DEVELOPMENY OF A VISUAL DISPLAY AS A MONITORING SYSTEM TO CALCULATE OVERALL EQUIPMENT EFFECTIVENESS (OEE)

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MANAGEMENT



UNIVERSITI SAINS MALAYSIA

School of Mechanical Engineering

Engineering Campus

Universiti Sains Malaysia

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature	
Name	
Date	

Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by Universiti Sains Malaysia.

Supervisor's Signature	
Name	
Date	

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Last but not least, all the references that are related to this project, including journals, books and website are much appreciated.

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ABSTRAK

Dalam pembuatan global, industri-industri pembuatan dari negara-negara yang berbeza berusaha untuk meningkatkan prestasi mereka dengan meningkatkan produktiviti pengeluaran mereka untuk mengekalkan kelebihan daya saing antara persaingan yang sengit dalam perniagaan. Banyak industri pembuatan telah mennggunakan pelbagai jenis kaedah seperti "Overall equipment effectiveness", OEE untuk menambahbaikan produktiviti. OEE adalah petunjuk prestasi yang digunakan dalam pembuatan supaya membolehkan industri mengukur keberkesanan dan kecekapan mesin tertentu yang digunakan dalam industri. OEE merupakan pandangan metrik yang dibahagikan kepada kualiti, kesediaan dan pretasi mesin tersebut. Ia boleh digunakan dalam analisis supaya mengenal pasti sebab-sebab yang merosotkan prestasi mesin yang tertentu. Kertas kerja ini akan membentangkan pembangunan paparan visual sebagai satu sistem pemantauan untuk mengira OEE. Objektif kajian ini adalah untuk mengautomasikan kiraan OEE dan untuk membangunkan paparan visual OEE sebagai sistem pemantauan. Pembangunan sistem ini memainkan peranan yang penting kerana ia dapat menjimatkan masa untuk menganalisis dan mengenal pasti kerosotan asas. Selain itu, ia membantu untuk menjejaki trend OEE dari semasa ke semasa dalam carta garisan untuk menilaikan prestasi. Hasil kajian ini akan menyediakan metodologi membangunkan paparan OEE visual sebagai sistem pemantauan dengan menggunakan "Visual Basic Application", VBA.

ABSTRACT

In global manufacturing, manufacturers from different nations strive to improve their performance by enhancing their manufacturing productivity than another to maintain a competitive advantage in this harsh business environment. Many manufacturers have adopted different kinds of manufacturing tools and methods such as Overall equipment effectiveness, OEE to make improvements in the productivity. OEE is a standardized performance indicator used in manufacturing that allows the manufacturers to measure the effectiveness and efficiency of a particular equipment used in the production shop floor. OEE is a top view metric on the quality, availability and performance of an equipment. It can be used in further analysis by identifying the reasons or losses behind the poor performance of a particular equipment. This paper will present the development of a visual display as a monitoring system to calculate OEE. The objective of this study is to automate the OEE calculation and to develop a visual display of OEE as monitoring system. The development plays an important role because it is able to save the time for analyzing and identifying the underlying losses. Besides, it helps to track the trend of OEE of a particular equipment from time to time in a line chart to observe the performance. The outcome of this paper will provide methodology of developing visual display OEE as monitoring system by using Visual Basic Application, VBA.

Chapter 1 INTRODUCTION

This introduction section discussed about project background, problem statement, project objectives and project scope.

1.1 Project Background

In manufacturing, Key Performance Indicators (KPIs) is important to be developed to allow management to measure and to identify problem areas for improvement as well as track improvements over time. Overall equipment effectiveness, OEE, a common indicator helps to measure the manufacturing efficiency by monitoring the performance of equipment in floor. To further improve the data processing efficiency, a monitoring system that calculates the efficiency of production and automatically concludes in visual display is developed. This study aims to develop a visual display OEE as monitoring system to track the improvement of OEE and to solve the problem of manual data calculation which frequently suffers from serious accuracy issue.

1.2 Problem Statement

Overall equipment effectiveness (OEE), a common standard is being used to measure the effectiveness and efficiency of an equipment in manufacturing. OEE is a tool that helps to monitor and improve the manufacturing processes.

From Nakajima (1989), OEE measurement is an effective way of analyzing the efficiency of a single machine or an integrated manufacturing system. It is a function of availability, performance rate, and quality rate.

Traditionally, the production data are collected by the operators manually in log sheets. The log sheets are reviewed by the executive at the next daily production meeting and an OEE report is finally generated. Unfortunately, this traditional sequence takes some time to identify and analyze the root causes using OEE tool calculation. Thus, it is a time-consuming process before driving improvement on the plant floor. An OEE visual display is developed to help the industry by providing real time information instantly. Eventually the latest information on current floor's performance can be easily obtained by the staff. This thesis seeks to provide visual display of OEE as a monitoring system by applying VBA (Visual Basic for Applications) knowledge.

1.3 Objectives

The objectives of this project are:

- To provide a visual display of OEE calculation.
- To develop the monitoring system by using VBA knowledge.
- To automate data and OEE calculation.

1.4 Project Scopes

The duration of the project is 40 weeks. To achieve the project objectives, it is necessary to compile the collected downtime and information into the excel file and use VBA to develop an OEE data visual display.

OEE is calculated by multiplying Availability, Performance, and Quality. In this project it is needed to use Microsoft Excel to develop programming code using VBA. In developing the monitoring system it should involve historical data analytics besides current data analytic.

Chapter 2 LITERATURE REVIEW

This chapter will discuss OEE, six big losses, the formulas and description of each variables. Other than that, this chapter will provide the review from previous research that is related to this final year project. Even though OEE is important yet the studies conducted for visual display management are not many.

2.1 OEE

OEE is done by evaluation of three measurement metrics:

- Availability
- Performance
- Quality

2.1.1 Application of OEE

From Nakajima (1989), the OEE measure can be applied at several different levels within a manufacturing environment. Firstly, OEE can be used as a ``benchmark" for measuring the initial performance of a manufacturing plant in its entirety. In this manner the initial OEE measure can be compared with future OEE values, thus quantifying the level of improvement made. Secondly, an OEE value, calculated for one manufacturing line, can be used to compare line performance across the factory, thereby highlighting any poor line performance. Thirdly, if the machines process work individually, an OEE measure can identify which machine performance is worst, and therefore indicate where to focus TPM resources.

From New (2014), availability rate referred to the percentage of time of machine is ready to produce, working properly and not in the midst of changeovers. Performance rate is the ratio of output rate compared to a standard. Quality rate is the ratio of good output compared to total output. OEE is the product of availability rate, performance rate and quality rate.

OEE (%) = Availability rate × Performance rate × Quality rate

- Availability rate = *Run Time / Planned Production Time*
 - Run Time (Planned Production Time Stop Time), Stop Time includes breakdowns and planned stops like setup and changeovers.
 - Planned Production Time (Shift Length Breaks) does not include any planned maintenance and break time. Any setup, adjustment, and breakdowns are considered as stop time or down time.

Performance rate = (Total Count /Run Time) / Ideal Run Rate

- "The rule of ideal run rate is to use the best output rate known to be produced on the machine, regardless of whether that is above or below design speed. If a machine consistently outperforms its design spec, the performance rate will exceed 100% and potentially mask availability problems. On the other hand, if the machine has never been able to achieve its design spec, it's usually not helpful to use that as the standard. Any losses due to minor stoppages, idling, or slowdowns show up in the performance rate." (New, 2014)
- Quality rate = Good Count +Total Count.
 - Any defective or scrapped output has to be eliminated from good count.

2.2 The Six Big Losses

According to Nakajima (1989), the main losses are classified related to availability, performance, and quality. He established the "six big losses": (1) poor productivity and lost yield due to poor quality, (2) setup and adjustment for product mix change, (3) production losses when temporary malfunctions occur, (4) differences in equipment design speed and actual operating speed, (5) defects caused by malfunctioning equipment, and (6) start up and yield losses at the early stage of production.

The "six big losses" are associated to the lack of performance in equipment, as follows:

- Equipment failure /breakdown losses are categorized as time losses when productivity is reduced, and quantity losses caused by defective products.
- Set-up /adjustment time losses result from downtime and defective products that occur when production of one item ends and the equipment is adjusted to meet the requirements of another item.

The first two big losses are known as downtime losses and are used to help calculate a true value for the availability of a machine.

- Idling and minor stop losses occur when the production is interrupted by a temporary malfunction or when a machine is idling.
- Reduced speed losses refer to the difference between equipment design speed and actual operating speed.

The third and fourth big losses are speed losses that determine the performance efficiency of a machine, i.e. the losses which occur as a consequence operating at less than the optimum conditions.

- Reduced yield occurs during the early stages of production from machine start up to stabilization.
- Quality defects and rework are losses in quality caused by malfunctioning production equipment.

The final two losses are considered to be losses due to defects, the larger the number of defects the lower the quality rate of parts within the factory. (Nakajima, 1989)

Availability (downtime)	1. Equipment failure (breakdowns)
	2. Setup and adjustment
Performance (speed)	3. Idling and minor stoppages
	4. Reduced speed of operation
Quality (defects)	5. Process defects (scrap, repairs)
	6. Reduced yield (from startup to stable production)

Table 2.1: Six big losses

2.3 World Class OEE

World class OEE is a standard which is used to compare the OEE of the firm. The percentage of World Class OEE was given in Table 2.2 as provided by Kailas (2009). From Leflar (1999), worldwide studies indicated that the average OEE rate in manufacturing plants was 60%. World class OEE is considered to be 85% or better. The World Class OEE figure indicates to be a good benchmark for discrete manufacturers. However, improvements do not stop at this figure even OEE has achieved 85%.

Table 2.2: World Cla	ss OEE
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OEE Factors	OEE World Class
Availability%	90.0
Performance%	95.0
Quality%	99.0
OEE%	85.0

2.4 Previous Research

In order to evaluate and monitor the performance of floor efficiently, some researches have been conducted previously and several methods are adopted. Iowa State University (n.d.) developed a visual display of calculating OEE by applying VBA knowledge. It takes daily production data and develop a weekly OEE report for a work center that consists of four machines that make similar parts. Excel file is being used to compile downtime and quality and use VBA to develop an OEE data display for each machine. The purpose of this research is to provide the industrial engineering students with real world industry examples OEE with the application of VBA Excel. Therefore, this reference also lacks of user-interference. For example, it does not have input mode for the working hours input because every companies have their own standards. One limitation of this research is that the parameters for OEE have been defined one way here and may be defined differently at companies.

Naik, Raikar, Poornima, and Naik (2015) developed a simulation model for OEE computation have been designed and implemented. The crisp model and the fuzzy model in their research are based on fuzzy inference system (Mamdani) with triangular membership functions are implemented and compared. In their research, total nine different rules set in the model. For example, the fuzzy input variables machine down time and machine setup time are corresponds to the fuzzy output parameter availability. Finally all the fuzzy input according to the rules set to obtain an output distribution. The front end of the application model is implemented in VBA and the simulation model is presented in MS-Excel. It is observed that the fuzzy model deviates from the crisp model as the overlap of the member functions is increased. In the future, they would focus on development of fuzzy simulation model incorporating hybrid soft computing technologies such as artificial neural networks and fuzzy logic.

Fernandez (2016) designed and implemented a performance indicator inspired by the OEE philosophy on semi-automated production lines. At the same time, the author of this research developed a tool to display the information of the measured performance visually in the production lines. The tool developed to provide information and visuals about the time losses and the performances of the production lines. During data collection phase of this research, operators were required to write daily the launch objective given by the manager, the launch realized, the delivery realized, the NOGO (Breakdowns) undergone in the table named 'Objectives' and the number of products impacted by time losses in the corresponding lines of the table named 'Time Losses'. A Pareto chart displayed the different sources of time losses undergone on the line. The chart displayed in the tool developed by the author provide a visual identification on the areas where improvement actions have to be set up first. This thesis provides a methodology to implement performance indicators on semi-automated production lines. Nevertheless, it does not provide indications on how to implement a performance indicator to assess the productivity at the company level.

Wojakowski (2015) described the main features of visual management systems applied to track production state inside manufacturing cells. The description is restricted to the class of the systems called 'electronic andon system'. From the research, a more sophisticated visual displays are often used for andon systems today. The sophisticated message boards show line status at a glance (e.g. running, stopped, changeover or standby), secondly enable operators to call for help as needed. Under the andon system, it can control the process by providing information OEE factor which presents every kind of production losses in the form of percentage value. The research focuses on closed architecture andon system, it integrates with production asset track process. The challenge is to integrate many andon units into one consistent system. This problem generally concerns closed architecture andon systems, because data and information stored in the unit are isolated and unavailable for other systems.

2.5 Literature Findings

The major findings of the studies is more to OEE computation and visual display development instead of manual calculation. The concept of visual management is important and was applied in the other studies to highlight the results, outcomes and problems. Different studies have different approaches to create the OEE monitoring and display system. Wojakowski (2015) adopted implementation of installing electronic andon system with standard I/O modules which allows to connect the system to access production asset to track production according to cycle time between two consecutive parts leaving the production asset. Iowa State University (n.d.) used Excel, VBA knowledge, to develop a weekly OEE report for a work center that make similar parts. The system calculate the efficiency value and then write the values into a new sheet that will display all of the information. However, these two researches can be better if the data are organized in charts or graphs to help the users to easily evaluate the data. Fernandez (2016) provided information and visuals about the time losses and the performances of the production lines to users. Pareto chart is used to display the different sources of time losses undergone on the line. This thesis only provide implementation of a performance indicator inspired by the OEE but does not provide a methodology on how to implement a performance indicator to assess the productivity in a production line.

This study adopts Excel VBA as a tool in developing the visual display and monitoring system. This study has provided automated calculation for OEE for each machine and display in a form in numbers. Line chart and pie chart are also being designed in this system to enable the users have a visual display on the improvement of production machine. However, this study has some research gap between others research. This study is only able to evaluate performance of one particular machine. Besides, it does not like electronic andon system integrated with the production machine to display the OEE efficiency on a message board because this system is separated from the production machine and it is required users to collect and to key in data.

Chapter 3 RESEARCH METHODOLOGY

This chapter will explain a summary of research methodology that is being used to ensure the project conduct and working well. A flowchart, System Development Life Cycle (SDLC) that details the project work from beginning until the end is proposed. According to Radack (n.d.), the multistep process that starts with the initiation, analysis, design, and implementation, and continues through the maintenance and disposal of the system, is called the System Development Life Cycle (SDLC).

3.1 Proposed Solution

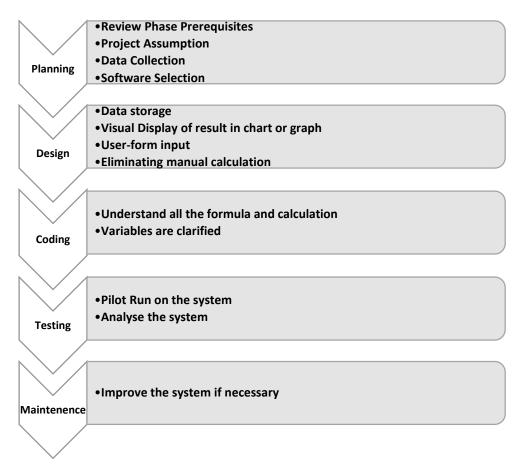


Figure 3.1: SDLC Flow Chart

Figure 3.1 shows the stages or methods involved in implementing this project from starting until the end. The above methods were used as a guide to ensure the success of this project.

3.2 Planning

Planning phase is the first phase in the SDLC. The planning phase reviews the objectives and project scopes as well as identify all the information. The planning phase involves four elements, review phase prerequisites, project assumption, data collection and software selection.

3.2.1 Review Phase Prerequisites

It is necessary to review the following prerequisites for this phase that was completed in the Research Plan:

- The needs for the project continues to be valid.
- The project scope and objectives are clearly defined and approved.
- The Gantt chart is fully defined.

3.2.2 Project Assumption

Project Assumptions are generally one of the factor to determine the success of the project. The assumptions are outside of the control of the project team. The assumptions are accepted as true or as certain to happen, without proof to generate a successful project.

In this project, it is assumed the values of data input for the system is created according industry's standard because it will not significantly affect the system.

3.2.3 Data Collection

Data collection is a stage that collects the information about the project resources and requirements, literature studies and the software to be used. The literature studies include the journal and research papers related to this project are collected and studied.

In planning, the research of this project related has been evaluated, which including the study about the OEE and the features of the system developed. The study is not just to evaluate the features of each studies but also evaluate the limitations. So the limitations can be addressed and eliminated to develop a sophisticated system.

3.2.4 Software Selection

The software chosen for this project is Microsoft Excel VBA which stands for Visual Basic for Applications. Excel VBA was chosen because it provides a visual display of the data collected by displaying the result in charts. Microsoft Excel is an extremely powerful tool that being use to manipulate, analyze, and present data.

Businesses and industries often rely on Microsoft Excel, VBA is originally integrated as part of the Microsoft Excel under Microsoft Office. This provides another advantages over other software because it is a common and popular resource in today's businesses.

The time for generating a report is extremely short as the result will be provided by just one clicking button in Microsoft Excel. The result and data can be stored in Excel database. Users can use Excel to easily gather and track data for the improvement in OEE monitoring system.

3.3 Design

In this stage, a flow diagram is developed logically to illustrate the workflow and algorithm. This is a crucial step as it provided a clear view on how to design the system.

To comply with the problem statement, this system is designed to automatically calculate the results and display in visual charts. Besides, for tracking the data, it is required to design a database storage so users can easily track back the data and result. In this system, an algorithm has been developed to save the data for monitoring and tracking.

The design approach clearly defines all the variables of the data inputs of the system. Users are only required to key in the data inputs without any extra calculation. The system would calculate and generate the result automatically once the data inputs are key in.

In order to make it user-friendly, user-form input is a must in designing this system for the users to key in the data.

3.3.1 Flow Diagram

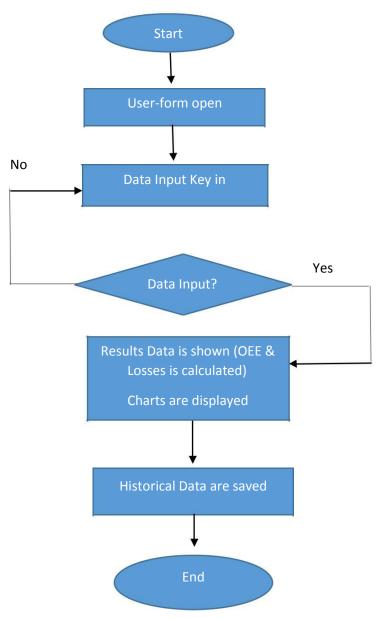


Figure 3.2: Flow Chart

3.3.2 Definition of Data

In the first stage, the simple data were defined before proceeding to the advanced stages. Data are divided into Input and Output Data.

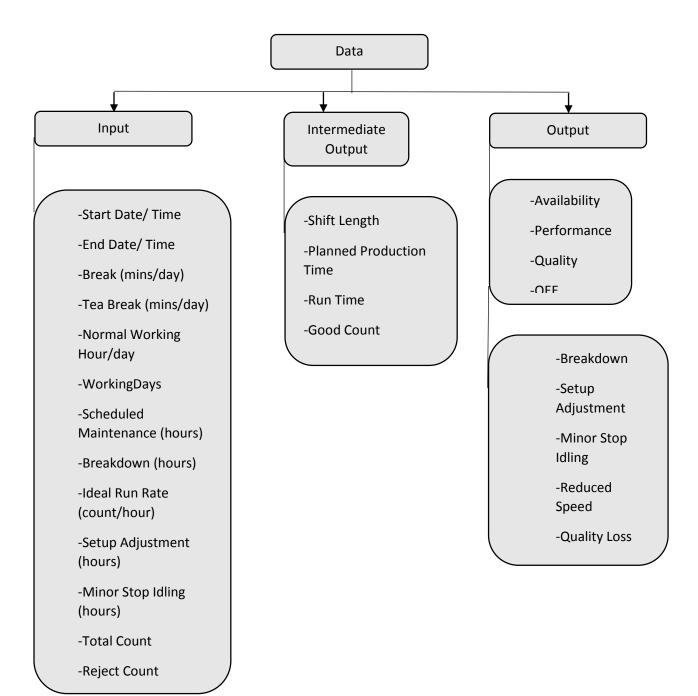
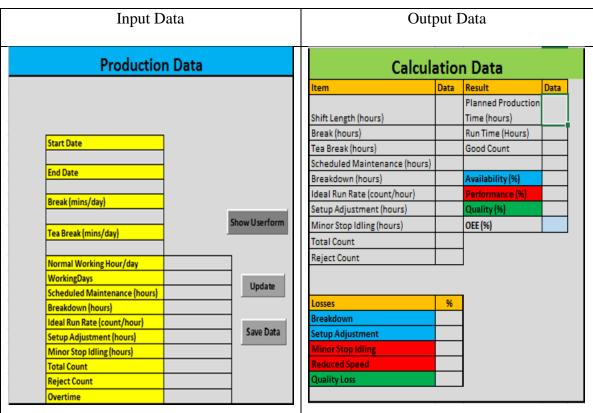


Figure 3.3: Definition of Data

Chapter 4

CODING IMPLEMENTATION

The coding was separated into 2 sessions which were worksheet and Userform. The code was initially assigned to worksheet and would be connected with Userform later. So users can fill in the information in Userform instead of worksheet.



4.1 Design Worksheet with VBA

Figure 4.1: Input and Output Data

Initially, an excel sheet was created and divided into Input and Output data as shown in Figure 4.1 above. In addition, three Buttons were added to implement coding. The code would be executed when the button was being clicked. By opening the tab "Developer", Button was formed by selecting "Button" located under "Form Control" from "Insert" as shown at Figure 4.2.

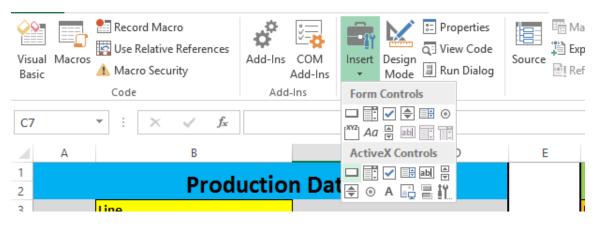


Figure 4.2: Development of Button

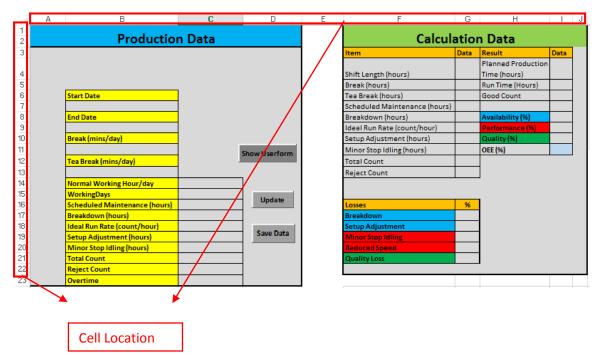


Figure 4.3: Cells Location of Data

Besides, all the cell locations of each data were well identified before entering the coding. The above Figure 4.3 showed the Excel sheet with all the data and information filled. It is important to identify all the locations cell of all data input and output because computer will not recognize the name but the location. For example, Cell B7 referred to Start Date which was required to be filled in by the users.

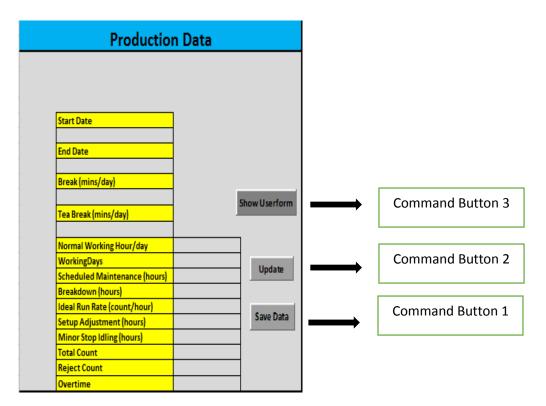


Figure 4.4: Creation of command buttons

Next, three command buttons were created in work sheet1 as shown in Figure 4.4. Command button was used to the code to perform an action by clicking on it. In work sheet 1, command button 1, 2 and 3 referred to Save Data, Update and Show Userform respectively. Users can change the name of the caption from "CommandButton2" to "Update" as shown in Figure 4.5.

(Marra)	Common d Button 2
(Name)	CommandButton2
Accelerator	
AutoLoad	False
AutoSize	False 💌
BackColor	&H80000010&
BackStyle	1 - fmBackStyleOpaque
Caption	Update
Enabled	True
Font	Calibri
ForeColor	&H80000012&

Figure 4.5: Changing Caption Name of Command Button

4.2 Design of Update Button in Worksheet

To perform the calculation automatically when button was clicked, VBA code was required to be added inside the "Update" command button. At first, the input, intermediate output and output data were declared as variables as shown Figure 4.6. Variables represented the value of information that could be changed but the operation remains.

Next, the formulas of the number of working days, total break and tea break hours were defined as shown in Figure 4.7. So, the users have to key in the Start Date and End date information, the formulas would be executed and provided the calculation of number of working days, total break and tea break hours.

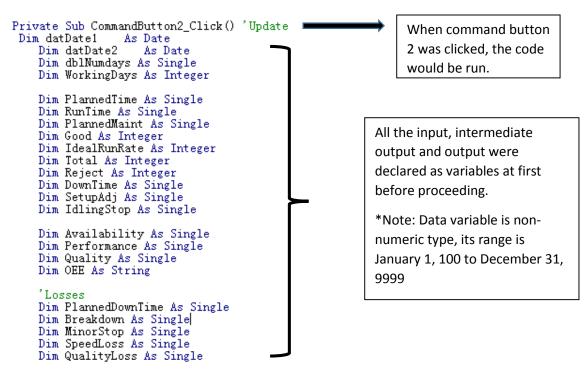


Figure 4.6: Declaration of Data input and output

Variables datDate1 and datDate2 would receive their data entered by the user into Cell B7 and B9 respectively

WorkingDays was roundup and when it was equal or larger than 1 Then Shift Length = (WorkingDays *

```
datDate1 = [B7]
datDate2 = [B9]
```

```
dblNumdays = (Abs(datDate1 - datDate2)) + 1
WorkingDays = Application.WorksheetFunction.RoundUp(dblNumdays, 0)
```

```
Cells(15, 3).Value = WorkingDays
Cells(5, 7).Value = (Cells(11, 2).Value * WorkingDays) / 60 'Breaks calculation
Cells(6, 7).Value = (Cells(13, 2).Value * WorkingDays) / 60 'Teatime calculation
If WorkingDays >= 1 Then
Cells(4, 7).Value = (WorkingDays * Cells(14, 3).Value) + Cells(23, 3).Value 'shift length
```

End If

Figure 4.7: Formulas of Data

Let j = 7 Let i = 16 PlannedMaint = Cells(i, 3).Value Cells(j, 7).Value = PlannedMaint DownTime = Cells(i + 1, 3).Value 'Down Time (hours) Cells(j + 1, 7).Value = DownTime IdealRunRate = Cells(i + 2, 3).Value 'Ideal Run Rate (count/hour) Cells(j + 2, 7).Value = IdealRunRate SetupAdj = Cells(i + 3, 3).Value Cells(j + 3, 7).Value = SetupAdj IdlingStop = Cells(i + 4, 3).Value Cells(j + 4, 7).Value = IdlingStop Total = Cells(i + 5, 3).Value 'Total Count Cells(j + 5, 7).Value = Total Reject = Cells(i + 6, 3).Value 'Reject Count Cells(j + 6, 7).Value = Reject

Figure 4.8: Location of Data Variable

The input data were defined according to the location cell of Sheet1 in Figure 4.8. Ideal Run Rate was taken as an example. Ideal Run Rate was firstly defined under "Production Data", this variable would receive the data entered by the user into Cells (18, 3) as shown in Sheet 1. At the same time, the data entered in Cells (18, 3) (Production Data) would also be transferred to Cells (9, 7) (Calculation Data) as shown in Figure 4.3.

```
RunTime = PlannedTime - (DownTime + SetupAdj) 'RunTime = PlannedTime-(Breakdown+SetupAdj)
Cells(5, 9).Value = RunTime
Good = Total - Reject 'Cells(9, 7). Value - Cells(10, 7). Value 'Good Count=Total Count-Reject Count
Cells(6, 9).Value = Good
Availability = (RunTime / PlannedTime) * 100
Performance = ((Total / RunTime) / IdealRunRate) * 100
Quality = (Good / Total) * 100
OEE = (Availability * Performance * Quality) / 10000
Cells(8, 9). Value = Availability
Cells(9, 9).Value = Performance
Cells(10, 9).Value = Quality
Cells(11, 9).Value = OEE
'Losses
Let x = 17
Cells(x, 7).Value = (DownTime / PlannedTime) * 100
Cells(x + 1, 7).Value = (SetupAdj / PlannedTime) * 100
Cells(x + 2, 7).Value = (IdlingStop / RunTime) * 100
Cells(x + 3, 7).Value = (((Good / (Total / RunTime)) - (Good / IdealRunRate)) / PlannedTime) * 100
Cells(x + 4, 7).Value = Reject / Total * 100
```



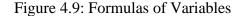


Figure 4.9 shows the formulas of each variables so it could perform calculation when a value was assigned to these variables. The formulas of variables were defined as below Table 4.1 and 4.2. When input data were entered, it would perform calculation and show on Sheet 1 under "Calculation Data" as output data.

PlannedTime = Cells(4, 7).Value - (Cells(5, 7).Value + Cells(6, 7).Value + PlannedMaint) ' Planned Prod Time=ShiftLength-(Break+Teatime+Planned Maintenance) Cells(4, 9).Value = PlannedTime

Table 4.1: Output Variables Formulas

Output Variables Formulas

Planned Production Time = Shift Length - (Break + Teatime + Planned Maintenance Time)

Run Time = Planned Production Time- (Breakdown + Setup Adjustment)

Good Count = Total Count – Reject Count

Availability = (Run Time / Planned Production Time)

Performance = ((Total / Run Time) / Ideal Run Rate)

Quality = (Good / Total)

OEE = (Availability * Performance * Quality)

Table 4.2: Losses Formulas

Losses Formulas
Breakdown = (Break Down Time / Planned Production Time)
Setup Adjustment = (Setup Adjustment / Planned Production Time)
Minor Stop Idling = (Idling Stop Time / Run Time)
Reduced Speed = (((Good Count / (Total Count/ RunTime)) - (Good Count/ IdealRunRate)) /
Planned Production Time)
Quality Loss = Reject / Total Count

4.3 Designing of Save Data Button

С	D	E	F	G	н	J	К	L	М	N
						Losses %				
Start Dat 👻	End Date 🔻	Availability % 🔻	Performance % 🔻	Quality % 🔻	OEE %	Breakdow 👻	Setup Adjustme 🔻	Minor Stop Idling 👻	Reduced Speet *	Quality Loss 💌

Figure 4.10: Historical Data Sheet

```
Private Sub CommandButton1_Click() 'Save Data Button
Dim Startdate, Enddate As Date
Dim Availability, Performance, Quality, OEE As Single
Worksheets("Sheet1").Select
Startdate = Range("B7")
Enddate = Range("B9")
Availability = Range("I8")
Performance = Range("I8")
Quality = Range("I10")
OEE = Range("I11")
Breakdown = Range("G17")
Setup = Range("G18")
MinorStop = Range("G19")
ReducedSpeed = Range("G20")
QualityLoss = Range("G21")|
```

Figure 4.11: Definition of cell location in Sheet 1

After clicking the "Update" button, the data of input and output would be displayed in Sheet 1. A "Save Data" button was then executed by clicking "CommandButton1" button and has data saved to a Sheet 3 from Sheet 1 in Excel. In creating the "Save Data" button, a new sheet, Sheet 3 was created and all the variables name were entered as shown in Figure 4.10's red box.

In Sheet 1, a "Save Data" Button was created by inserting Command Button under Active X controls. Next, users could click on the command button to open the Visual Basic Editor after making sure design mode was pressed. After opening the Visual Basic Editor, each variables were defined as shown in Figure 4.11. The variables were defined with Range function that specified the value of a cell or a range of cells in Sheet 1 spreadsheet.