity will increase the manufacturing company's profit, which can be determined by the availability of physical capital, human capital, natural resources, and technological knowledge.

2.3 Types of Productivity

There are many types of productivity we can measure: Overhead Productivity, Material Productivity and Labor Productivity.

2.3.1 Overhead Productivity

Efficiency of all resources refers to overhead productivity. This group consists of various inputs such as floor space, machines, tools, and computer software, if any. Machine cost may include charges like energy (power and fuel), preservation, renovate and property tax. Tool cost may occur from monitoring tool wear and potential breakage. Floor space cost may consist of energy, maintenance, repair, insurance and property tax (Rawat et al., 2018).

When attempting to measure the productivity of an organization's overhead operations, such as administrative chores, support functions, and indirect costs, the standard practise is to evaluate the efficiency and effectiveness of those functions.

2.3.2 Material Productivity

In manufacturing systems, material productivity refers to the efficient use of materials in the production process to obtain desired outputs while minimising waste and maximising resource utilisation. It entails optimising material inputs, reducing waste, and enhancing overall resource efficiency.

Material productivity calculates the capacity of raw material use. This criterion is beneficial when material cost is a large scrap of the total cost (Rawat et al., 2018). Material productivity is a long-term metric that analyses the effectiveness with which raw materials are used. It is determined by dividing economic output (such as GDP) by material input (Wang et al., 2016).

Furthermore, Material productivity refers to the efficiency and effectiveness with which materials are used in the manufacturing process to obtain desired results. It is a measure of how efficiently resources are used to produce goods or services while minimising waste and environmental damage. Material productivity is a significant issue in many companies and sectors since it directly influences profitability, resource conservation, and sustainability goals.

2.4 Labor Productivity

Labor productivity calculates that how much labor performance is necessary to give maximum output. This productivity is useful in manned cellular manufacturing systems or labor-intensive industries (Rawat et al., 2018).

Productivity is one of the most important indicators of overall economic performance. It is possible that the high quality of the labour force serves as an indicator of the level of labour productivity. To increase the productivity of labour, capital, or any other resource, it is necessary to take into consideration the measure of output per unit of output (or output per unit of output measure). The inefficient methods that will occur during the process are the reason why productivity needs to be measured. These inefficient methods include excessive handling of materials, lack of availability of a substitute worker due to an emergency absence, unnecessary operations, and lack of equipment for certain operations such as assembly operations. It is necessary to measure the labour productivity since this will result in a consistent workflow, which would lower the amount of fatigue experienced by workers while simultaneously increasing their working efficiency. Since all of the possibilities could occur, it is necessary to assess the labour productivity.

Those companies that were less productive as a result of inefficient management had lower worker productivity, and as a result, those companies had poorer returns on their investments in terms of profitability. However, those businesses that had higher worker productivity would have higher returns. The amount of financial return a company has been able to produce for each work hour is measured by labour productivity. Additionally, it has to do with how effectively labour turned an input into a finished good with a much higher perceived value. For instance, it would be a gauge of how effectively a company uses its resources to create and implement the necessary code in software companies.

In addition, increasing labour productivity is possible by doing any kind of work research, including time study, with the goal of finding solutions to issues that develop during the manufacturing process.

2.5 Time Study (Work Measurement)

Work measurement, which establishes standard timings for various production processes, was the primary focus of the majority of the research into work study. A time study is a method that can be used to quantify the productivity of an operator. This method normally computes the amount of time required by a qualified operator to carry out a task at a particular level of performance. The processing time is being recorded in addition to the amount of work that was predetermined using the circumstances that were stated.

Utilizing a particular time study approach can allow for the observation and analysis of the performance of the labor, which can then be followed by the optimization of the process. Estimates, direct methods, and indirect methods are the fundamental approaches utilized in work measurement methodologies. The direct method involves determining the precise amount of time that is consumed as well as the precision with which the time is distributed. On the other hand, the indirect method involves determining the amount of time that is consumed based on the movements of the operator. This method will determine the precise amount of time that is consumed on the basis of the operator's movements while he is working.

Indirect methods, often known as movement studies, can be referred to by either of two acronyms: PMTS or PTS, which stands for "Predetermined Motion Time System" or "Predetermined Time Standards". These techniques are a series of operations that are broken down into their constituent simple movements. As a direct consequence of this, the utilization of either manpower or machinery can be adjusted to achieve the desired level of production.

One of the most common methods used inside the industries for determining the standard activity time is the Methods Time Measurement (MTM), developed in 1948 for dividing the operations into basic motions. The detailed nature of MTM leads to a number of drawbacks such us the tediousness of the work, the handling of a huge amount of detailed data during their application, and etc (Tuan et al., 2014).

In addition, every manufacturing company can make use of a variety of methods to conduct a time study of particular processes. approaches Time Measurement (MTM), Maynard Operation Sequence Technique (MOST), and Modular Arrangement of Predetermined Time Standards (MODAPTS) are examples of well-known indirect approaches.

2.5.1 Predetermined Motion Time System (PMTS)

According to Laring et al. (2002), as cited in RAJ et al. (2021), during the course of the last few decades, the use of PMTS approaches across a variety of industries has been widely accepted by a number of developing countries. The strategy that is offered to accept the concept that facilitates many job variables by focusing on worker motions and working environments is called the Predetermine Motion Time system (PMTS). PMTS is frequently utilized in the manufacturing industry for the purposes of measuring the performance of labor and obtaining standard data.

Predetermined motion time system (PTMS) has been widely used in industry for many years. Instead of doing a time study using a stopwatch as is normally done, PMTS can be used as an alternative (Meyer and Steward, 2002). This method of work measurement data collection is both quick and accurate.

On the other hand, there are a variety of different PMTS methodologies that can be used to calculate an appropriate standard time for finishing particular activities. Methods Time Measurement (MTM), Maynard Operation Sequence Technique (MOST), and Modular Arrangement of Predetermined Time Standards (MODAPTS) are widely used techniques that are recognized as Excellent approaches to improve existing processes and estimate standard time. These techniques are commonly abbreviated as MTM, MOST, and MODAPTS, respectively. Without the use of a stopwatch, PMTS is a method that can analyze manual operations in terms of the micro movements that are necessary to complete those activities (RAJ et al., 2021).

2.5.1.1 Method Time Measurement (MTM)

Methods-Time Measurement (MTM) originated in time studies as a fixed motion time system (Morlocka et al., 2017). Human resource management can be managed by applying MTM as a workplace design strategy. MTM is classified as MTM-1, MTM-2, and

MTM-3, according to Zandin (2001) in RAJ et al. (2021). In the 1940s, MTM-1 was established to determine the standard time required to finish a task before it is processed.

The manual activities will be analysed, characterised, arranged, and planned in the same way as work studies are. Because the process is methodically organised, the aspects that influence the design working system during the planning phase will be visualised first. The MTM basic system will monitor motion sequences in fundamental movements that are linked in time based on influence elements such as distance, motion, and others. However, MTM is not generally employed because the application necessitates complex intensive training and lengthy time studies. Methods-Time Measurement (MTM) originated in time studies as a fixed motion time system (Morlocka et al., 2017). Human resource management can be managed by applying MTM as a workplace design strategy. MTM is classified as MTM-1, MTM-2, and MTM-3, according to Zandin (2001) in RAJ et al. (2021). In the 1940s, MTM-1 was established to determine the standard time required to finish a task before it is processed.

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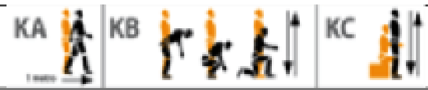
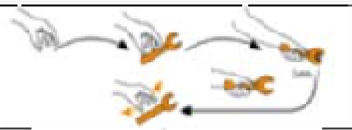
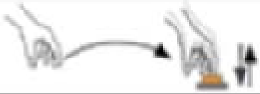
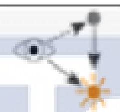
Table 2-1 MTM basic movements

Basic MTM-UAS Movements		**Movement Description**	**Symbol (First Character)**
Body Movements	Body Motion		K
Hands Movements	Get and Place		A
	Handle		H
	Place		P
	Cycle Motion		Z
	Operate		B
Eye movement	Visual Control		V

2.5.1.2 Modular Time Standard Modulation (MODAPTS)

In the garment, healthcare, service, and manufacturing industries, MODAPTS is one of the most extensively utilised PMTS techniques. It is also one of the most popular PMTS approaches. The MODAPTS system will analyse the body motion of workers while they carry out the tasks that have been allocated to them. The determination of standard time using this method is both quick and accurate, and there are very few opportunities for mistakes to occur in the process. When using MODAPTS, the standard amount of time required to complete a task can be estimated in advance of when the task will actually be carried out, at which point the mobility of the operators can be rationalised accordingly.

According to Hoffmann and Hui (2010) in RAJ et al. (2021), MODAPTS categorises the movement of operators into twenty-one different categories, and a constant value is approximated as the standard amount of time required to finish a certain operation. The MODAPTS system will detect whether there are any excessive movements made by operators and will, as a result, reduce the amount of fatigue experienced by those operators.

The study might be carried out with the removal of tasks that do not offer value, which would be followed by MODAPTS if the goal is to develop an approach that is effective. Executing work-study methodologies helps any industry improve productivity, quality, and reduce production cost and time (Jargalsaikhan et al., 2019). This is due to the reduction of Non-Value Added (NVA) activities, which are operations that do not add value to the final product.

2.6 Maynard Operational Sequence Technique (MOST)

MOST was evolved by H.B. Maynard and Co. Inc., Pittsburgh, U.S. in 1970. It was based on MTM and was simplified greatly so as to be understood with a little bit of training and applied more easily for any job estimation. The new system was implemented in the U.S. in 1975 (Vivek A. Deshpande et al., 2007).

It has three different iterations: Basic MOST (for activities lasting 20 seconds to two minutes), Mini MOST (for actions lasting less than 20 seconds), and Maxi MOST (for activities lasting more than two minutes). Standard times for tasks are typically determined using MOST in an industrial context. An operation or sub-operation can be broken down into several steps, and MOST analysis will examine all of them along with the corresponding sequence model. Method study, work measurement, and the study of how things are done collectively make up MOST. The study's target company has operator idle time and labor tiredness problems. Accordingly, the true task at hand was to single out NVA actions and zero in on the root causes of worker exhaustion. For this, we use MOST, a method for estimating how much time something will take together with its associated costs. The majority of manufacturing work measurement needs can be met by the Core MOST System. Every business has some tasks for which Basic MOST is the most sensible and useful method of measuring effort (Karad et al., 2016).

MOST was designed to be much faster than other work measurement techniques. MOST was a work measurement system that could be easily implemented and practically maintained. It was a system to measure work and concentrated on the movement of objects. The movement of objects followed certain consistently repeating patterns such as reaching, grasping, moving, and positioning of the object. These sequences could be identified and arranged as a sequence of events that manifested the movement of an object. A model of this sequence was made and acted as a standard guide in analyzing the movement of an object (Rohana Abdullah et al., 2014).

MOST is a simple work measurement system that may be readily installed and maintained. This notion serves as the foundation for MOST models of sequence. The key work units are no longer simple movements as in MTM, instead being fundamental tasks involving moving objects. These activities are explained in terms of fixed-sequence sub-activities.

As a result, it is an effective analytical tool for increasing productivity, improving procedures, facilitating planning, establishing workloads, estimating labor costs, improving safety, and maximizing resources. Thus, a MOST work measurement approach is a comprehensive examination of an operation or sub-operation that includes one or more method steps and the accompanying sequence model, parameter time values, and normal time values (Gadakh et al., 2017).

Lastly, in this project we will mainly focus on Basic Most.

2.6.1 Basic Most

The Basic MOST method is an all-purpose application that takes 3235 seconds to finish balancing. TMU is utilised in the process of recording the number of movements in a certain index on a recording sheet that constitutes a sequence model while simultaneously defining time criteria for each activity.

The Time Measuring Unit, or TMU, is a standard that is used to measure time in the research that is done on motion time systems. Within the basic MOST, all of the movements are recorded within the TMU. TMU is used in the calculation of process time to find the optimal sequence to achieve maximum output by lowering work in progress (WIP) and cycle time in order to increase worker performance. This approach is used to calculate TMU, and its results are employed in the determination of process time. The first step in determining how long an operation will take is to perform a calculation utilising four different sequences of movement. These sequences include general move, controlled move, and tool use. These sequences include fundamental acts such as reach, grasp motion, position, the object, and other things.

According to the specific characteristics associated with the activities predefined in MOST tables, numerical parameters including time used, distance, manner of placement, and others are assigned to basic movements such as general move, controlled motion, and tool use as indicated in the table below. As a result, the sequence models indicated in the table below compose the Basic MOST work measuring technique.

Table 2-2: Sequence model of MOST

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

The **general move's** actions are defined as the unrestricted movement of a subject in space. Before travelling to its final destination, the item will be moved from its original location. Its sequence model is ABG| ABP| A, and it describes the GET - PLACE - RETURN process. The GET model is made up of A (the distance of action), B (body movement), and G (gain control), and all of the specifics will be on the recording sheet. The PLACE model is made up of A-BP (Placement), whereas the RETURN model is made up of A (Distance of action).

The **controlled move** refers to the linked movement of an object in space or the object remaining in contact with another surface while moving, and it is also a component of other moving projects. It uses the ABG| MXI| A sequence model, which is described as GET - MOVE - RETURN. The GET model is A-B-G, the MOVE model is M (Move control), X (Process time), and I (Alignment), and the RETURN model is A (Distance of action).

Finally, the **tool use** sequence model is defined as the use of an ordinary hand tool related to the specific job. Its sequence model is ABG| ABP| U| ABP| A, which stands for GET - PLACE - TOOL ACTION - PLACE - RETURN. The GET model is made up of the letters A-B-G 33, while the PLACE model is made up of the letters A-B-P. A TOOL ACTION model includes U and PLACED it back, followed by RETURN the object A.

Furthermore, one final time is determined from the total of the provided parameters. Because the final time is calculated in a special unit known as the Time Measurement Unit (TMU), it must be converted to the ordinary time unit (1 TMU = 0.036 seconds).

2.7 Automation system

Systems that are accurate and efficient, as well as automation made possible by the technologies of Industry 4.0, offer a number of benefits and advantages to a diverse range of industries and sectors. Processes are more likely to be completed accurately and consistently when accurate and efficient systems are linked with automation technology. This in turn reduces the possibility of errors and faults occurring. Automation can also assist in maintaining consistent quality by reducing the amount of error caused by human hands. Because of this, we are able to generate the most table result in the shortest amount of time and reduce the amount of time needed to calculate productivity for a single operator at each manufacturing firm. In a fast-changing business landscape, companies that embrace the technologies of Industry 4.0 are better positioned to meet the demands of their customers, reduce the amount of time it takes to bring a product to market, and maintain a competitive advantage over their rivals.

Furthermore, the use of the Internet has been increasing at a rate that is comparable to an exponential growth rate as a result of the rapid development of new computer and network technology. It is currently widely utilized by people all over the world as a reference tool for personal, educational, commercial, and industrial purposes. Internet users have been known to spend significant amounts of time perusing homepages, conducting informational searches, engaging in online discussion, and both downloading and uploading content. The Internet has begun to function as a medium that enables the monitoring, control, and interaction with machines and equipment as a result of the rapid development of new technologies such as JAVA. This is possible thanks to the fact that the Internet is a global communications network (Al-Ali et al., 2004).

In addition, the world is being consumed by software as well as the fact that more and more software is being built in JavaScript (JS). Applications for computers are rapidly moving towards web-based, distributed forms, and the logic for web applications is also moving increasingly towards client-side implementations (Jueckstock et al., 2019).

Last but not least, human error is common in manual calculations, especially when working with difficult calculations or huge datasets. By eliminating human errors such as data entry errors and miscalculations, automation assures consistent accuracy. Table calculation automation enhances efficiency greatly. It saves time by calculating quickly and by eliminating the need for manual data entry and repetitive calculations. Automated systems can handle enormous amounts of data and execute calculations in seconds that would take time and be prone to error if done manually. Next, MOST tables frequently necessitate repetitive calculations, where the results of one calculation are dependent on the results of prior calculations. The automation of these repeated procedures enables faster and more accurate calculations, eliminating the possibility of errors that can arise during manual iterations.

2.8 Industrial 4.0

Industry 4.0, also known as the Fourth Industrial Revolution, had its beginnings in a project that was part of the high-tech plan that was being implemented by the German government in 2011. This initiative was given the German name Industrie 4.0. The idea of Cyber Physical Systems (CPS) was developed further into Cyber Physical Production Systems (CPPS) because of this (Xu et al., 2021). The Fourth Industrial Revolution, also known as Industry 4.0, is becoming the focal point of discussion regarding the implications of the future of industrial systems in developed nations, both economically and socially. It is being praised as the new fundamental paradigm change in the creation of industrial goods (Chiarello et al., 2018).

The First Industrial Revolution saw a shift away from manual labor and towards machinery driven by steam or water. The Second Industrial Revolution, thanks to electricity, converted factories into sophisticated production lines, resulting in great productivity and tremendous economic expansion. During the Third Industrial Revolution, field-level computers such as the Programmable Logic Controller, or PLC, and technology for communication were used in the manufacturing process, leading to automated manufacturing. Production infrastructure, in the form of CPPS, can make intelligent decisions in the industry 4.0 era through real-time communication as well as collaboration between "manufacturing things" (Xu et al., 2021) (Lu et al., 2020).

Industry 4.0, also known as the Fourth Industrial Revolution, refers to the integration of advanced digital technologies into manufacturing and industrial processes. It encompasses various technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, cloud computing, and more. In the context of Industry 4.0, JavaScript, HTML, and CSS play significant roles in enabling digital transformation and enhancing the capabilities of industrial systems.

JavaScript is a fundamental technology in Industry 4.0 due to its versatility and extensive use in web-based applications. JavaScript enables the development of interactive and dynamic interfaces that are crucial for real-time monitoring, data visualization, and control in industrial settings. JavaScript frameworks like React, Angular, and Vue.js empower developers to create responsive and user-friendly interfaces, enabling seamless integration with other industrial systems and enhancing the overall user experience.

HTML (Hypertext Markup Language) is the standard markup language for creating web pages. In the context of Industry 4.0, HTML is used to structure and present data, facilitating the visualization of industrial information. HTML provides the foundation for displaying real-time data, dashboards, reports, and other visual elements. With the advent of HTML5, new features such as canvas and web sockets further enhance its capabilities for interactive data visualization and communication.

CSS (Cascading Style Sheets) is a styling language used to define the look and formatting of HTML documents. In the context of Industry 4.0, CSS is utilized to create visually appealing and consistent user interfaces for industrial applications. CSS enables developers to customize the presentation of web-based interfaces, ensuring a cohesive design language across different devices and platforms. It plays a crucial role in enhancing the user experience, readability, and aesthetics of industrial applications.

In terms of integration and data exchange, JavaScript, HTML, and CSS contribute to the integration and data exchange capabilities in Industry 4.0. Through JavaScript, web-based applications can communicate with industrial devices, sensors, and IoT platforms, enabling seamless data exchange and control. HTML and CSS provide the necessary structure and styling to present data from various sources in a unified manner. JavaScript frameworks and libraries offer tools and APIs to facilitate data integration, enabling real-time data visualization and analysis for decision-making.

In addition, JavaScript, HTML, and CSS are inherently cross-platform technologies, ensuring compatibility across different devices and operating systems. This aspect is crucial in Industry 4.0, as it allows industrial applications to be accessed and utilized on various devices, including desktop computers, smartphones, tablets, and industrial IoT devices. JavaScript frameworks like React Native and frameworks such as Cordova and PhoneGap enable the development of cross-platform mobile applications using web technologies, making them well-suited for industrial mobile solutions. JavaScript, HTML, and CSS also play integral roles in Industry 4.0 by enabling the development of web-based applications, facilitating data visualization, supporting integration and data exchange, ensuring cross-platform compatibility, and enhancing the user experience. These technologies empower the digital transformation of industrial systems and contribute to the advancements and efficiencies brought about by the Fourth Industrial Revolution.

2.9 Waterfall Method

The waterfall model is a prominent method to the software development lifecycle (SDLC) that takes a linear and sequential approach to the process. It is used in software engineering and product development.

The waterfall model is an approach to software development life cycle (SDLC) that follows a sequential order of phases, much to the way water pours over the edge of a waterfall. It establishes clear milestones or objectives for the completion of each stage of growth. After reaching such endpoints or goals, there will be no opportunity to do so again.

The waterfall approach is still often utilized in several aspects of industrial design. Many people consider it to be the first software development technique ever created. Additionally, the model is utilized on a more general level as a high-level project management methodology for undertakings that involve a variety of components. Waterfall is useful for software development if an app has to function on the first try to avoid losing clients.

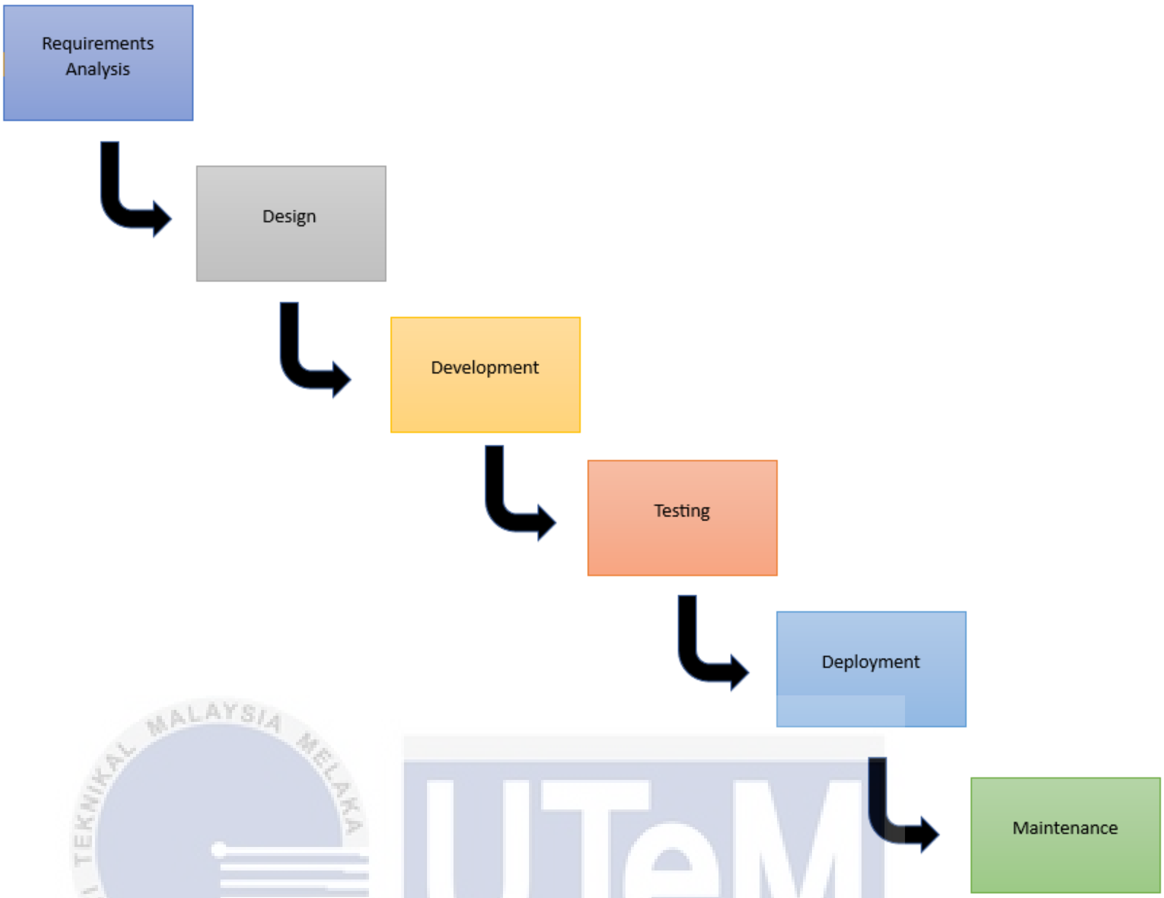


Figure 2-1 The Waterfall method sequence (Lutkevich and Lewis., 2022)

The waterfall has seven steps. First, requirements analysis. A functional specification, or requirements document, analyses project requirements, timeframes, and guidelines. This phase plans and defines the project. Analyzing system specs creates product models and business logic for production. Financial and technological resources are examined for viability.

Design specifications include programming language, hardware, data sources, construction, and services. Next, development. Models, logic, and requirement standards from past phases are used to build source code. Before assembly, the system is programmed into units. In addition, when in testing phase the quality assurance, unit, system, and beta need to be tested to recognize issues or errors that must be fixed. This might require the system coding to be repeated for debugging the errors. After integration and testing phases pass, the waterfall continues. After testing, the product or application is deployed to a live environment. Finally, in maintenance, the corrective, adaptive, and perfective are done forever to improve, update, and enhance the product and its functionality. Release patch updates and new versions (Lutkevich and Lewis., 2022).

In a typical implementation of this Waterfall model, the output of one phase serves as the input for the following phase in the model's sequential progression. All of the appropriate steps in planning have been taken, and the plan can now be put into action effectively, which will result in the production of a comprehensive system that is well-organized, simple, and possesses all of the characteristics that are required.

2.10 JavaScript

I am using JavaScript because it is easier to handle and suitable for my project. Web application creation necessitates understanding of programming languages, front-end web development with HTML, CSS, and JavaScript, and database administration. Frameworks for website applications have been provided to aid with web development (Goto et al., 2017). Front-end development tools incorporate markup languages such as HTML, JavaScript, and Cascading Style Sheets (Carter, 2014).

We can find numerous types of small devices loaded with application programmes that perform specialized activities on their own and, if necessary, communicate data to other devices. Low-level languages such as C and assembly languages are commonly used to create such application programmes. However, programme development utilising these low-level languages has productivity issues. Such as programmes created in low-level languages have portability issues. Even if a programme is written in C, it is less portable than a programme written in a high-level language such as JavaScript (Ugawa et al., 2019).

Languages having a greater level of abstraction are preferable to low-level languages because of the fundamental characteristics of scripting languages, JavaScript is well suited for the rapid development of prototype programmes. This allows programmers to quickly test and develop new ideas (Ugawa et al., 2019).

Scripting languages are currently experiencing somewhat of a rebirth as a direct result of the growing popularity of the World Wide Web. Growing up with programming languages such as JavaScript is giving rise to an entirely new generation of programmers. The exceptional attention that dynamic languages are receiving is something that has not happened since the early days of personal computers and the widespread adoption of the BASIC programming language in the late 1970s and early 1980s. This is something that has not occurred since dynamic languages were first introduced. The World Wide Web is Quickly Becoming the De Facto Target Platform for Modern Software Applications at the Same Time, the World Wide Web is Quickly Becoming the *de facto* Target Platform for Modern Software Applications Such as Social Networking Systems, Games, and Productivity Applications, etc (Mikkonen et al., 2007).

The types of variables are determined dynamically while JavaScript is being executed, making JavaScript a usual dynamic language for programming in the sense that it does not require variables to be declared in advance before they can be used and therefore declaring variables in JavaScript is not required. While the program is being executed, definitions of functions and other pieces of code can be updated using JavaScript. The interpretation of the source code forms the foundation of the execution model used by

JavaScript. In contrast to languages that are less dynamic, such as the programming language Java, there is no public final representation format such as class files or files that are binary. These are examples of file types that are used by Java. In a nutshell, JavaScript is a dynamic language in every sense of the word since it possesses all three of the fundamental qualities outlined below (Mikkonen et al., 2007).

Table 2-3 Fundamental qualities of JavaScript dynamic language

No.	Characteristics
1.	Dynamic typing. Before the compilation process can begin in static languages like C, C++, and Java, the types of variables and parameters need to be explicitly assigned. However, in the vast majority of dynamic programming languages, declaring variables before using them is not required. In addition, their type is not known until runtime, which is when the information on their type is truly required.
2.	Interpretation. Before being put into action, the programme code for static languages is first compiled into a binary representation or some other intermediate form. During the runtime of a programme written in a dynamic language, the source code is read, and then dynamically translated into an intermediate representation or machine code. The programme is then immediately executed. When seen from the perspective of the end user, each of these stages is performed in a seamless and automatic manner.

3.	Runtime modification. Code structures are unchangeable at runtime when utilising static programming languages, with the exception of a certain amount of limited extensibility. This extensibility could come, for example, in the form of dynamically linked libraries (DLLs) or other plug-in components. However, class hierarchies and other structural and behavioural characteristics of the programme can be updated dynamically during runtime when using languages known as dynamic programming languages. For example, new functions and variables can be added to classes and objects on the fly. This is possible because to dynamic programming.

Despite sharing its name, Java, a programming language, has only a tenuous connection to the scripting language known as JavaScript. The primary resemblance between the languages is seen in the syntactic similarities that both Java as well as JavaScript have in common with the programming language C. This is where the majority of the similarities lie. JavaScript is semantically a lot closer to dynamic programming languages than other languages.

2.11 Html

In-depth knowledge of HTML and CSS is required in order to create responsive layouts that can adapt to the screen sizes of a variety of devices (Goto et al., 2017).

HTML, which stands for "Hypertext Markup Language," is one of the most important languages used to structure and display information on the internet. It gives web sites their structure, layout, and meaning by describing how things are put together and what they mean. HTML uses a set of tags or parts to describe how a web page is put together. These parts are surrounded by opening and ending tags and give the content meaning and context. For example, the '<h1>' element is used to define a top-level heading, while the '<p>' element is used to define a paragraph. HTML parts can be put inside each other to make a structure with levels. Elements can also have characteristics that tell us more about them or change how they act. For example, the '<img>' element is used to show a picture and has attributes like 'src' (source) and 'alt' (alternative text).

Semantic Markup is one of the most important parts of HTML because it gives text meaning. Semantic markup is when HTML elements are used to describe the meaning and goal of the content, not just how it looks. By using parts like <header>, <nav>, <article>, and <footer>, developers can make web pages that are easier for people to use and that search engines can find. Semantic markup helps assistive tools understand how a page is put together and what is on it. This makes it easier for people with disabilities to use websites. It also makes it easier for search engines to scan and understand the information on a website, which could help it show up higher in search results.

HTML is the basis for making interactive and dynamic web pages because it works well with other web technologies like CSS (Cascading Style Sheets) for styling and JavaScript (which makes web pages interactive) for interactivity. CSS is used to control how HTML parts look. This lets developers change fonts, colours, layouts, and other things. JavaScript, on the other hand, gives HTML parts behaviour and interaction. This lets developers make things like form validation, event handling, animations, and data manipulation. By using HTML, CSS, and JavaScript together, developers can make web apps that are rich, interactive, and give users interesting experiences.

HTML is a markup language that is used to organise and show information on the web. It uses a set of elements and attributes to describe how web pages look and what they mean. Through semantic markup, HTML makes it possible to make material that is easy to find and read by search engines. It also works with CSS for styling and JavaScript for interactivity, so you can make web apps that are both dynamic and engaging. HTML is the most important part of the web because it provides the structure and basis for how web pages look and work.

2.12 CSS

The World Wide Web Consortium (W3C) came up with the idea of using cascading style sheets (CSS) as a method for regulating the presentation of HTML texts. The actual web page ought to include both content and structural tags, in addition to a link to one or more style sheets that decide how the document will be presented, and this ought to be done in order to comply with web standards. Consequently, there is a clear distinction between the structure of the document and its look; nonetheless, the designer maintains a significant amount of influence over the document's final appearance. Cascading Style Sheets are a new tool that the W3C has developed for use with HTML texts.

A style sheet is made up of rules. The first utilises the identifier H1 to specify that it applies to all elements with the tag "H1", and that first-level heads should be shown in a 13 pt font. The second guideline states that paragraph components should be 11 pt in size. The third rule governs how text appears in a "BLOCKQUOTE", stating that the font-size should be 90% of the surrounding element (Badros et al., 1999).

There are several different libraries and frameworks available, like Bootstrap and Foundation, that can assist developers in the process of building flexible designs. The frameworks include CSS rules for a starting point of standardized and re-usable user interface components such as designs, typography, forms, buttons, and navigation (Goto et al., 2017).

2.13 CASE STUDY

Case study 1: Development of a website for wound assessment (de Paiva Santos et al., 2023)

The article describes the creation of a wound assessment website to help nursing staff evaluate and monitor the management of chronic wounds. The problem statement of this study's article is that nurses and their teams are responsible for wound assessment and treatment, and it is up to the nurses to develop a therapeutic strategy for tissue healing. The nurse needs to be scientifically trained to employ dependable instruments during the evaluation process. The goal of this study is to create a website for tracking the progression of wounds based on the RESVECH 2 questionnaire to help nursing practitioners evaluate and monitor the management of chronic wounds.

The objective of this research is to give technological innovation in the field of wound care by developing a new light-hard technology capable of providing more competent support and more resolute therapy. The creation of a wound assessment website to aid nursing professionals in evaluating and tracking the management of chronic wounds. The website employs an adapted and validated assessment questionnaire known as RESVECH 2.0, which is comprised of six surveys that comprise the evaluation procedure. The website allows nurses to track the patient's progress using graphs and past assessments stored in a database. The system automates the evaluation process and monitoring control connected to patient evolution, promoting wound assessment support to health professionals, providing them with a scientific basis for the aid provided, as well as speed.

The flowchart for the development of RESVECH 2.0 is as shown below.

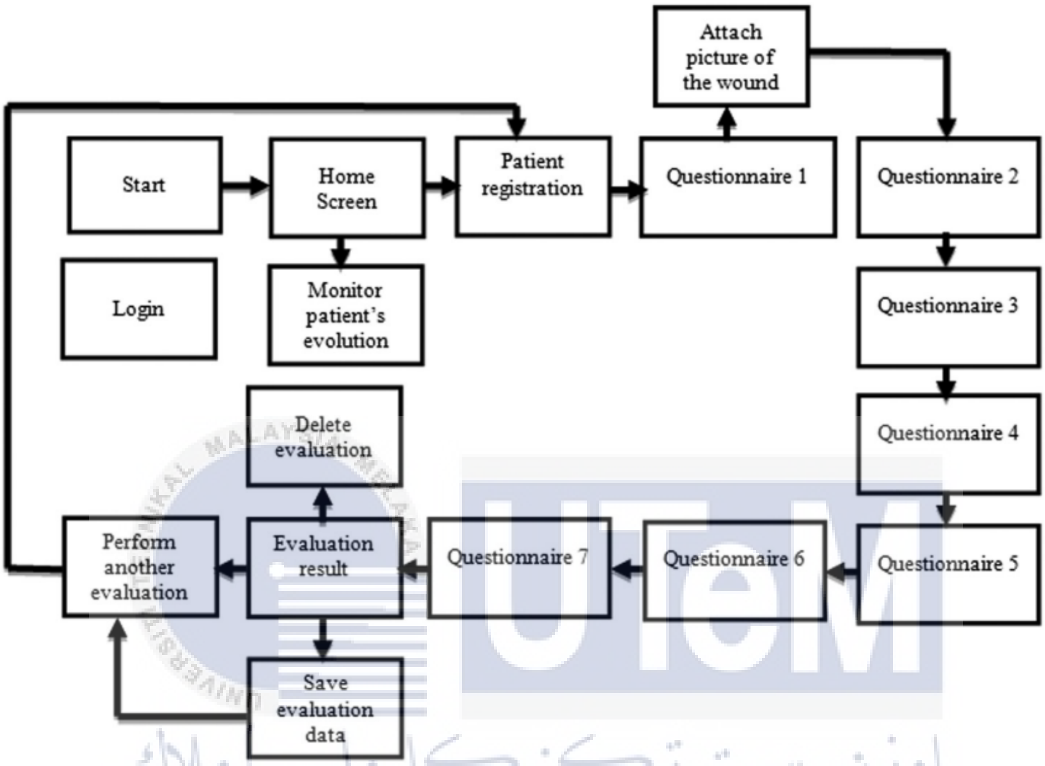


Figure 2-2 Flowchart for the development of RESVECH 2.0 (de Paiva Santos et al., 2023)

The development of a website for monitoring the evolution of wounds based on RESVECH 2.0 is an essential innovation for the nursing team, according to the findings of this study paper. The website is expected to be very useful in supporting wound assessment and monitoring, promoting direct benefits to health professionals by increasing the agility of some processes, and, most importantly, benefits to people with wounds by ensuring evidence-based standardization and continuity of care. The findings highlight the necessity of incorporating technology into wound care, giving more qualified help and more resolute therapy.

Case study 2: Collection, compilation, and analysis of bacterial vaccines(Gupta et al., 2022)

This research paper highlights the many sources of host immune response activation, such as pathogenic microbial infections, immune system internal malfunction, and genetic transmission. Pathogenic microbes such as bacteria, fungi, viruses, parasites, and protozoans can cause a variety of illnesses in host organisms and can be transmitted via numerous pathways such as air, food, water, or biological vectors. Bacteria are single-celled organisms that can reproduce on their own and are found everywhere. Based on cell wall features, most bacteria can be classified as gram-positive or gram-negative. The research project looked at 371 vaccinations against 30 human bacterial infections in BacVacDB, of which 167 have been authorised and 204 are in clinical testing. BacVacDB is a knowledgebase that provides comprehensive information regarding human bacterial illness vaccines on a single platform.

This research paper's problem statement is that bacterial illnesses are one of the leading causes of millions of deaths worldwide, owing primarily to antibiotic resistance. Antibiotic abuse or overuse has led in a rapid growth in antibiotic/antimicrobial resistance (AMR). According to the World Health Organisation (WHO), AMR is one of the top ten dangers to human health because antimicrobial-resistant bacteria cause many fatalities. Bacterial vaccines may offer promising answers to AMR and aid in the reduction of infection load. The study's goal was to gather various information about bacterial vaccines, including their kinds, efficacy, mechanism of action, status, method of administration, and other pertinent characteristics, into a knowledgebase called as BacVacDB.

The objective of this research study is to combine and analyze information regarding bacterial vaccines, including their kinds, efficacy, mechanism of action, status, method of administration, and other pertinent characteristics, into a knowledgebase called BacVacDB. The study's goal was to give researchers with a complete platform for exploring, searching, and downloading information about vaccines for human bacterial illnesses. The report also attempted to incorporate vaccine history, mechanisms, types, routes of administration, and approving agencies. The ultimate goal of this project is to reduce the burden of bacterial infections and antibiotic resistance by offering a centralized platform for bacterial vaccination information.

The strategy is used in the study to build a knowledgebase named BacVacDB on the Linux-Apache-MySQL-PHP (LAMP) platform. MySQL was used to manage the data, and Apache was used as an HTTP server to design the database. HTML, PHP, CSS, and JavaScript were used to create responsive front ends. A common interface was created using the PHP programming language. Data was compiled from a variety of sources, including books, databases, and pertinent web resources. Reviewed 371 vaccines against 30 human bacterial diseases in BacVacDB, 167 of which are licensed and 204 of which are under clinical studies.

This research paper's result analysis examined 371 vaccinations against 30 human bacterial diseases that are preserved in BacVacDB. Of these vaccines, 167 have been licensed for use, while 204 are currently participating in clinical studies. The BacVacDB database features an intuitive search interface that may be accessed by any of its four modules—"Search," "Browse," "External Links," and "General Information"—respectively. The database contains information on the development of vaccinations, as well as details on their mechanisms, kinds, routes of administration, and licensing agencies.

The conclusions of this research paper are that bacterial vaccines are highly effective in preventing many infectious diseases caused by bacteria. The study reviewed 371 vaccines against 30 human bacterial diseases maintained in BacVacDB, of which 167 are approved and 204 are in clinical trials. BacVacDB provides an intuitive interface that allows users to explore, search, and download information as well as to submit new bacterial vaccines. The database is a comprehensive platform for researchers to access information about bacterial vaccines, their types, efficacy, mechanism of action, status, route of administration, and other relevant details. The study also included the history of vaccines, their mechanism, types, route of administration, and approving agencies. The development of bacterial vaccines can be a promising solution to combat the emergence of antimicrobial resistance and reduce the burden of bacterial infections.

Case study 3: Smart vehicle management using cost effective approach (Tripathi et al., 2021)

The study analyses how rising temperatures and road congestion have increased the popularity of carpooling as an eco-friendly and cost-effective transport choice. Carpooling is a form of ridesharing in which more than one person shares a trip in their own vehicle, which reduces pollution and is also cost effective because travel expenses are shared among the drivers. The purpose of this paper is to provide a web application that provides a simple riding platform between car owners and car users, allowing users to access mobility assets owned by others when they are needed. The online application is widely used and can be used by any traveler globally. The project's users are divided into two groups: drivers who drive their vehicle to work every day and passengers who visit work every day. The project's goal is to foster confidence between passengers and drivers, promoting careful and informed travel.

The paper's problem statement is the growth in climate conditions and traffic congestion, which has led to the popularity of carpooling as an eco-friendly and cost-effective travel choice. The purpose of this paper is to provide a web application that provides a simple riding platform between car owners and car users, allowing users to access mobility assets owned by others when they are needed. The project's goal is to foster confidence between passengers and drivers, promoting careful and informed travel.

The goal of this paper is to provide a web application that provides a simple riding platform between car owners and automobile users, allowing users to access mobility assets owned by others when necessary. Its objective is to foster confidence between passengers and drivers, promoting careful and informed travel.

This paper also uses the waterfall method. Firstly, they need the specific requirements, the paper explains the software requirements for creating a carpooling online application. Identifying linkages between the carpooling system and other specific software components, such as databases, operating systems, tools, libraries, and integrated commercial components, is one of these criteria. The document also emphasizes the significance of identifying data items or messages as they enter and exit the system, as well as describing the purpose of each item. The article also examines the services necessary, and the type of communication required for the carpooling system. Finally, the article identifies data that is shared by software components and, if necessary, outlines implementation constraints.

Next in testing, the paper gives a short explanation of software testing as a way to figure out how good a software product or service is. In the testing process, a program or application is run to look for software bugs or mistakes and make sure the software is ready to be used. The paper also says that making test cases can help find problems with an application's needs or design.

The report divides the carpooling web application into modules such Login module. This module lets visitors log in with their email and password. Drivers and passengers can choose. Drivers and passengers can register on this module. Drivers must submit their name, mobile number, vehicle number, email address, and agreement to the website's terms and conditions. Registration requires passengers to accept the website's terms and conditions. Ride search module: Passengers can search for rides by inputting their starting location, destination, and desired date. Ride booking module: This module lets passengers choose and book a ride. SMS APIs send passenger and driver booking and confirmation messages. Ride sharing module: Drivers can add rides when available. Drivers must specify their starting location, destination, travel date, and seat count. As for feedback module, the customer can give a rating after they successfully completed their ride. The modules provide a simple, effective, and eco-friendly platform for car owners and users to share trips and decrease travel costs.

The research suggests that carpooling is an efficient strategy to minimize vehicle pollution and congestion in cities, while simultaneously providing an environmentally beneficial mode of transportation and the opportunity to meet new people. The importance of pre-registration in ensuring security and building confidence among carpooling participants is emphasized in the article.

2.14 Summary or Research Gap

The focus of this chapter is the Maynard Operational Sequence Technique (MOST) and how it can be used to figure out which part of a process takes the most time. From what

I've learned, work measurement studies can be used to figure out how productive workers are. These studies are called PMTS or PTS, which stand for "Predetermined Motion Time System" or "Predetermined Time Standards." Next, the Methods Time Measurement (MTM) is the most common way for businesses to figure out how long an activity usually takes. Each manufacturing company can also use a variety of methods to study how long a process takes. indirect methods Some well-known indirect approaches are Time Measurement (MTM), Maynard Operation Sequence Technique (MOST), and Modular Arrangement of Predetermined Time Standards (MODAPTS). The chapter talks about the study that was done to figure out how to make work more productive by making websites with software like JavaScript, HTML, and CSS and using the Waterfall method to finish them.

CHAPTER 3

METHODOLOGY

3.1 Overview of Methodology

This chapter described the project planning workflow for FYP 1 and FYP 2, which was essential to achieving the objectives. A more transparent workflow was provided from the time the project was initiated until the report was submitted by generating a process flowchart. Later, a brief explanation of each aspect will be given. The activities of FYP 1 included conducting research at an aerospace component factory, composing a report on the literature review, collecting data, analyzing the project's requirements, and designing the layout of the MOST Calculator website. FYP 2 consisted of website development, which was followed by website testing using the gathered data. After that, the findings were analyzed, and the results were examined. Finally, a summary of the study's findings and suggestions for future research.

In addition, this section also highlighted the methodology used to perform the project. A flowchart was used to detail the activities involved for every phase. Each phase was described in detail to achieve the objectives in this chapter. The main focus of this study was to examine the methods or procedures used to calculate Maynard Operational Sequence Technique. Then, a website was developed using a current trend system, based on the MOST template in Excel to make it easier and more efficient and eliminate the need for an Excel template in the future. Lastly, we tested the improvement of its success in achieving higher labor productivity.

3.2 Introduction

In this chapter, the System Development Life Cycle, or SDLC, approach of the Waterfall model was utilised to ensure the successful completion of the project. The SDLC Model saw widespread adoption in the software engineering industry. The entire process of developing the website followed "The Waterfall" methodology, which divided the process into several phases until the testing phase to complete my project. The process began with requirement analysis for my project, followed by designing a layout that aligned with the requirements from the previous phase. Furthermore, the development phase was moved to in order to make the website work properly, and finally the testing phase was conducted.

The data in this project originated from assembly line production at SME Aerospace, Sungai Buloh. This data was from 2022 and had already been updated to the latest. This step was conducted in "Projek Sarjana Muda" (PSM 2). This improvement was made with the intention of making the MOST calculation more efficient and creating a website that could improve the time consumed to calculate the enormous amount of data.

Finally, an 18-acre location in Sungai Buloh was selected for the completion of this project by SME Aerospace Sdn. Bhd. SMEA was ideally located outside Kuala Lumpur to service local and international customers. SME Aerospace (SMEA) Sdn. Bhd., a wholly owned subsidiary of National Aerospace & Defence Industries (NADI), was established in 1992 as a result of the Government Offset Programme. High-precision machining, fabrication, surface treatments, and assembly were available at the company's vertically integrated facilities. With these skills, SMEA was at the forefront of establishing and sustaining a world-class commercial aerospace industry in Malaysia and became a major manufacturer of aircraft components for Boeing and Airbus.

3.3 Flowchart

Figure 3-1 below demonstrated the step that had to be conducted to achieve the three-objective set for that final FYP. This flowchart used the Waterfall method.

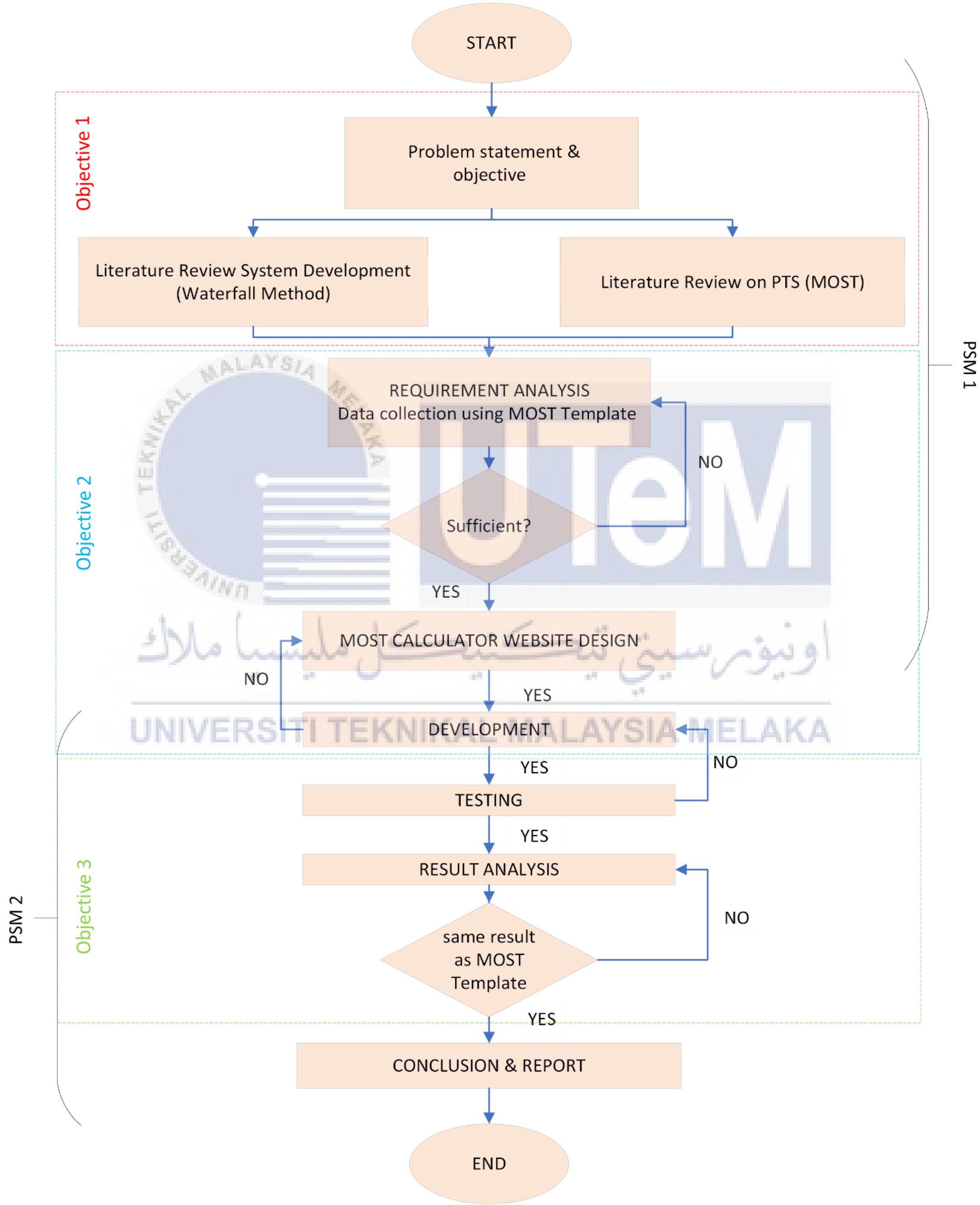


Figure 3-1 Flowchart for this FYP

3.4 Requirement Analysis Phase

Prior to approaching the requirement analysis, we defined the objective for the project. The objective was stated in Chapter 1. We conducted some research on Maynard Operational Sequence Technique (MOST) in Chapter 2. The previous way or process to calculate MOST was by using Excel software. Secondly, a website was developed using a current trend system. This aimed to provide a more efficient and user-friendly method of calculating MOST hence obviating the necessity for an Excel template. The type of data collected was represented using MOST Index codes (Appendix C) obtained from the observation of a group of the operators' detailed activities at the workstations under study. Data collection was focused on the labor movements that drove the identification of labor efficiency and the analysis of the value added and non-value-added activities. However, we discovered that utilizing Excel had certain drawbacks. When dealing with large amounts of data, it would often consume significant time and result in errors. Excel was slow and used a lot of resources when complex calculations were done on big datasets. Excel took a long time to respond or stopped working when it had to do a lot of math’s or handle a lot of data. This could have slowed you down and made your work less efficient.

Next, the website was created to eliminate the disadvantages of Excel and make work much more efficient. This study was conducted to find a more efficient method of calculating productivity for manufacturing industries. Finally, I tested the improvement in order to achieve higher labor productivity.

3.4.1 Requirement for MOST Calculation in MOST Template Phase

There were 3 types of sequence models in basic MOST which are general move, controlled move and tool use sequence and the detailed were described in table 3-1 below.

Table 3-1 Sequence model of basic MOST

Activity	General Move			Controlled Move			Tool Use				
Sequence Model	ABG	ABP	A	ABG	MXI	A	ABG	ABP	U	ABP	A
	Get	Put	Return	Get	Move	Return	Get	Put	Tool action	Put	Return
Description	A=Action distance; B=Body motion; G=Gain control P=Placement; M=Move controlled; X=Process time; I=Alignment; U=Tool use										

Consider this operation:

i. Choosing a job within reach

ii. Placing it on the table

iii. Returning to initial position

Table 3-2 below shows the phases needed to calculate this timing. Summarise and multiply by 10 to get the time in seconds that represent as Time Measuring Unit (TMU).

Table 3-2 Phases of General Move

Get	Put	Return
Within reach, no body motion, grasp the phone.	Walk 5-7 steps, within reach, place the phone on the table.	Return to initial position.
$A_1B_0G_1$	$A_{10}B_0P_3$	A_{10}

Table 3-3 Example template for MOST in Excel

-REEL CHANGE-								
No.	Activities	Activities Sequence	Frequency		TMU	TIME (Sec)	Normal Time	Standard Time
			RF	CF				
1.								

Data collection was conducted at SME Aerospace Sdn. Bhd. in Sungai Buloh, in assembly line production. The data had to follow the MOST template as shown in Figure 3-2 below. It was necessary to collect all this data for calculation later. First, we recorded the activities in the stages, and from those activities, we identified the type of activity sequence.

No.	Stage 4	L R	Activities Sequence
1	Walk 30 steps to ovecoat room to do a fillet and adjust the beam in its position on the table		A54 B0 G3 - A1 B0 P3 - A0
2	Reach soft cloth and and chemical liquid to do the cleaning on excessive sealent with care		A1 B0 G1 - A1 B0 P6 - U10 - A1 B0 P1 - A0
3	Reach brush and apply promoter around hinge bracket (side) exist on the beam		A1 B0 G1 - A1 B0 P6 - 12 [U10] - A1 B0 P1 - A0
4	Wait 30 minutes for promoter to dry		-
5	Mixed sealent using spatula		A1 B0 G1 - M1 X10 I1 - A0
6	Apply sealent thoroughly on fillet at every side of the hinge bracket		A1 B0 G1 - A1 B0 P6 - 12 [U10] - A1 B0 P1 - A0
7	Get spatula then coated it with oil to flatten the sealent with care and flip beam to apply oil on the other side		A1 B0 G1 - M6 X81 I3 - A0
8	Lift the beam and walk 55 steps out from the overcoat room to the working table		A96 B0 G3 - A1 B0 P1 - A0
9	Reach the soft cloth with chemical liquid and do the cleaning for entire beam		A1 B0 G1 - A1 B0 P6 - 4 [U24] - A1 B0 P1 - A0
10	Walk 10 steps to another table and place the beam		A16 B0 G3 - A1 B0 P1 - A0
11	Walk 5 steps to get pen and return		A10 B0 G1 - A1 B0 P0 - A10
12	Write data for primer/ painter with 2 alphabets and 18 digits then attached the paper on the primer container		A1 B0 G1 - A1 B0 P3 - U42 - A1 B0 P1 - A0
13	Reach the brush and touch up lightly onto all bolt, nut and rivet exist on the beam		A1 B0 G1 - A1 B0 P6 - 49[U6] - A1 B0 P1 - A0
14	Wait 30 minutes for the primer to dry		-
15	Reach the brush to paint bolt and nut (10 bolt and nut)		A1 B0 G1 - A1 B0 P6 - 10[U6] - A1 B0 P1 - A0
16	Paint 39 rivets		A1 B0 G1 - A1 B0 P6 - 39[U6] - A1 B0 P1 - A0
17	Once done, walk 4 steps to place the beam on the table		A6 B0 G3 - A1 B0 P1 - A0

Figure 3-2 Example of Excel template

3.4.1.1 MOST Elements

Table 3-4 MOST elements

Elements	Description
Time Measuring Unit (TMU)	1 TMU = 0.00001 hour 1 TMU = 0.006 minute 1 TMU = 0.036 second
Normal Time	Normal pace without any delays Normal time = TMU (second)x Performance Rating Factor
Standard Time	Perform an operation with some unavoidable delays. Standard time = Normal Time x (1 + allowance)
Performance Rating Factor	Average work pace: PRF =1 Slower than average: PRF < 1 Faster than average: PRF > 1
Allowance Factor	Relaxing allowance given to the worker: Individual –5% Tiredness –4% Position –2% Weightlifting –1% Mental- 1% Physical – 1

3.4.1.2 Input in MOST Template

In this template, user was required to input all the values of every sequence model. After that all the data was summed up and then multiplied by the final value with 10 and that final value is called as Total Time Measuring Unit (TMU).

TMU used seconds to measure time. One TMU was defined to be 0.00001 hours, 0.006 minutes, or 0.036 seconds. Each motion of labour's movements carried time in TMU where the motion codes were used as the reference to obtain the standard time in the MOST template.

Afterward, the total TMU needed to be multiplied it by 0.00001 to convert it to normal time. The standard time was obtained by multiplying the value of normal time by (1+0.15), which represented a 15% fatigue allowances value.

Standard time was obtained from a trained worker who operates with some unavoidable delays. The allowance was involved in the standard time as there were not many time constraints when working under the standard time, which resulted in high productivity to perform well in the production line process. Furthermore, standard time were always dependent on the normal time. Using MOST, the standard time could already be obtained from the conversions of the TMU units into time measurement values.

3.4.1.3 Process and Output

Users had to add all mathematical calculations in Excel template for the value to be appeared. This was the standard method for obtaining the output. All the values for total TMU, time in hours and standard time with 15% fatigue allowances were calculated and appeared. If the users wanted a bar graph to appeared, user needed to do it manually by selecting all the data needed for bar graph and the graph would appear.

3.4.2 Requirement for MOST Calculation in MOST Calculator Phase

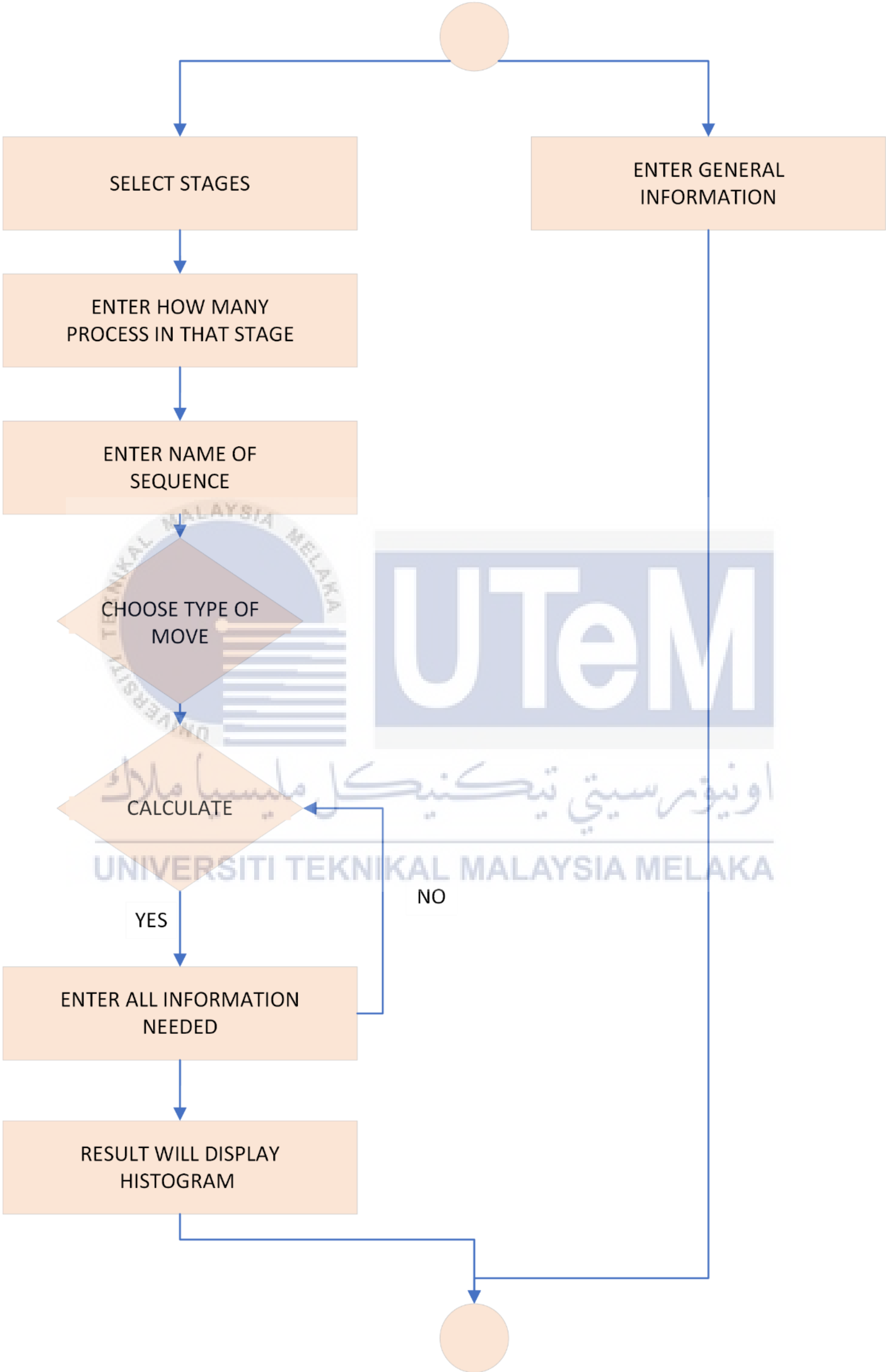


Figure 3-3 Website workflow diagram

3.4.2.1 Input in Most Calculator Website

Users needed to select which stages that user wanted to calculate. Following the selection of the stages, the user is required to indicate the number of processes or sequences that were contained within each stage. In the following step, the user was required to either provide the sequence name or state the activities sequence for each process for the purpose of future reference. Before moving on to the next stage, the user must first determine the type of move that will be performed for each and every sequence. Immediately following the declaration of the type of move, the user was required to enter all of the necessary data and information for each procedure.

3.4.2.2 Process in Most Calculator Website

Excel software was typically utilised to carry out the mathematical calculations and display the output. This was the standard method for obtaining the output. With the goal of this project, during the process phase, the user did not have to worry or think about how to achieve the outcome or what formula would use. This happened because the user was not responsible for either of those things. This is due to the fact that after the user chooses the option to calculate, the website calculated all of the data for the user and display the results in the output.

3.4.2.3 Output in Most Calculator Website

During this stage, the results were displayed using a histogram graph, and a comparison was made to determine which stage required the most amount of time to complete the operation. A comparison was made based on the sum of standard time value to determine which took the most time.

3.5 Design Phase

This stage of the development of the system focused on technological aspects. During this phase, the system design was being prepared, and from the previous phase's requirement specifications were being reviewed for understanding. This system design helped in choosing the optimum hardware and system for constructing this system, and it also contributed to establishing the overall architecture of the system. The layout needed to provide a spot for the user to insert the data that they have obtained from operator observation in the department that has been selected. The layout of the website was straightforward and easy to navigate.

3.6 Development Phase

Initially, the system was built in a very small programme that is referred to as a unit. Subsequently, the unit was incorporated into the next phase utilizing the inputs from the system design. Unit testing was a feature that involved the creation and testing of each individual unit. HTML and CSS were the tools used to design the website layout and structure that were used on this website. After that, every calculation that comes with a formula on this page was performed using JavaScript. In addition, a histogram graph was displayed. This system would have been successful if the coding were free of errors, and it had fulfilled all of the requirements were set forth for it.

3.7 Testing Phase

All implementation-phase units were integrated into the system after testing. After integration, all problems and bugs were tested. It was then tested on actual hardware and the system was developed to confirm it satisfied criteria. This phase included a range of sample users, and their suggestions were considered to improve the system and project built.

This phase comes after all of the development of website is being completed, the comparison between updated data that acted as secondary data and website output were implemented to demonstrate the effectiveness of the website.

No.	Stage 2	Activities Sequence	rf	cf
1	Walk 3 steps to get sellotape and return	A6 B0 G1 - A6 B0 P0 - A0		
2	Do masking on clipping plates with care and precision	A1 B0 G1 - M3 X196 I3 - A0		
3	Walk 55 steps to the overcoat room while lifting beam and adjust in it position	A96 B0 G3 - A1 B0 P3 - A0		
4	Walk 55 steps to the working area table to get the chemical cleaner and soft cloth and return	A96 B0 G1 - A96 B0 P1 - A0		
5	Do the cleaning on the beam with care [Rivetted area]	A1 B0 G1 - A1 B0 P6 - U10 - A1 B0 P1 - A0		
6	Reach the promoter and apply it on the rivetted area with care and precisely [30 rivets]	A1 B0 G1 - A1 B0 P6 - 39U6 - A1 B0 P1 - A0		
7	Walk 25 steps to get sealent outside of the room and wait	A42 B0 G0 - A1 B0 P0 - A0		
8	Back to origin destination	A42 B0 G1 - A1 B0 P1 - A0		
9	Get rid the maskant from clipping plates	A1 B0 G1 - M3 X113 I3 - A0		
10	Wait for 30 minutes for the promoter to dry	-		
11	Reach the brush and sealent and apply overcoat on clipping plates	A1 B0 G1 - A1 B0 P6 - 13U10 - A1 B0 P1 - A0		
12	Reach chemical cleaner and soft cloth to clean with care	A1 B0 G1 - A1 B0 P6 - U16- A1 B0 P1 - A0		
13	Walk 40 steps and place beam on the jig	A67 B0 G3 -A1 B0 P1 - A0		

Figure 3-4 Data for assembly line in SME Aerospace Sdn. Bhd.

TOTAL TMU	Time (HOUR)	STD TIME (with 15% allowances)
80	0.0008	0.0009
2040	0.0204	0.0235
1030	0.0103	0.0118
1940	0.0194	0.0223
210	0.0021	0.0024
2450	0.0245	0.0282
760	0.0076	0.0087
450	0.0045	0.0052
1210	0.0121	0.0139
1410	0.0141	0.0162
270	0.0027	0.0031
720	0.0072	0.0083
		0.14

Figure 3-5 Data for assembly line in SME Aerospace Sdn. Bhd.

Next, if the error percentage of comparison was low, then the website could be considered a success. If the result showed that the outcome was much different, and the error percentage was high, then the development process needed to be examined back.

3.8 Result Analysis Phase

This stage was conducted after finishing key in all the data and compared it to older way of calculation to confirm whether the website was working properly and could manage to get the same output. This stage of the system focused on the result aspects. During this phase, it was determined whether or not the final system had been fully set up and whether the final system was complete or not. Additionally, it helped ensure that the website could be used to assist in determining the level of productivity achieved by different industries or stages.

3.9 Gantt Chart

The Gantt Chart is as the in appendix.

3.10 Conclusion

In this chapter, it explains about the flow to develop a website based on MOST calculation. This chapter also adapted the waterfall methodology to finish developing a website. The requirements to finishing the construction of a website included requirement analysis phase, design phase, development phase and finally testing phase that will determine the website is functional. After that, we had a result analysis to create a report for the website.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, it will present the research achievement and explain about the completed website and determine whether the purpose is achieved or not. After the coding for the website has been completed, the result will be displayed in this chapter. It will present the website that is capable of calculating MOST in determining and resolving an issue that may occur in each of the working areas.

A series of data is being measured using MOST and the data is calculated using a website. Then, the updated MOST data that is known as secondary data will be compared with the website outcome. This is to analyze if the website is capable of calculating MOST or not. The comparison for both data is being done through a histogram graph for better visualization of data.

A further in-depth study can be performed using the histogram graph by determining which part of the stages requires the most amount of time to complete. During this session, we will have the opportunity to make improvements that are ideal for increasing the productivity of labor. In conclusion, the firm authority will be responsible for maintaining continuous control of the working approach that has been designed. Updated standard operating procedures within a predetermined amount of time, regular audits, and the use of one-point lessons as reminder notes for workers are the controls that can be implemented.

4.2 Requirement Phase and Design Phase in MOST Calculator Website

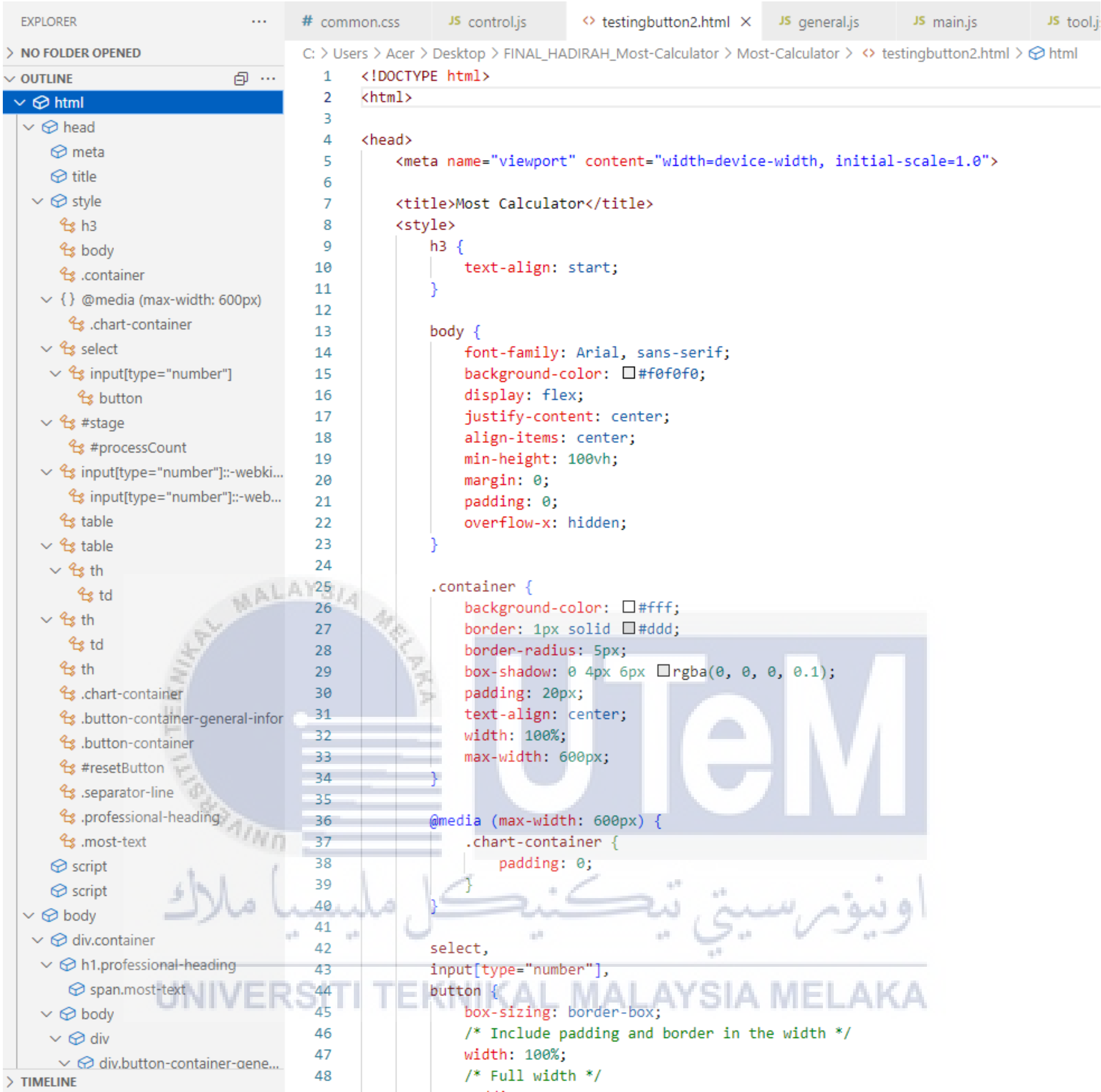


Figure 4-1 HTML coding part

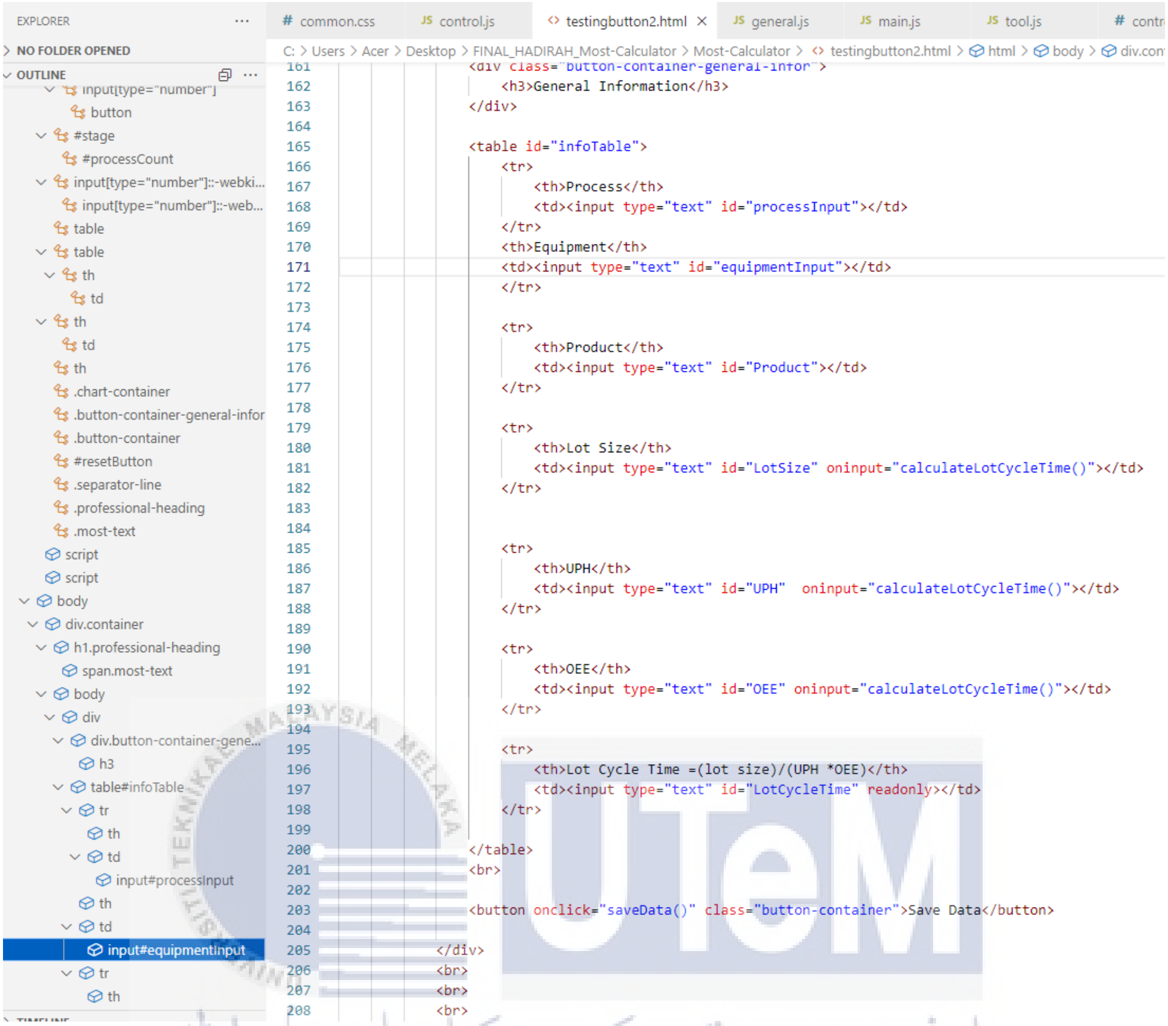


Figure 4-2 HTML coding part

All the scripting code is done with Visual Studio Code software. The files are mainly saved as the '.html' as content that the server generates. The use of HTML tags allows for the meticulous creation of essential elements such as headings, paragraphs, forms, and page divisions, which are then used to provide a strong foundation for the content and appearance of the website. Through its inherent structure, HTML ensures that elements have logical relationships with one another, which allows for greater accessibility and maintainability.

Figure 4-3 CSS coding part for common information

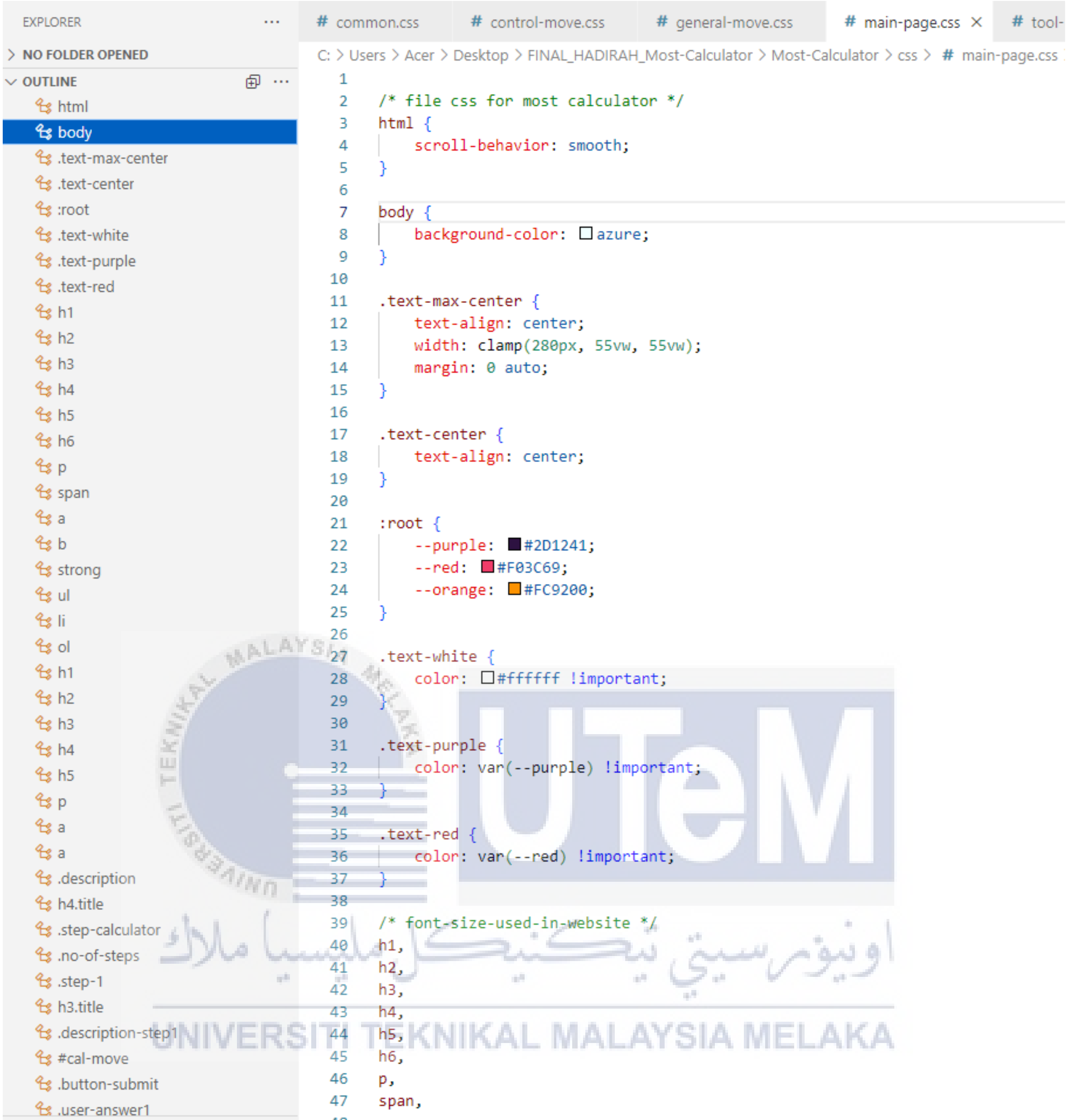


Figure 4-4 CSS coding part for main page

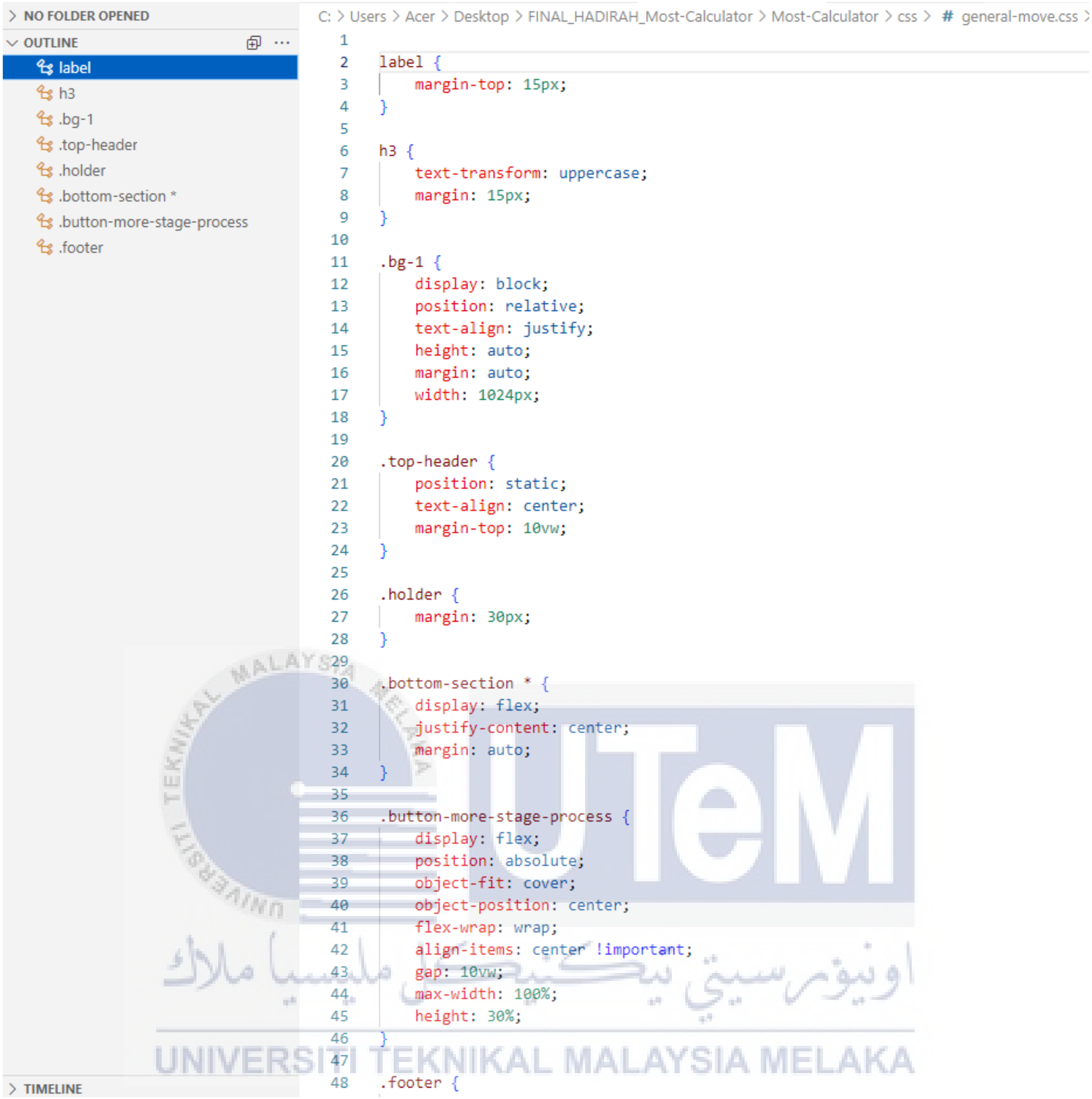


Figure 4-5 CSS coding part for general move

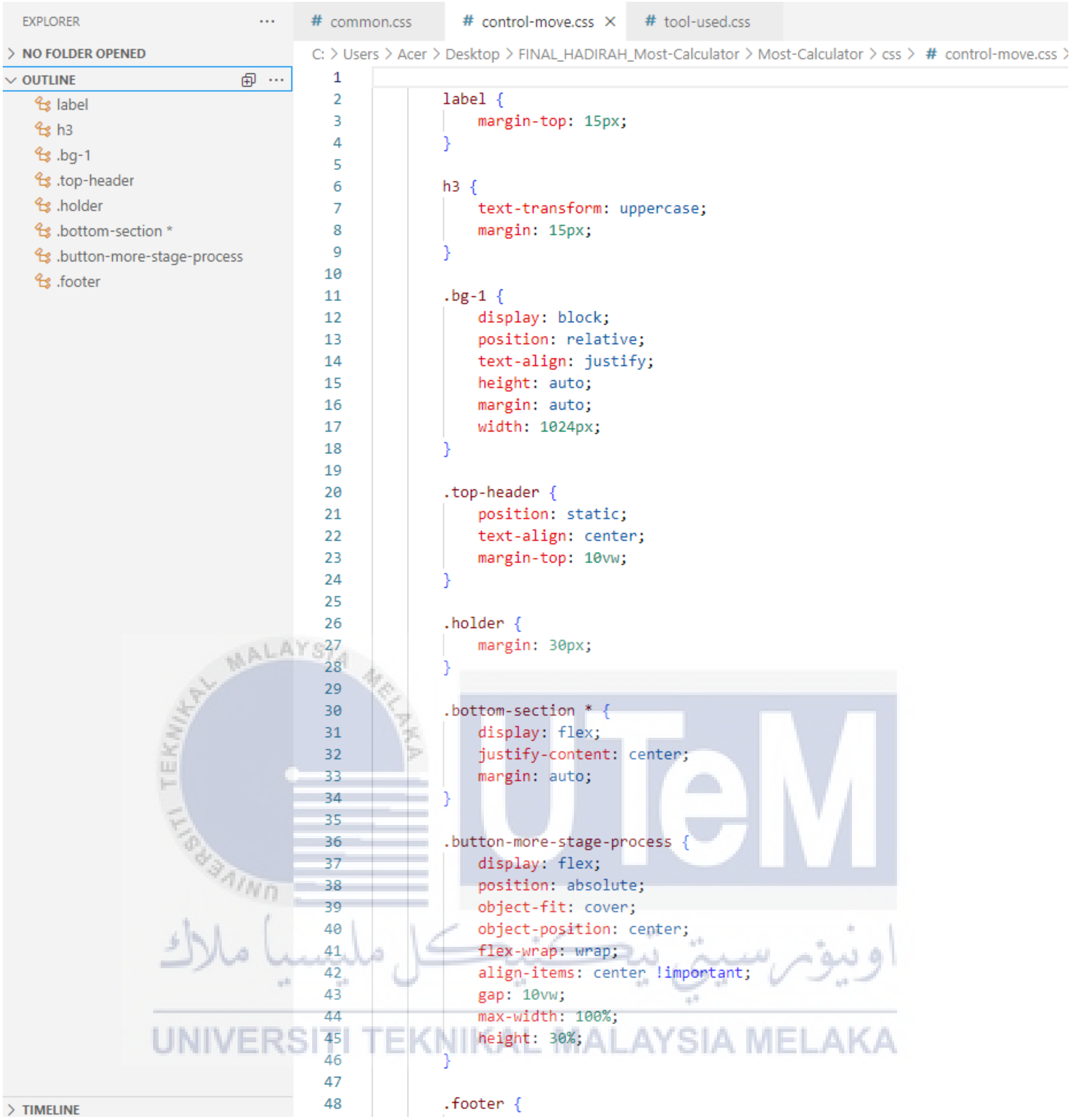
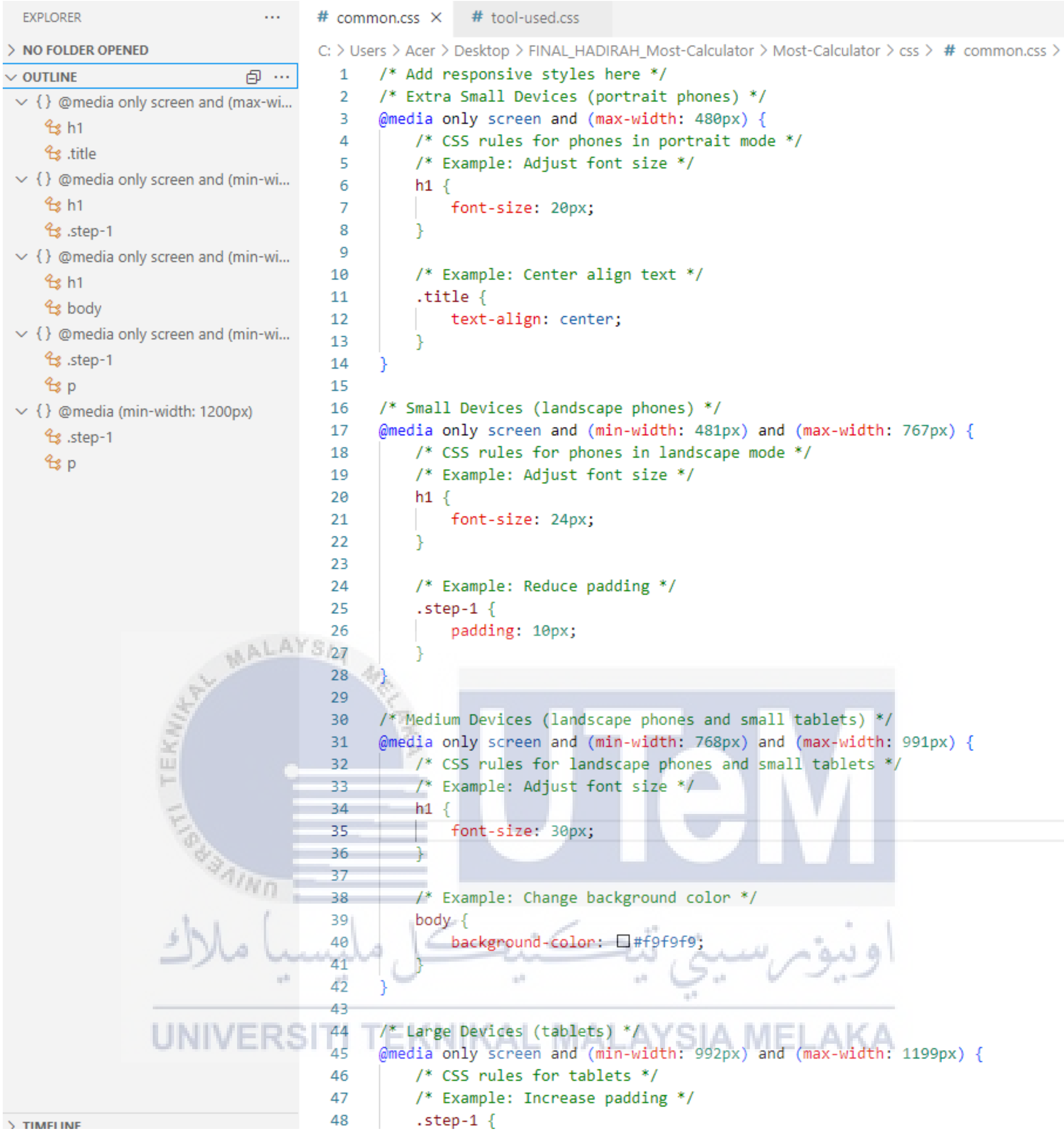


Figure 4-6 CSS coding part for control move.




```css
/* Add responsive styles here */
/* Extra Small Devices (portrait phones) */
@media only screen and (max-width: 480px) {
    /* CSS rules for phones in portrait mode */
    /* Example: Adjust font size */
    h1 {
        font-size: 20px;
    }

    /* Example: Center align text */
    .title {
        text-align: center;
    }
}

/* Small Devices (landscape phones) */
@media only screen and (min-width: 481px) and (max-width: 767px) {
    /* CSS rules for phones in landscape mode */
    /* Example: Adjust font size */
    h1 {
        font-size: 24px;
    }

    /* Example: Reduce padding */
    .step-1 {
        padding: 10px;
    }
}

/* Medium Devices (landscape phones and small tablets) */
@media only screen and (min-width: 768px) and (max-width: 991px) {
    /* CSS rules for landscape phones and small tablets */
    /* Example: Adjust font size */
    h1 {
        font-size: 30px;
    }

    /* Example: Change background color */
    body {
        background-color: #f9f9f9;
    }
}

/* Large Devices (tablets) */
@media only screen and (min-width: 992px) and (max-width: 1199px) {
    /* CSS rules for tablets */
    /* Example: Increase padding */
    .step-1 {
```


Figure 4-7 CSS coding part for tool use

Through the use of CSS rules, colours, fonts, spacing, and layout are meticulously choreographed in order to provide a user experience that is visually engaging and consistent. CSS media queries ensure that adjustments are made without any interruptions across a wide range of screen sizes and devices, hence improving the experience for a variety of users.

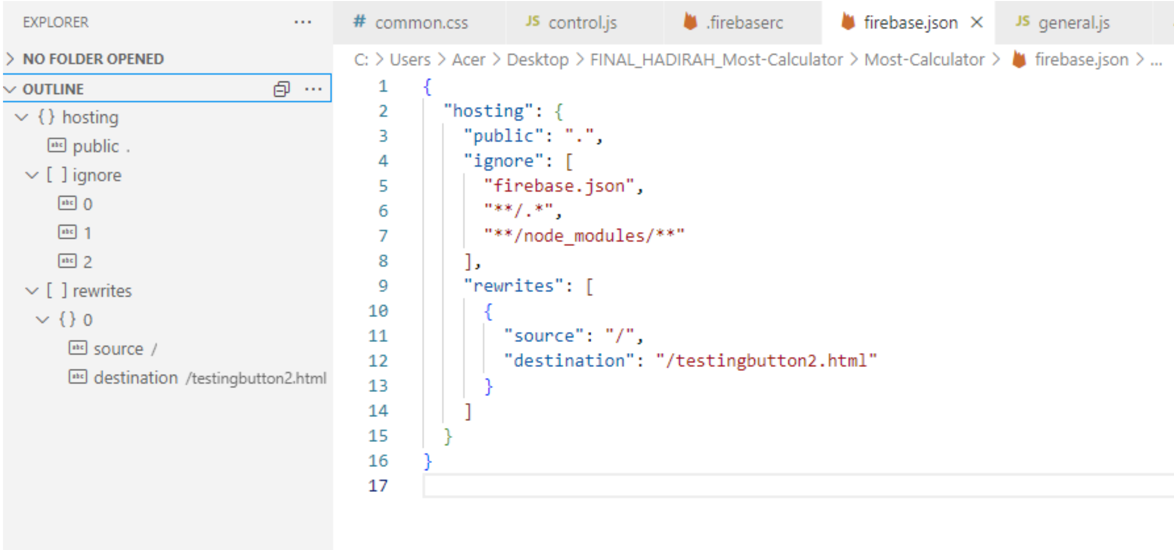


Figure 4-8 JavaScript coding part

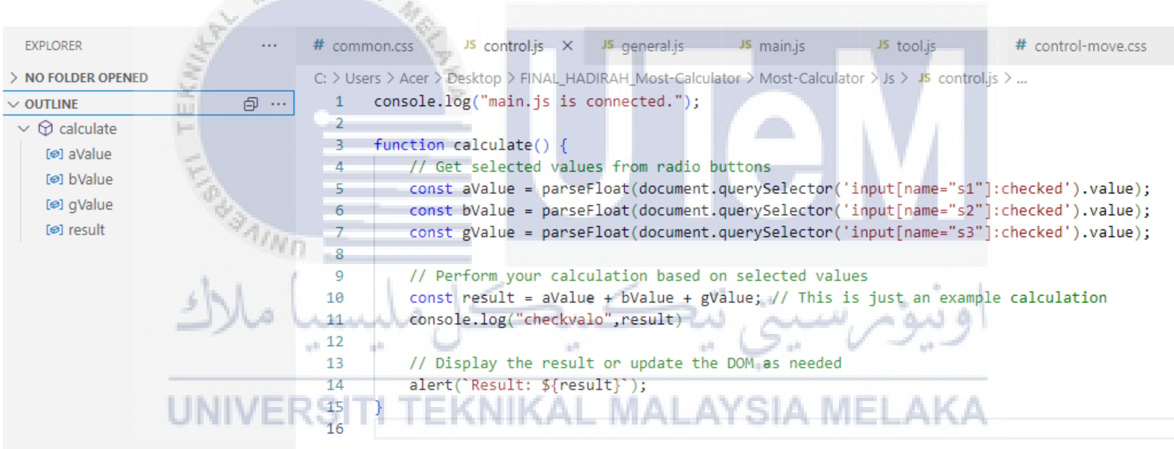


Figure 4-9 JavaScript coding part

JavaScript gives the project a sense of vitality by reacting to user events such as clicks, form submissions, and mouse movements. This creates an atmosphere that is both captivating and dynamic. This allows for smooth updates, animations, and real-time data displays without the need for the entire website to be reloaded. It does this by dynamically modifying the HTML content. JavaScript is frequently used alongside CSS animations and interactive effects, which further enhances the pleasure of viewing the content.

4.3 Development Phase MOST Calculator Website

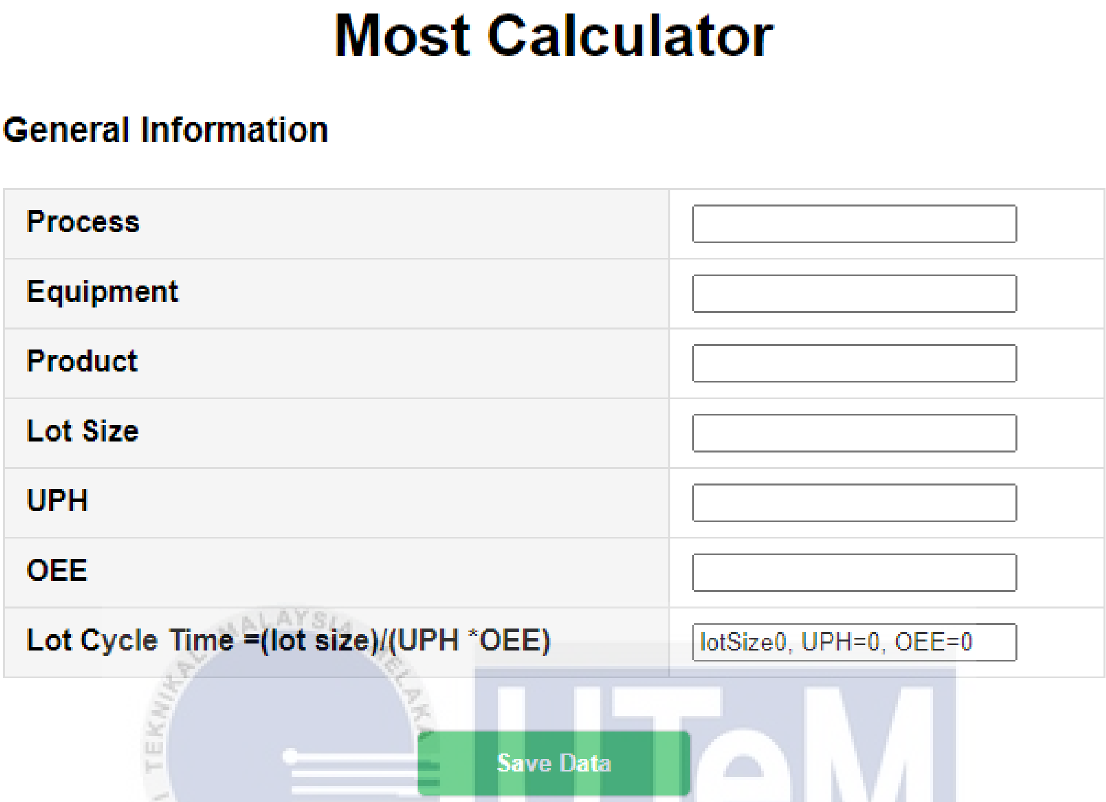


Figure 4-10 General Information table

The general information section of the *MOST calculator* is the first thing that users will see when they open the tool. This section is not mandatory to be filled in, but it can be helpful to do so if you have the information. The table in the general information section includes fields for entering the process name, equipment name, product name, lot size, UPH (units per hour), and OEE.

Once you have entered all of the information in the general information section, you can click the "Save Data" button to save all of the information that you have entered. The MOST calculator can be used to calculate the lot cycle time, which is the time it takes to complete one lot of products. The lot cycle time is calculated automatically by dividing the lot size by the UPH and the OEE.

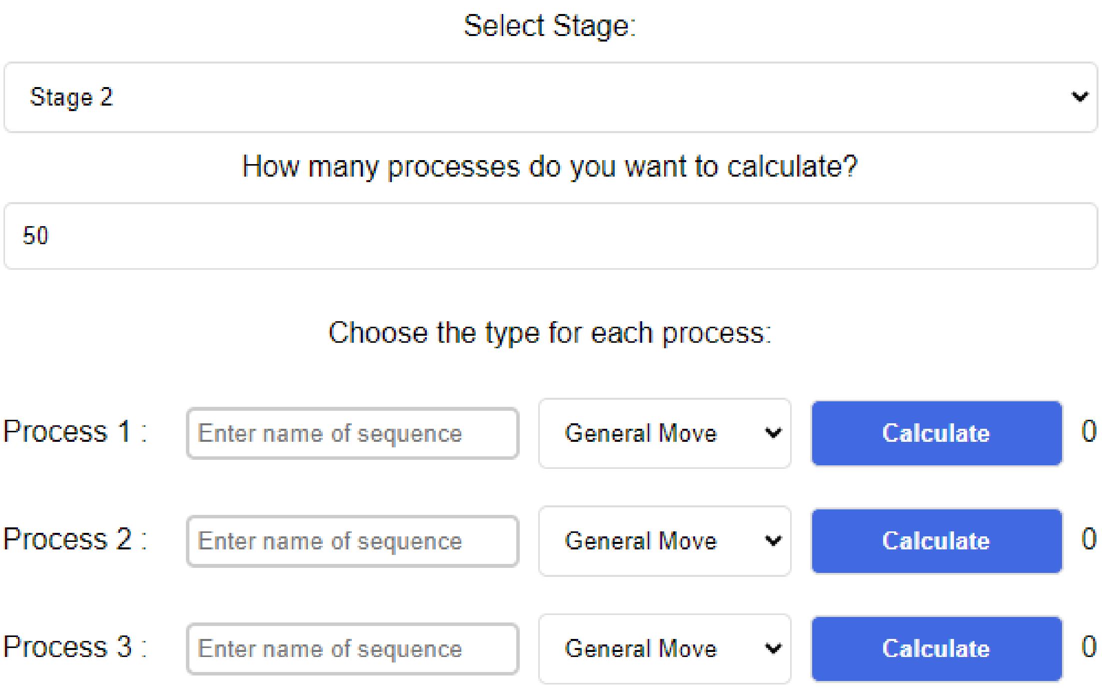


Figure 4-11 MOST Calculator page

The initial screen of the *MOST calculator* presents the user with a stage selection. The user can select one until four stages. After selecting the stage, the user is prompted to indicate the number of processes to calculate. The calculator then generates the corresponding number of process entries dynamically.

Each process entry contains three critical fields. The first one is name of sequence, this field allows the user to give the process a descriptive name, which promotes clarity and reduces the chance of errors. Secondly, type of movement which the user can select the type of movement engaged in the process from a drop-down menu in this box, such as a general move, controlled move, or tool use. Lastly, calculate when this button is pressed for a given process, it leads the user to the next step of that process's calculation where data regarding the movement will be entered. The *MOST calculator* ensures that accurate and relevant data is entered for each procedure by prompting the user to define these specifics before advancing.

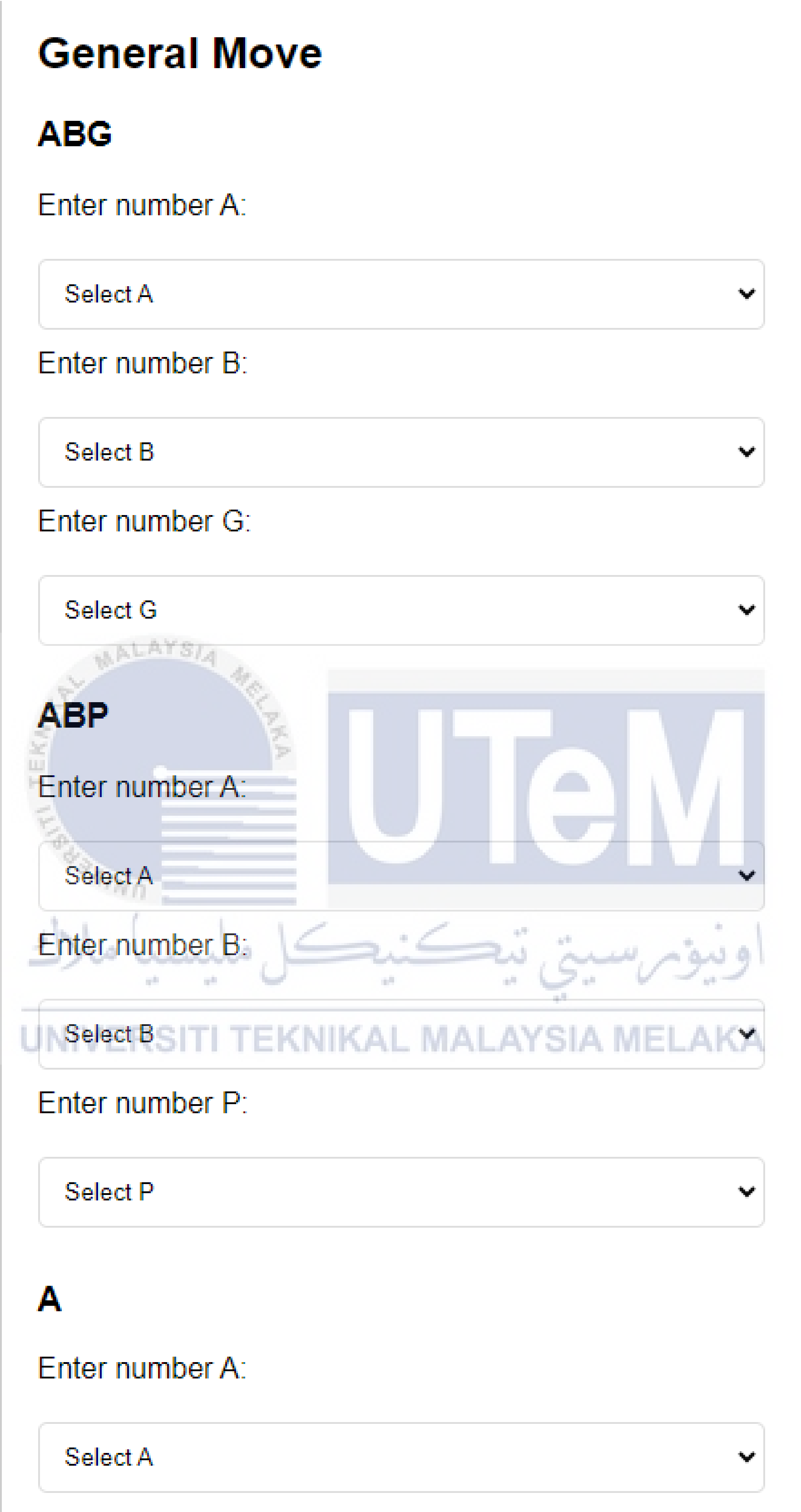


Figure 4-12 Web page layout for the General Move calculation

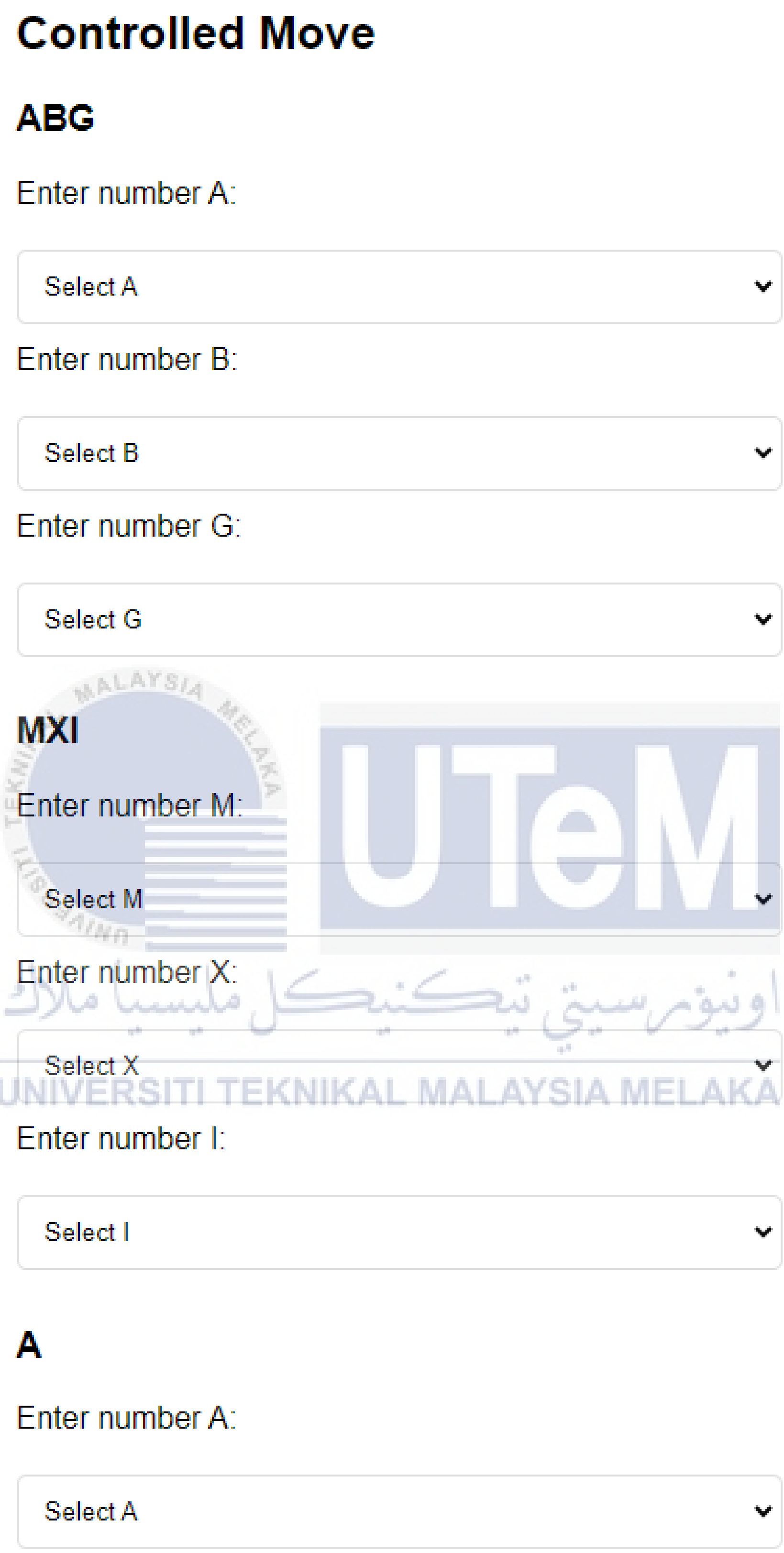


Figure 4-13 Web page layout for the Controlled Move calculation

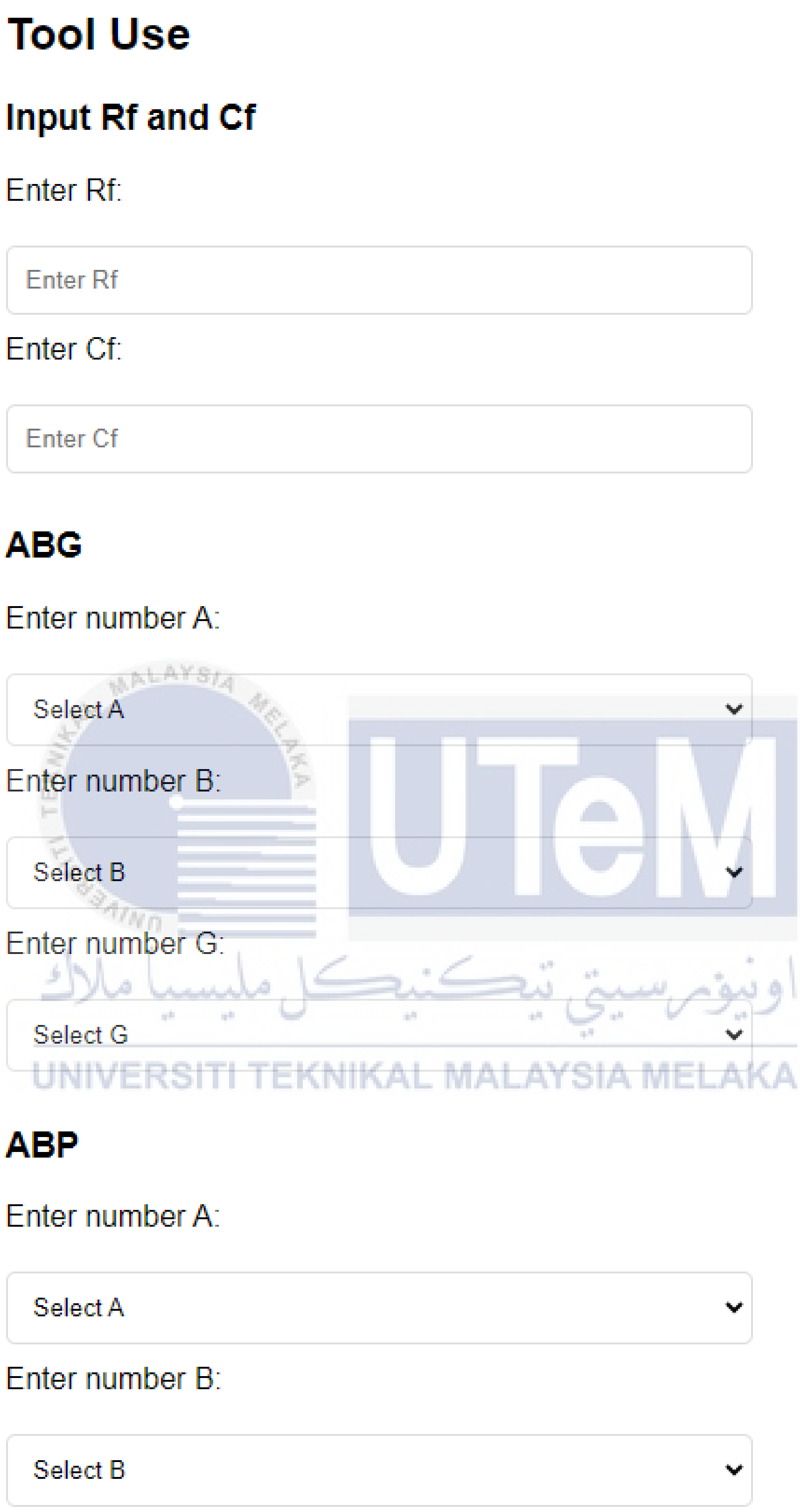


Figure 4-14 Web page layout for the Tool Use calculation

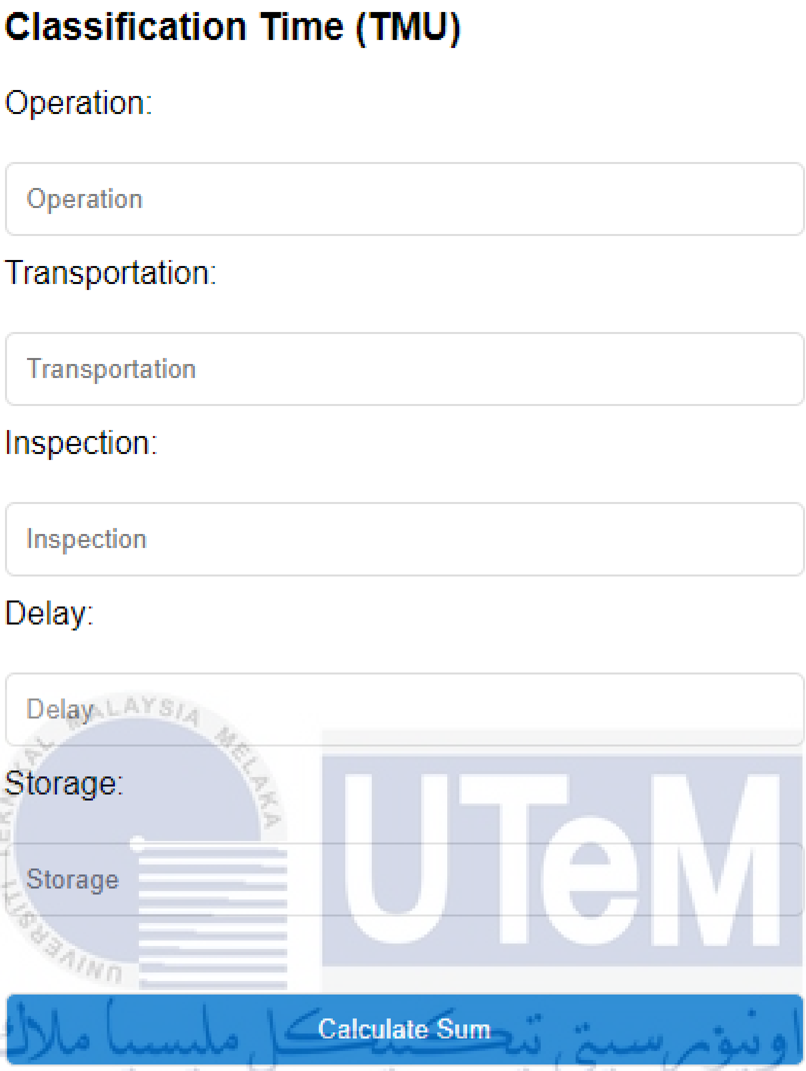


Figure 4-15 Calculate Sum button at the end of every move calculation page

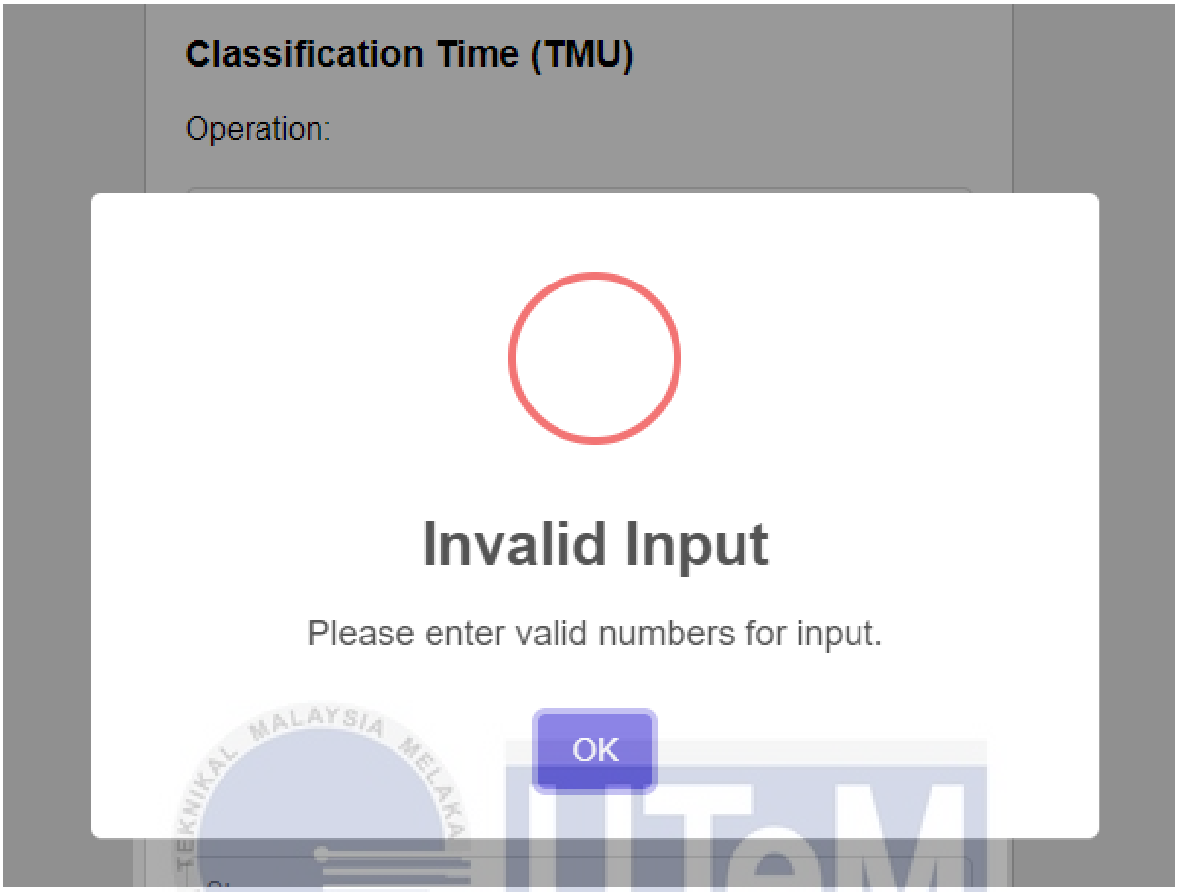
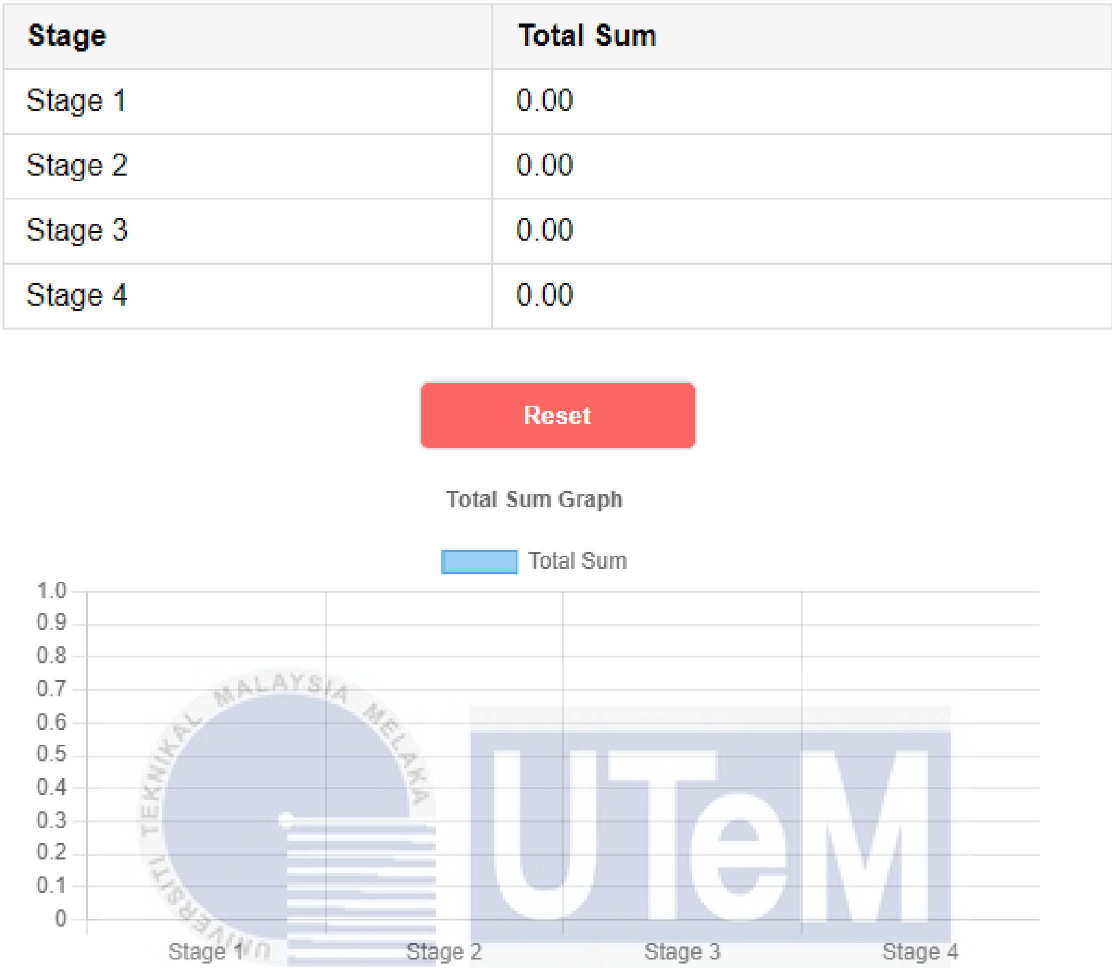


Figure 4-16 Invalid Input warning

Figure 4-11 until **Figure 4-13** shown the web page layout for the General Move, Controlled Move and Tool Use calculation. The user must enter all data in the layout by selecting the right values for each sequence from dropdown menus or input fields, ensuring accurate representation of movement characteristics. Upon complete data entry, the user initiates the calculation process by clicking the "Calculate Sum" button located at the bottom of the page as shown in **Figure 4-14**. This action automatically generates the total standard time for the specified activity sequence. To ensure data integrity, the system issues a visual warning as shown in **Figure 4-15**, if any required data fields remain unfilled or left blank, prompting the user to complete all necessary fields before proceeding with the calculation.



Stage	Total Sum
Stage 1	0.00
Stage 2	0.00
Stage 3	0.00
Stage 4	0.00

Figure 4-17 Result page

Compare the sum of OTIDS in every stage.

Classification Time (TMU)	STAGE 1	STAGE 2	STAGE 3	STAGE 4
OPERATIONAL	0	0	0	0
TRANSPORTATION	0	0	0	0
INSPECTION	0	0	0	0
DELAY	0	0	0	0
STORAGE	0	0	0	0

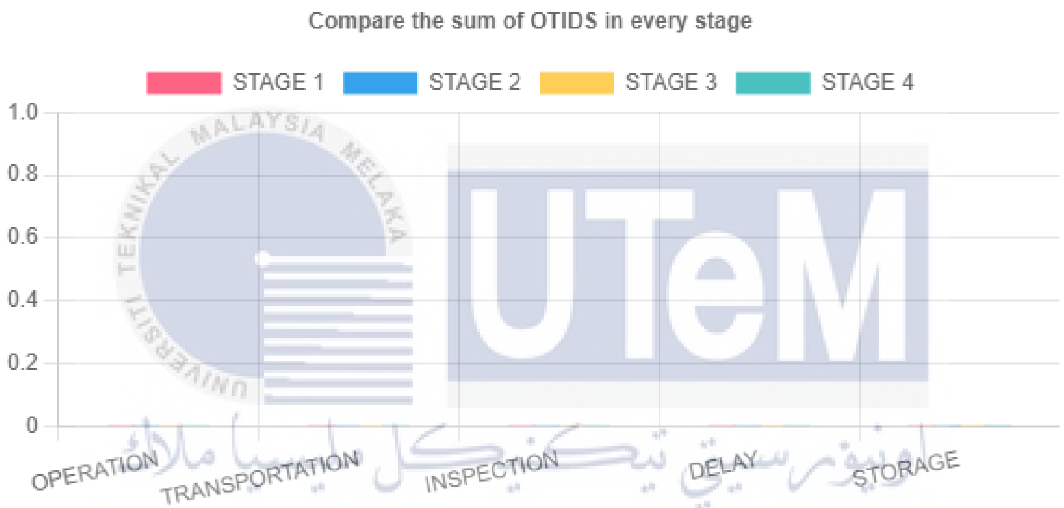


Figure 4-18 Result of OTIDS (Operation, Transportation, Inspection, Delay and Storage) page

Upon completion of data entry, the histogram graph instantly appears on the screen to provide instant visual feedback and support a smooth workflow. This quick visualisation allows users to quickly grasp the distribution of their entered data, allowing for more efficient analysis and decision-making. As users continue to enter information, the histogram graph precisely follows the data entered, offering a fascinating and responsive visual experience. Each new data point integrates neatly into the graph's structure. After all data has been properly recorded, the histogram graph will presenting a comprehensive visual summary of the entire dataset. This final representation is a useful tool for additional research and interpretation, allowing users to get know which stage has highest and lowest time taken.

4.4 Testing Phase

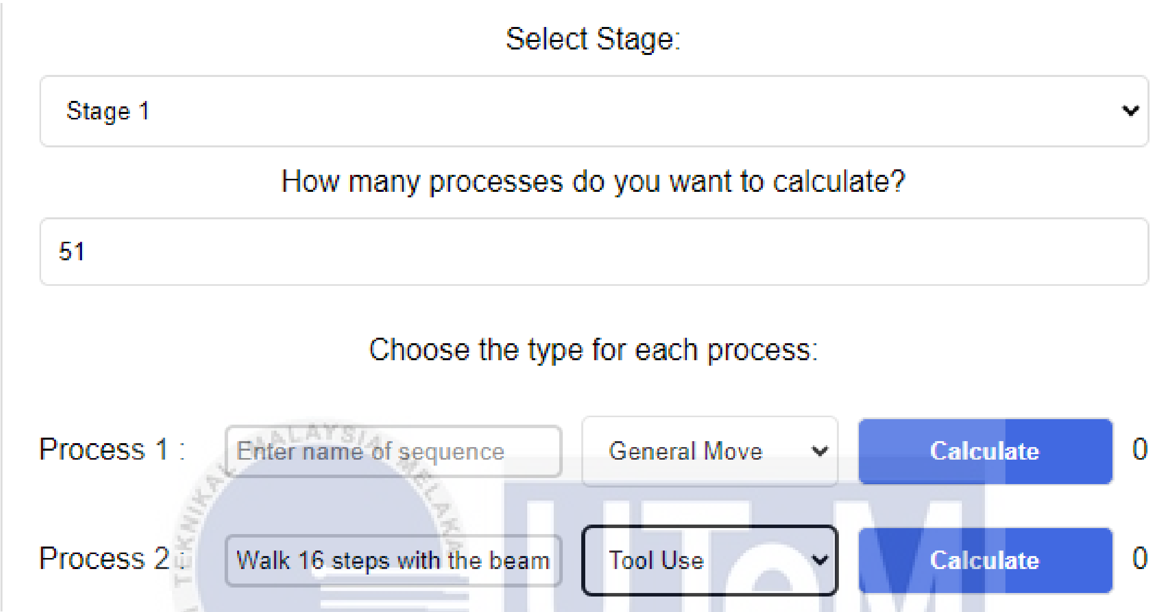


Figure 4-19 Main page of MOST Calculator website

The main page for the website design allows users to precisely define the quantity of processes they desire to compute during the designated stage. The page generates a corresponding number of process submission fields in a dynamic manner; each field comprises two essential components which is name of sequence that user can enter the descriptive of every process which promote clarity particularly when managing a large number of processes. Secondly, users also are provided with a dropdown menu that contains options of type of movement that user are required to specify before continuing with calculation.

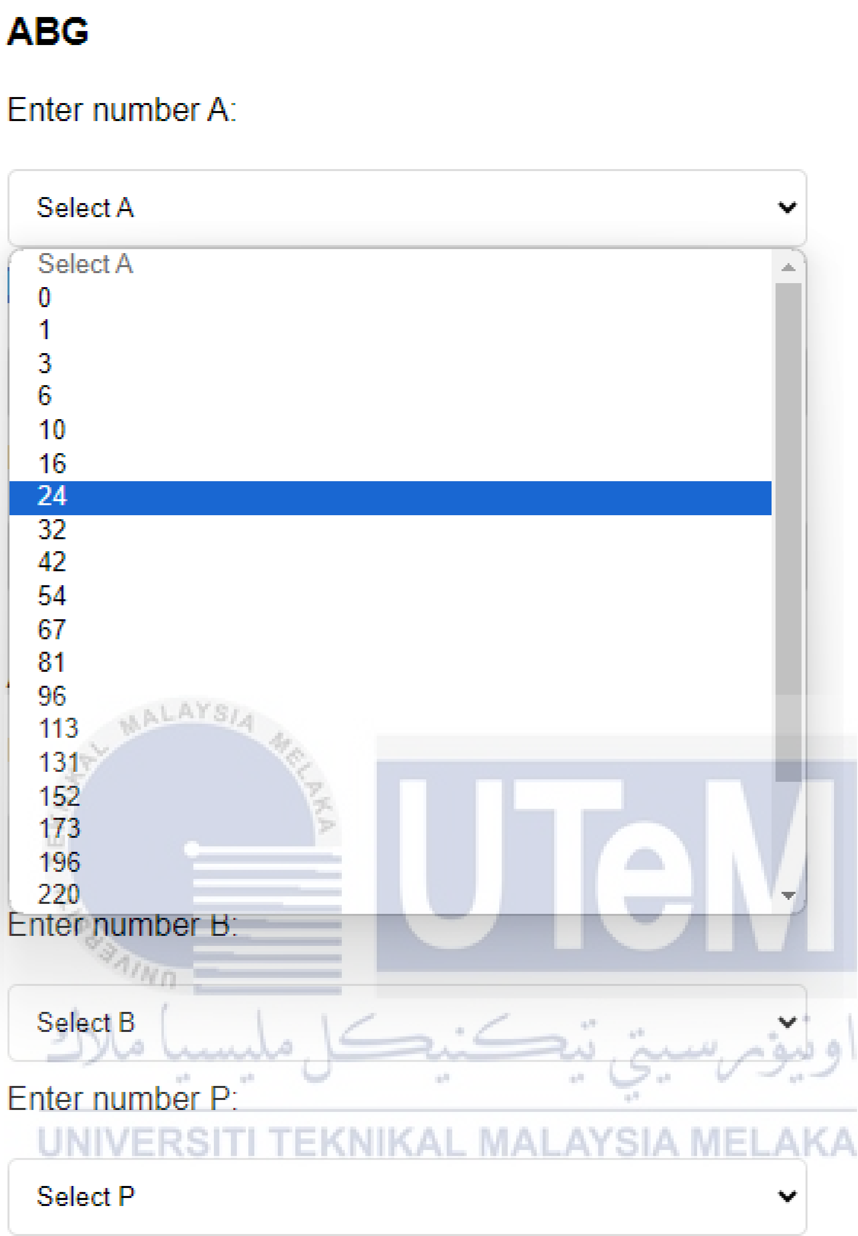


Figure 4-20 Calculation page

On the page that displays the calculation, the user is just required to complete the calculation by selecting a value from a dropdown menu for each alphabet in the sequence.

4.5 Result Analysis Phase

No.	Stage 2
1	Walk 3 steps to get sellotape and return
2	Do masking on clipping plates with care and precision
3	Walk 55 steps to the overcoat room while lifting beam and adjust in it position
4	Walk 55 steps to the working area table to get the chemical cleaner and soft cloth and return
5	Do the cleaning on the beam with care [Rivetted area]
6	Reach the promoter and apply it on the rivetted area with care and precisely [30 rivets]
7	Walk 25 steps to get sealent outside of the room and wait
8	Back to origin destination
9	Get rid the maskant from clipping plates
10	Wait for 30 minutes for the promoter to dry
11	Reach the brush and sealent and apply overcoat on clipping plates
12	Reach chemical cleaner and soft cloth to clean with care
13	Walk 40 steps and place beam on the jig

Figure 4-21 Secondary data of MOST in Excel template

Activities Sequence	rf	cf	O	T	I (inspection)	D (delay)	S (storage)	TOTAL TMU	Time (HOUR)	STD TIME (with 15% allowances)
A6 B0 G1 - A6 B0 P0 - A0			10	120				130	0.0013	0.0015
A1 B0 G1 - M3 X196 I3 - A0			2040					2040	0.0204	0.0235
A96 B0 G3 - A1 B0 P3 - A0			70	960				1030	0.0103	0.0118
A96 B0 G1 - A96 B0 P1 - A0			20	1920				1940	0.0194	0.0223
A1 B0 G1 - A1 B0 P6 - U10 - A1 B0 P1 - A0			210					210	0.0021	0.0024
A1 B0 G1 - A1 B0 P6 - 39[U6] - A1 B0 P1 - A0	39		2450					2450	0.0245	0.0282
A42 B0 G0 - A1 B0 P0 - A0			10	420		330		430	0.0043	0.0049
A42 B0 G1 - A1 B0 P1 - A0			30	420				450	0.0045	0.0052
A1 B0 G1 - M3 X113 I3 - A0			1210					1210	0.0121	0.0139
-										
A1 B0 G1 - A1 B0 P6 - 13[U10] - A1 B0 P1 - A0	13		1410					1410	0.0141	0.0162
A1 B0 G1 - A1 B0 P6 - U16- A1 B0 P1 - A0			270					270	0.0027	0.0031
A67 B0 G3 -A1 B0 P1 - A0			50	670				720	0.0072	0.0083
			7780	4510						0.14

Figure 4-22 Secondary data of MOST in Excel template

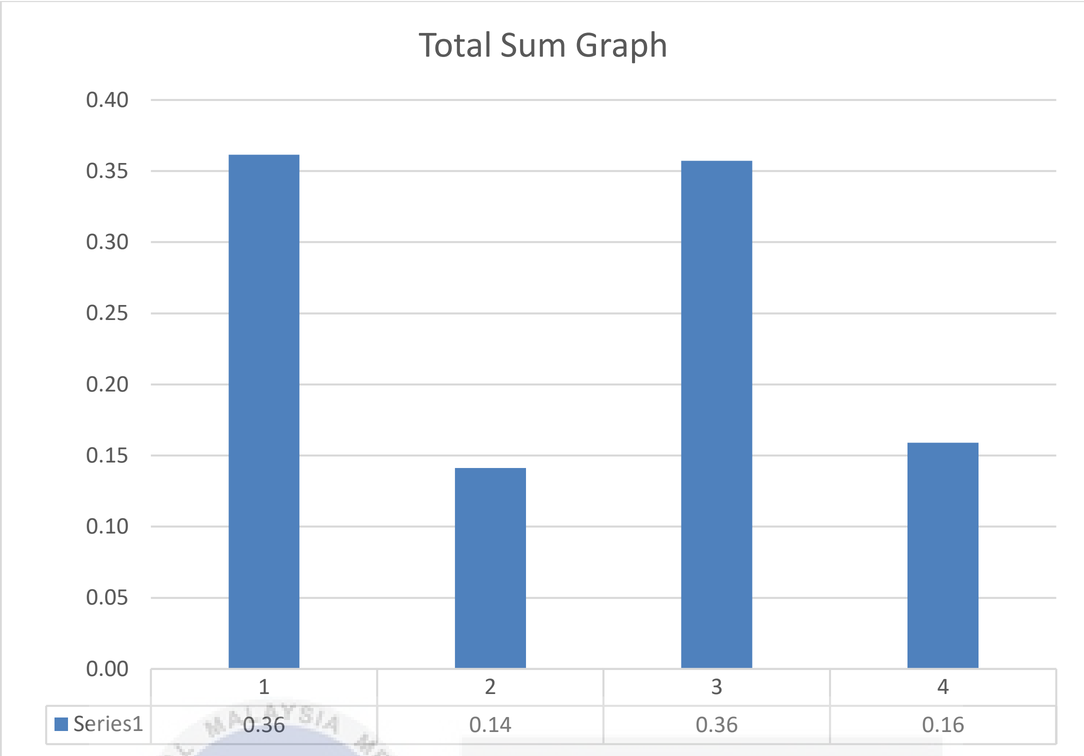


Figure 4-23 Histogram Graph from Excel MOST Template

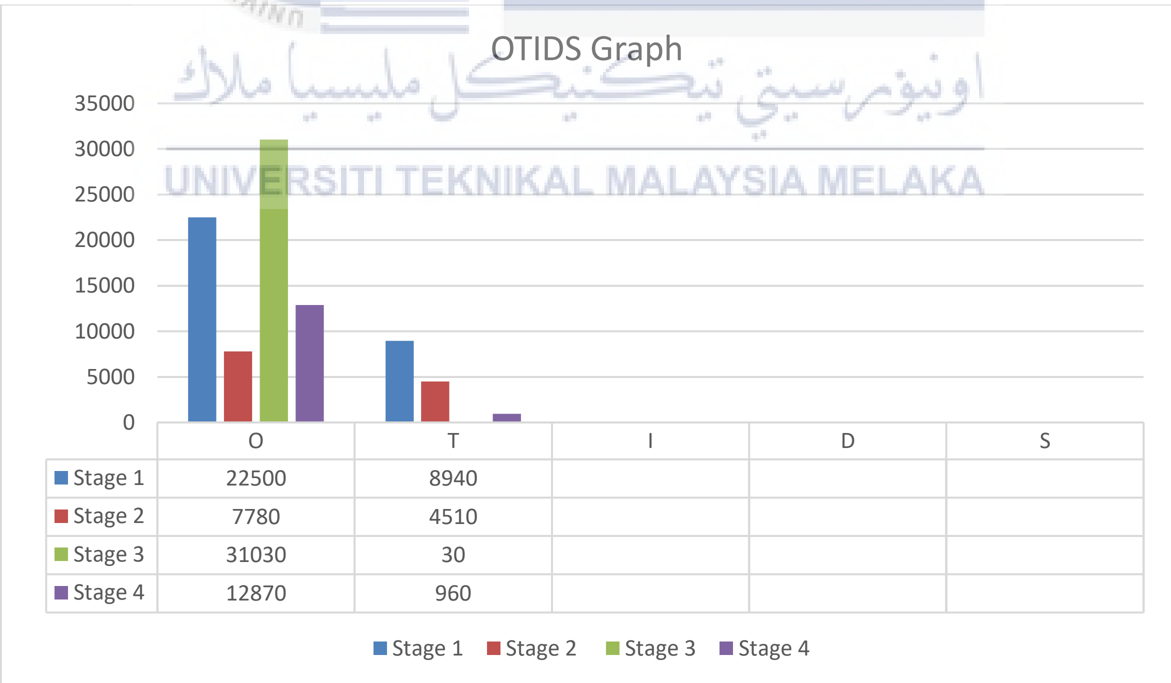


Figure 4-24 Histogram Graph from Excel MOST Template

Stage 2 is use for result analysis because it has the least data compare to others. Figure 4-20 and Figure 4-21 is the result for the MOST data is calculated using Excel template by enter all mathematical calculations in Excel template for the value to be appeared. This is the standard method for obtaining the output. All the value for total TMU, time in hour and standard time with 15% fatigue allowances is calculated. Data for standard time need to be manually select for the histogram graph to be appeared. Same process needs to be done for Operation, Transportation, Inspection, Delay and Storage (OTIDS) histogram graph. MOST computations necessitate extensive data input, such as motion codes, time values, and element descriptions. Manually entering this information into Excel can be time consuming and prone to data entry errors.

Compatibility issues may develop when sharing Excel files with others that utilize distinct versions of the software, potentially resulting in inconsistencies in computations and data. MOST analysis typically entails the preservation of historical documents documenting time studies. Excel lacks comprehensive functionality for data versioning, archiving, and audit trails. Excel offers limited collaboration capabilities, which may not be ideal for conducting multi-user or collaborative MOST analysis. Producing summary statistics for MOST analysis could face greater difficulties in Excel when compared to MOST Calculator website particularly tailored for this specific task.

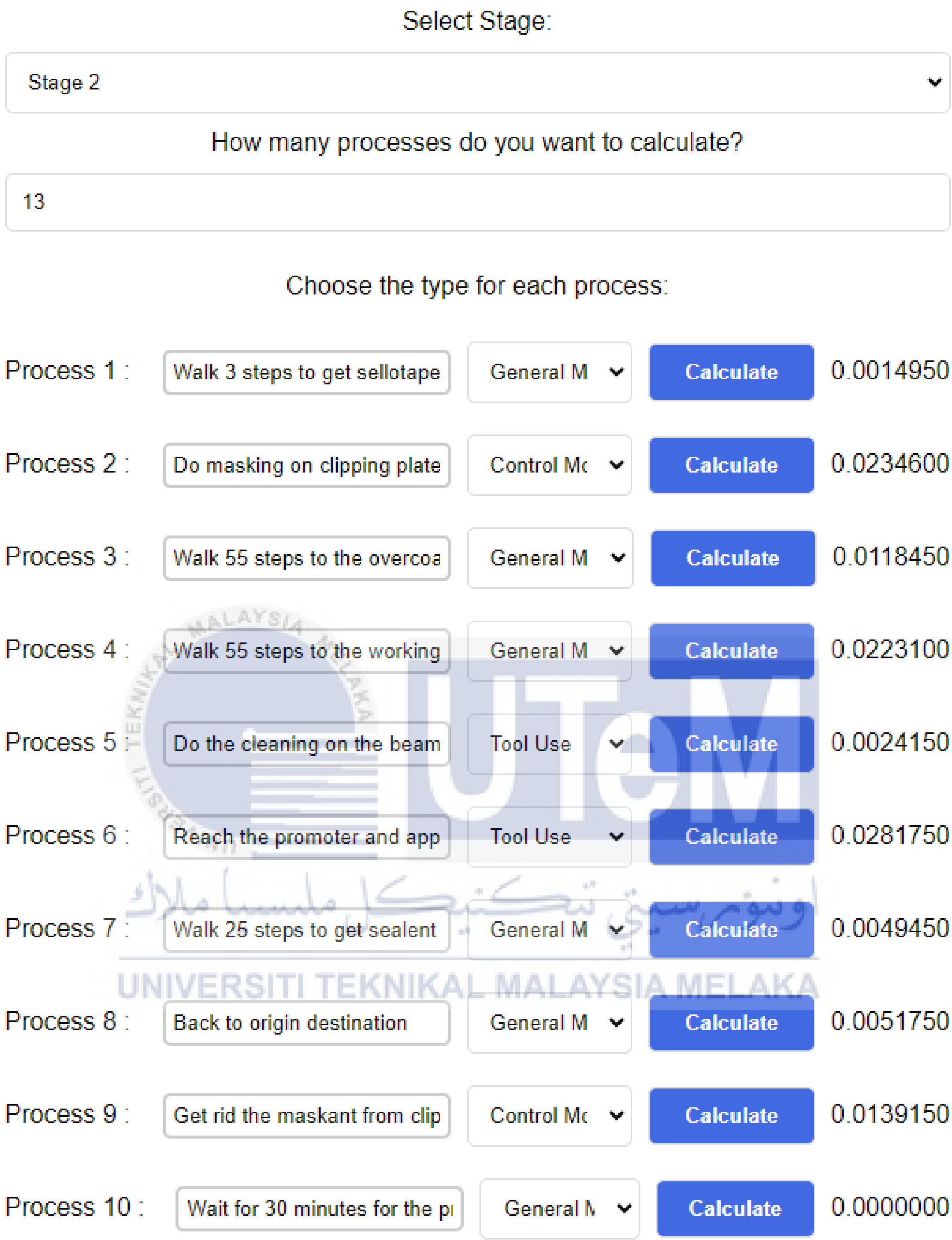


Figure 4-25 MOST data in MOST Calculator website

Figure 4-26 MOST data and result in MOST Calculator website

Compare the sum of OTIDS in every stage.

Classification Time (TMU)	STAGE 1	STAGE 2	STAGE 3	STAGE 4
OPERATIONAL	22500	7780	31030	12870
TRANSPORTATION	8940	4510	30	960
INSPECTION	0	0	0	0
DELAY	0	0	0	0
STORAGE	0	0	0	0

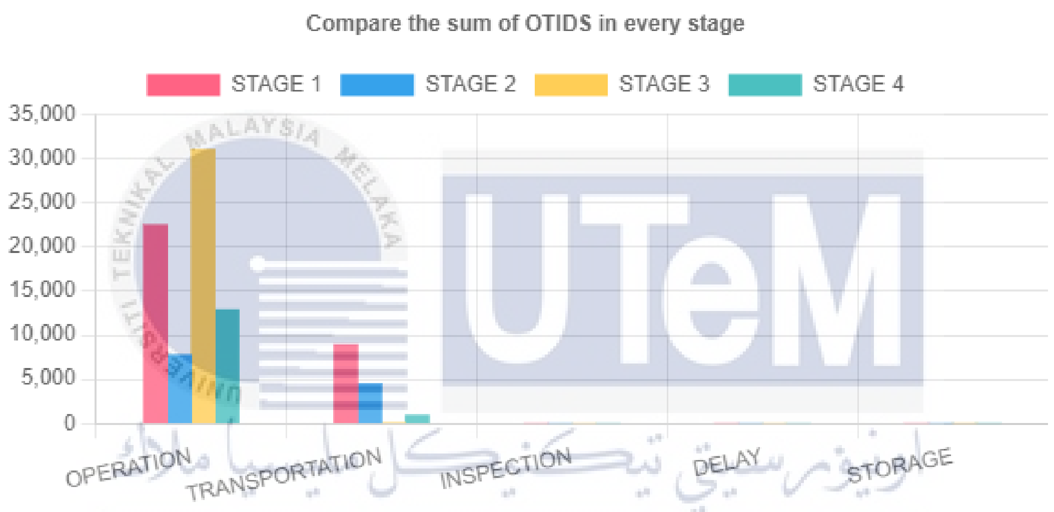


Figure 4-27 MOST result in MOST Calculator website

This is the result from MOST Calculator website Figure 4-24 and Figure 4-25 are for stage 2 data. The MOST Calculator website and the Excel template generate identical results, indicating precision in both approaches. The website presents a notable increase in speed while generating results in comparison to Excel. The results reveal that stages 1 and 3 take the most time when compared to the other stages. The website generates a graph automatically, whereas Excel necessitates manual graph creation. The advantages of utilising the MOST Calculator Website are it enhanced calculation speed and accelerated generation of output, resulting in time and effort savings. It also allows access to web content from any internet-enabled device, without the need for programme installation. The MOST Calculator website also have user-friendly interface with clear input fields and instructions, typically easier for less Excel-proficient users. Efficiently generate graphs for visual analysis, minimising time and work.

4.6 Summary

This chapter details the development of the MOST Calculator website and proves that the website works as wanted. The project involves data from assembly line production at SME Aerospace Sdn. Bhd. The website is developed based on the waterfall concept where the problem is being defined and objective is being identified for the study first. Then the requirement analysis is determined and then proceed with design and development using JavaScript, HTML and CSS. The testing and result analysis is being conducted, and from there it is concluded that the website is successfully develop. At the end, the stage that cause of delay in the production line is determined and recognized. Further inspection of that particular stage needs to be observed and the industries authorities can make a suitable change in the processes involved to increase productivity.

CHAPTER 5

CONCLUSION AND FUTURE WORK.

5.1 Conclusion

This thesis presents a method for developing a MOST Calculator website that calculates productivity with Maynard Operation Sequence Technique (MOST) by using the waterfall method. The first objective is to study the current ways or process to calculate Maynard Operational Sequence Technique. Next, to develop a website using a current trend system. This is to create a more efficient and easy way to calculate MOST and to eliminate the need for an Excel template. This to reduce time consuming by organization to calculate productivity of worker and create a user-friendly website for less Excel-proficient users. Lastly, to test the improvement with the aim to achieve higher labor productivity and less time consuming. All these objectives are successfully achieved.

The website is being developed using the waterfall method, beginning with requirement analysis and design, until development is successfully achieved by using JavaScript, HTML, and CSS. Then testing and result analysis are done by comparing the website result with an Excel template calculation, in which the website successfully generates identical results, and it is proven that the website can calculate productivity. The website has additionally reduced the duration required for MOST calculations by 50% and eliminated the need for Excel templates, as it can store data as long as it is not discarded for future user reference. Finally, the results reveal that stages 1 and 3 take the most time when compared to the other stages. This shows that the source of the assembly line delay has been identified and acknowledged. The industry authorities can make the necessary changes in the processes involved to boost productivity.

5.2 Future Work

The following adjustments can be made to the efficiency of the MOST Calculator website in the future:

i. Incorporate Mini-MOST and Maxi-MOST computations into the current standard MOST framework, accommodating intricate operations and micro-tasks to support a wider range of applications.

ii. Accommodate multi-stage jobs with intricate workflows, enabling calculations for larger manufacturing companies with complex production lines.

iii. Implement man-to-machine calculations to assess operator utilization and optimize configurations of man-machines, thereby gaining a more comprehensive understanding of production efficiency.

The above-mentioned developments will boost the website's standing as a comprehensive instrument for evaluating and enhancing productivity in various manufacturing contexts, thereby augmenting its utility for operations of varying scales.

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APPENDICES

APPENDIX A Gantt Chart for PSM 1 & 2

Table 5-1 Gantt Chart PSM 1

No.	Project Activities	Plan VS Actual Plan	March			April				May				Jun			
		Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	PSM Briefing	Plan															
		Actual															
2.	Report Briefing with Supervisor	Plan															
		Actual															
3.	Report writing: Chapter 2 (Literature Review)	Plan															
		Actual															
4.	Report writing: Chapter 3 (Methodology)	Plan															
		Actual															
5.	Report writing: Chapter 4 (Preliminary Results)	Plan															
		Actual															
6.	Report writing: Chapter 1 (Introduction)	Plan															
		Actual															
7.	Report Finalization	Plan															
		Actual															
8.	Report Submission	Plan															
		Actual															
9.	Slide Preparation	Plan															
		Actual															
10.	Final Improvement	Plan															
		Actual															
11.	Final Presentation	Plan															
		Actual															

Table 5-2 Gantt Chart PSM 2

No.	Project Activities	Plan VS Actual Plan	October			November				December				January			
		Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Data Collection	Plan															
		Actual															
2.	Development	Plan															
		Actual															
3.	Testing	Plan															
		Actual															
4.	Analysis	Plan															
		Actual															
5.	Discussion	Plan															
		Actual															
6.	Conclusion	Plan															
		Actual															
7.	Report Finalization	Plan															
		Actual															
8.	Report Submission	Plan															
		Actual															
9.	Final Presentation	Plan															
		Actual															

APPENDIX B MOST Index Table

GENERAL MOVE					
ABG - ABP - A					
Index	A Action Distance	B Body Motion	G Gain Control	P Place	Index
0	≤ 2 In ≤ 5 Cm			Hold Toss, Strike	0
1	Within Reach		Light Object Grip Light Objects Simo	Lay aside, Place Loose Fit (LF)	1
3	1-2 Steps	Bend And Arise 50% Occ	Non-Simo Heavy or Bulky Blind or Obstructed Disengage Interlooked Collect	Adjustment Light Pressure Joggle, Lf With Intermedite Moves	3
6	3-4 Steps	Bend And Arise	Very Heavy And Diffcult Grasp	Care Or Precision Heavy Pressure Blind Or Obstructed Search And Select	6
10	5-7 Steps	Sit Or Stand			10
16	8-10 Steps	Through Door Climb On Or Off			16

CONTROLLED MOVE							
ABG - MXI - A							
Index	M Move Controlled		X Process Time			I Align	Index
	Push/ Pull/ Pivot	Crank (Revs)	Seconds	Minutes	Hours	Object	
1	≤ 12 Inches (30cm) Button/ Switch/ Knob		0.5	0.01	0.0001	To one point	1
3	> 12 Inches (30cm) Resistance, Seat or Unseat High Control 2 stages ≤ 12 Inches (30 cm)	1	1.5	0.02	0.0004	To two points ≤ 4 Inches (10cm)	3
6	2 stages > 12 Inches (30 cm)	3	2.5	0.04	0.0007	To two points > 4 Inches (10cm)	6
10	3-4 stages	6	4.5	0.07	0.0012		10
16		11	7.0	0.11	0.0019	Precision	16

TOOL USE (FASTEN/ LOOSEN)											
ABG - ABP – U – ABP - A											
Index	Finger Action	Wrist Actions				Arm Action				Power tool	Index
	Spins	Turn	Reposition	Crank	Tap	Turn	Reposition	Crank	Strike	Screw Dia.	
	Fingers Screw Driver	Hand Screw Driver Ratchet T-Wrench	Wrench Allen Key	Wrench Allen Key Ratchet	Hand Hammer	Ratchet T - Wrench	Wrench Allen Key Ratchet	Wrench Allen Key Ratchet	Hand Hammer	Power Wrench Screw Dia Inches	
1	1	-	-	-	1	-	-	-	-		1
3	2	1	1	1	3	1	1	-	1	0.25" 6mm	3
6	3	3	2	3	6	2	-	1	3	1.0" 24mm	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

APPENDIX C MOST Template

WORK CATEGORY 1								
No	**Activities**	**Activities Sequence**	**Frequency**		**TMU**	**Time (Sec)**	**Normal Time**	**Standard Time**
			RF	**CF**				
1								
2								
3								
4								
5								
6								
7								

WORK CATEGORY 2								
No	**Activities**	**Activities Sequence**	**Frequency**		**TMU**	**Time (Sec)**	**Normal Time**	**Standard Time**
			RF	**CF**				
1								
2								
3								
4								
5								
6								
7								

APPENDIX D Turnitin Report

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