A CASE STUDY OF THE IMPROVEMENT IN BATIK PRODUCTION

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UNIVERSITI MALAYSIA PAHANG

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I hereby declare that the work in this report is my own except for the quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATION

This thesis is dedicated to my parents, Hassan Bin Dun and Mek Nah Binti Mat. They give a lot of support to me while I do my research. They give an encouragement and unconditional all this time. They provided me strengths and determination to move through the final stages of this process. They are the reasons why I keep going until I done this research. Besides that, this dissertation is also dedicated to my siblings, friends and classmates. They are so kind and helpful. They often shared what they have done and never hesitated to help me in my research. Special appreciation I would like to dedicate this thesis to my supervisors, Mr. Wan Noor Sarbani Bin Mat Daud who give me a lot of advice and suggestion throughout my study. Thank you.

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ABSTRACT

The process improvement in producing batik is an important aspect for the development of Malaysian SMEs. The unwanted process in production of batik can affect the company's image and also involved the customer dissatisfaction. The aim of this research is to identify the critical process in production of batik and at the same time some improvement plan can be recommended. The scope of this study is focusing on production line of batik such as the process flow, workstations involved, footsteps, resource capacity, cycle time and etc. A quantitative data are collected through the site visit of Batik RM Company. The results of this research show that company is facing a problem with total average time at each of the workstations. From the research that has been done, proves that kaizen activities and line balancing improve the productivity and process improvement. However, to achieve more successful and effective improvement, further work standardization on each process is needed. This study is conducted by using the time study and using Microsoft Excel software to solve it.

ABSTRAK

Peningkatan proses dalam penghasilan batik merupakan aspek penting bagi pembangunan PKS di Malaysia. Proses yang tidak diingini dalam menghasilkan batik boleh menjejaskan imej syarikat dan juga menyebabkan ketidak puas hatian pelanggan. Tujuan kajian ini adalah untuk mengenal pasti proses yang kritikal dalam menghasilkan batik dan pada masa yang sama beberapa pelan peningkatan boleh disyorkan. Skop kajian ini memberi tumpuan kepada pengeluaran keseimbangan dalam menghasilkan batik seperti aliran proses , stesen kerja yang terlibat, jejak langkah, kapasiti sumber , masa kitaran dan lain-lain. Data kuantitatif dikumpul melalui lawatan industri ke syarikat Batik RM. Hasil kajian ini menunjukkan bahawa syarikat sedang menghadapi masalah dengan masa purata di setiap stesen kerja. Daripada kajian yang telah dilakukan, membuktikan bahawa aktiviti kaizen dan mengimbangkan talian meningkatkan produktiviti dan penambahbaikan proses. Walau bagaimanapun, untuk mencapai peningkatan lebih berjaya dan berkesan , piawaian kerja selanjutnya kepada setiap proses diperlukan. Kajian ini dijalankan dengan menggunakan kajian masa dan menggunakan perisian Microsoft Excel untuk menyelesaikannya

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INTRODUCTION

1.1 INTRODUCTION

Small Medium Enterprise (SME) play a significant role in the national economy, there is a need to help them improve their competiveness. Mostly, SMEs operate with poor forecasting and planning systems and long cycle times. These will affect the delivery performance of the SMEs. SME is due their small size, limited managerial capabilities, as well as limited resources do face a challenging task in innovating and as compared to larger firms are weakly structured in innovation, low market power and scarcity of resources in order to appropriate the benefit of their innovation. It is not surprising then, that SMEs in developing countries have been labeled as imitators rather than innovators. The situation is however different in developed countries such as the United States of America. It is important for SMEs to implement materials management systems based on Material Requirements Planning (MRP), Just In Time (JIT) / Kanban concepts together with implementation of Kaizen.

The focus of the study based on the production process improvement of making batik. Implementation of Kaizen helps to increase productivity in a company. Productivity is usually defined as output over input, for example correctly produces products that fulfill their specifications over the value of all resources spent for producing these products during specific time period (Tangen, 2005). An effective regime of productivity measurement is essential for the management of a productivity

improvement programme. A productivity measurement system enables an organization to formulate goals and targets with regard to productivity and to identify problems areas of the organization. The measurement system should specify the desired outputs and output levels, and work to the required inputs and input levels. Key, relevant performance indicators such as delivery times, quality, lead times, and equipment utilization and so on may be part of the overall measurement programme.

In this research, one of the improvement tools from Japanese which known as Kaizen will be discuss. For instant, Kaizen is a system that involves the worker from upper management to lower operators. Everyone is encouraged to come up with a small improvement to gain profit for the company. Kaizen focuses on eliminating waste, improving productivity, and achieving sustained continual improvement in targeted activities and processes of an organization.

Even though there are continuous and great demand from customer, but there are still a problems in the production of Small and Medium Enterprise (SME) that need to overcome. A bottleneck in operations management occurs in sequential manufacturing when a backup happens in one step of the sequence. For example, if there are three machines on an assembly line and the first and last machines can produce 120 units per hour, but the second machine can produce only 80 units per hour, it will cause a bottleneck to occur. This is because the second machine cannot produce enough units to keep pace with the other machines. A bottleneck has a terrible effect on the efficiency of production. The stages following the bottleneck must function below their capacity because they do not receive enough input to operate at full capacity. The stages before the bottleneck need to slow down production because the subsequent stages cannot handle the capacity. As a result, the overall efficiency of the system is significantly reduced.

A bottleneck in the manufacturing process can be difficult to identify in a complex system. The bottleneck can be found by looking at each sequence of the process individually and measuring the production level at each step. If a particular sequence has a low production level then it is the source of the bottleneck. It should be noted that there can be multiple bottlenecks within a complex system. According to Wendel Clark, a bottleneck can be solved by adjusting the production level in the

sequence where the bottleneck is happening. This might be achieved by installing more efficient equipment or, re-layout and combine workload. In some situations, it may not be possible to increase production in that area and it may be more efficient to reduce production capabilities in the other areas in order to create efficiency.

Thus it is important to increase the customer satisfaction by removing bottleneck in the production and implementation of Kaizen. Effectiveness of Kaizen is a powerful tool to reduce cycle time of the production line or assemble line. The purpose to reduce cycle time is to produce products on-time which will fulfill the customer demand and low work-in-progress costs. This will increased satisfaction for customer. As a conclusion, implementation kaizen and doing line balancing is necessary in production line or assembly line to reduce cycle time in production of batik.

1.2 PROBLEM BACKGROUND

People who claim to be discussing productivity are actually looking at the more general issue of performance. Even though productivity is a multidimensional term, one has to remember that it is a fairly specific concept related to the ratio between output and input. Performance, on the other hand, is an even broader term that covers both overall economic and operational aspects.

Improving productivity is now a complex process of manipulating business levers in concert. Often, profitable production is a matter of choosing between adding capacities or increasing the capacity of the current production line. By working closely with production experts, there will be a clear picture of what has to be done. There are a few reasons of failed productivity improvement programs. One of the reasons is the work are not standardized on each of the process. Improving standardized work is a never-ending process. Without standardized work, continuous improvement activities are not manageable due to process in a constant of change cannot be improved. Basically, standardized work consist of three elements standard inventory including units in machine that required it keep the process operating smoothly, takt time which is the rate at which products must be made in process to meet the customer demand and precise work sequence in which an operator tasks within takt time.

Besides that, there are few problems regarding to layout design for small and medium enterprise company. When a co-worker is constantly moving in their own way because of a poorly designed plan, the results can be frustrating and deleterious to the company bottom line. An efficient layout will allow each station in the company to function independently from one another. If the worker is walking two extra steps to produce the products, that waste could equate to paying another employee over time. If

the company layout allows to function with two employees rather than three, or three rather than four; the labor savings will add up quickly.

In addition, worker needs to make sure that whether the work is clearly assigned and divided between each of them. The workload must be regularly monitored to ensure that an imbalance work is not occurring between the two parties. Besides that, clear lines of responsibility and decision making must be drawn up to avoid any confusion around who takes the lead on specific tasks. An excellent channel of communication must be in place between the employees undertaking the workload. Participation in decision making and providing feedback must not be neglected. Besides that, an excellent communication will be needed to avoid misunderstandings, inaccuracies or a failure to relay important information so that there will be a continuous improvement to produce batik.

Often, there are no proper schedule and planning in small and medium enterprise in producing batik. Company will concentrate in short term approaches to productivity improvement – at the expense of the longer term. It is easy to plan for the short term on a reactive basis; longer-term planning needs a significantly higher degree of proactivity, unfortunately too often lacking in management teams. It is still too typical to see a concentration of improving breakdown maintenance rather than looking more carefully at what can be achieved with preventive maintenance. Inappropriate or unclear productivity goals can have a significant negative effect on an improvement programme. In addition, there will be problems if productivity improvement skills and expertise are lacking.

For a conclusion, many problems currently occur in production of traditional batik such as high work-in process, over process in production line, narrow and unsystematically layout, too much operator in charge of a process and not enough skill of operators. It takes cost and time in the producing of batik. So, by implement kaizen and line balancing, it may reduce cycle time and improve production line so that customer satisfied with the service provided.

1.3 PROBLEM STATEMENT

In order to achieve highly productive production line, an optimum amount of workstations and labor needed to be determined. Small and Medium Enterprises (SME) company have few problem and difficulties which are still unsolved such as the improper environment of working area, continuous waste in the processing area. These situations occur because there is no professional position in the company such as their management to monitor and solve problems in the processing line and no continuous improvement. The productivity of a company is an important factor for its success in aggressive on the global market.

The following are some of the specific issues that time study is used to address in producing batik. The need for and the quantity of equipment and personnel number, type, and layout of machines for a particular objective, support equipment, evaluation of the effect of a new piece of equipment on an existing production system, labor requirements planning and number of shifts.

There are several different ways to make modern and traditional batik. There are differences in terms of technology. In the previous days we need to apply wax and dyes to fabric to achieve intricate and colorful patterns. However, due to industrialization in the early 20th century, batik cap emerged in Batik Industry. The batik cap is where the wax is applied using a copper stamp, called cop instead of being hand-drawn onto the fabric. A quantity of batik output in traditional manufacturing produced is limited. When the process is not smooth, the profit received also will not be encouraging. Besides, there are problems in the layout for this small and medium enterprise.

Based on the background study, another problem of the production of traditional batik is their long cycle time at the production line. Then, there should be a line balancing study. Implementation of kaizen will help to continuous improvement. Line balancing will be able to evaluate and optimize the line throughput, machine utilization and cycle time. For a conclusion, longer cycle time of production line will reduce company's profit and time for the service to the customer. An improvement for the industry need to be reviewed so that it would look efficient in the future.

1.4 RESEARCH OBJECTIVE

In order to explore the objectives of the research are as follows:

1) To identify the critical process in the producing of Batik.
2) To propose improvement that can increase productivity in producing Batik.

1.5 RESEARCH QUESTIONS

1. What are the bottlenecks in producing 'Batik'?
2. How to improve productivity in producing 'Batik'?

1.6 SIGNIFICANCE OF STUDY

The research aims to identify the problems and bottlenecks at the production line of producing batik. This study was conducted to improve productivity in producing batik by reduce the cycle time. To solve the problems in production SME Company, implementation of production and line balancing is an important way to be concern. Line balancing technique is used to balance workloads in the production line. However, implementation of kaizen is a never ending improvement to create momentum for a lasting success in the company.

1.7 SCOPE OF STUDY

The scope of this research is time study for a production line of traditional batik such as the process flow, workstations involved, footsteps, resource capacity, cycle time and etc. For this research, a small and medium enterprise in producing of batik in Kuantan, Pahang is selected as the scope. This research presents the case study in a local SME company about the way to improve the productivity in producing batik and the problem background. The technique use is by using a simple kaizen concept. Furthermore, line balancing was use to re-balance the line so that the process cycle time could be reduce. The information data about the process flow in each workstations and cycle time for all process was collected. This significance of study is to identify the problem facing in the company and the technique or tools that used to reduce cycle time in the production of batik.

1.8 OPERATIONAL DEFINITION

An operational definition defines something like variable, term, or object in terms of the specific process or set of validation tests used to determine its presence and quantity. For this study, there will be some of operational definition such as:

1. Productivity improvement

In making 'batik', the productivity improvement is a ratio of production output to what is required to produce it inputs of capital, labor, land, energy, materials.

2. Continuous improvement

It is defined as an ongoing effort to improve products, services, or processes. Delivery processes are constantly evaluated and improved in the light of their efficiency, effectiveness and flexibility.

3. Critical process

Business process that must be restored immediately after a disruption to ensure the affected firm's ability to protect its assets, meet its critical needs, and satisfy mandatory regulations and requirements.

4. Bottleneck

A bottleneck is a phenomenon where the performance or capacity of an entire system is limited by a single or limited number of components or resources.

5. Cycle Time

The period required to complete one cycle of an operation; or to complete a function, job, or task from start to finish. Cycle time is used in differentiating total duration of a process from its run time.

6. Kaizen

Kaizen means improvement, continuous improvement involving everyone in the organizations from the top management, to managers then to supervisors, and to workers.

7. Line balancing

Line balancing is leveling the workload across all processes in a cell or value stream to remove bottlenecks and excess capacity. A constraint slows the process down and results if waiting for downstream operations and excess capacity results in waiting and absorption of fixed costs.

1.9 EXPECTED RESULT

1) The process step in making batik will be decrease.

Last time, it will takes a long time to make batik from the early process the materials until the process of making batik but with this research, the process step in making batik will be decrease to one or two steps.

2) The cycle time to make batik will be decrease.

Cycle time is the total elapsed time required to complete a business process. Cycle time reduction has become a key area of opportunity for organizations that are under increasing pressure to get more done with fewer resources in order to remain competitive. By reducing cycle time organizations can reduce cost, increase quality, and improve customer service.

3) The capacity of the output will be increase.

Measuring the capacity of output is an important basic business metric used to gauge overall production trends and monitor the business performance relative to the resources invested in production.

4) Good knowledge to those wants to make batik widely.

More in-depth study of this research will lead to the extensive knowledge in the manufacturing of batik thus promote SMEs to international level.

5) Better layout

By re-layout the design and additional of equipment, the process time to making batik will be reduce. Besides that, reduce the movement that does not add value can increase the productivity of the products.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will review the relevant literature that had related to the assumptions of this research. Thus, it will discuss the ways to reduce cycle time in production of traditional batik. It is useful to understand the term of cycle time in the production line. There will be some quality tools that will be discussed in this chapter.

2.2 SMALL AND MEDIUM ENTERPRISE (SME) IN MALAYSIA

In Malaysia, SMEs are generally defined based on fixed quantitative criteria such as the number of employees, amount of assets, amount of capital and sales turnover. As pointed out earlier, different organizations have different perceptions and definitions of an SME. Previously, the Coordinating Council for Development of Small-Scale Industry (CCDSI), which acted on behalf of Division of Small Enterprise in the Ministry of Trade and Industry (MITI), defined SMEs as enterprises with fixed assets of less than RM 250,000 or in the case of companies, the shareholders' fund not exceeding RM 250,000.

Under the Industrial Coordination Act 1975 (Amendent 1986), the promotion of Investments Act 1986 and as noted in the Bank Negara's lending guidelines, SMEs are defined as enterprises with net assets or shareholders' funds of not more than RM 2.5 million (Malaysia, 1998). Under this definition, a firm with shareholders' funds of less than RM 500,000 is considered as small, whereas a firm with shareholders' funds of between RM 500,000 to RM2.5 million is labeled as medium-sized. Other definition of SMEs in this country are one provided by the former Small-Scale Industry Division of MITI. According to this definition, an enterprise with assets or shareholders' funds of between RM 500,000 to RM 2.5 million and employ full time employees or between 5-100 employees is an SME. However, according to Taj (2006) SMEs can be classified into three categories which is Manufacturing, Agro and Manufacturing-Related Service industries.

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2.2.1 APPROVED SME DEFINITIONS

Manufacturing, Agro and manufacturing-Related Services industries.

General Definition

A small and medium enterprise in manufacturing (including agro-based) on MRS is an enterprise with full-time employees not exceeding 150 or with annual sales turnover not exceeding RM 25 million.

Specific Definitions:

- A medium enterprise in manufacturing (including agro-based) and MRS is an enterprise with full-time employees of between 51 and 150 or with annual sales turnover of between RM 10 million and RM 25 million.
- A small enterprise in manufacturing (including agro-based) and MRS is an enterprise with full-time employees of between 5 and 50 or with annual sales turnover of between RM 250, 000 and less than RM 10 million.
- A micro enterprise in manufacturing (including agro-based) and MRS is and enterprise with full-time employees of less than 5 or with annual sales turnover of less than RM 250, 000.

2.3 WHAT IS KAIZEN?

Kaizen, focuses on eliminating waste, improving productivity and achieving sustained continual improvement in targeted activities and processes of an organization. Kaizen was created in japan following World War II. The word Kaizen means continuous improvement. It comes from Japanese word (kai) which means “change” or to “correct” and (zen) which means “good”. According to Imai (1986), Kaizen is a system that involves every employee which from upper management to the bottom operator. Imai said that Japanese management practices succeed simply because they are good management practices.

Some of the key objectives of the Kaizen philosophy include the elimination of waste, quality control, just-in-time delivery, standardized work and the use of efficient equipment. An example of the Kaizen philosophy in action is the Toyota production system, in which suggestions for improvement are encouraged and rewarded, and the production line is stopped when a malfunction occurs. The kaizen philosophy is to do it better, make it better, and improve it even if it isn’t broken because if we don’t, we can’t compete with those who do.

2.3. 1 Kaizen as methods for work process improvement

There are five methods to gain the process improvement for the Kaizen which is define, measure, analyze, improve and control.

Analyze

- Define product group, and identify the customer demand

Measure

- Map the product and information flow.

Analyze

- Determine bottleneck and process efficiency

Improve

- Streamline process flow and eliminate waste

Control

- Develop system to meet takt time and zero work in process.

The basic mechanism for the kaizen approach makes any possible improvements under the PDCA (plan-do-check-act) cycle, standardizes the improvements, and continues for another PDCA cycle. With quality improvement activities, managers and workers are encouraged to use innovation and risk-taking as an opportunity so that will be better meet the customers' requirements. Kaizen methods have in common:

(1) Involve at minimum, the workers who execute a work process
(2) Focus on improving the performance of the work process
(3) Seek to make incremental improvements
(4) Intended to be repeated over time.

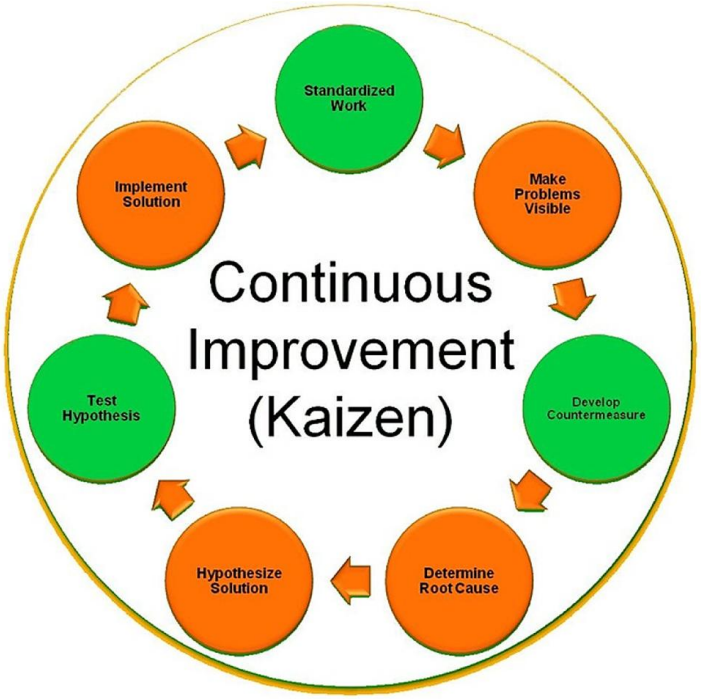


Figure 2.1: Kaizen continuous improvement

Source: www.pinterest.com

2.4 CONCEPT OF PRODUCTIVITY IMPROVEMENT

It is important to provide a precise definition of the concept of productivity (Diewert, 1992). Productivity is a measure of the rate at which inputs are transformed into output. Productivity therefore provides the technical relationships that exist between inputs and0outputs. It is a measure of technical efficiency not economic efficiency. According to Thomas and Baron (1994), many people who claim to be discussing productivity are actually looking at the more general issue of performance. Even though productivity is a multi-dimensional term, one has to remember that it is a fairly specific concept related to the ratio between output and input.

The level of productivity within a firm or an industry depends on labor, capital and the state of technology. Productivity growth over time will reflect the growth in these factors over time. The most common measure of productivity usually used is labor productivity or output per person employed or per hour worked. Conceptually hours worked is better measure because this takes into account both changes in persons employed and overtime worked standard weekly hours, leave taken and the proportion of part-time workers. However hours worked can be difficult to measure and are different from paid-for hours. Workers are often paid for standard weekly hours without being fully utilized (Ball and St Cyr, 1966). In recent times there is ample evidence to suggest that working overtime without being paid for is quite wide-spread in Australia. (Wooden, 2001)

Productivity is measured in terms of output. Output is most commonly measured in terms of value but in some cases physical units are also used. Production in terms of value can be measured ether as the real value of turnover or the real value added. However turnover does not provide a precise measure of productivity as it incorporates a fair amount of double counting due to value added by bought in inputs. Therefore production is0measured as the real value-added by the industry. Value added is defined as sales less the cost of raw materials, services and components to produce them. Data on value added is deflated by an index of domestic transaction prices to obtain the real value added. When output is defined as value added, the factor inputs are labor and capital (Muellbauer, 1991).

2.4.1 Defining Productivity

An organization can be seen as a system, using inputs (labor, material, and capital, and energy, information) to deliver outputs to their external customers (products, services). This system view can also be applied to individual departments, teams providing products or services to internal customers. Productivity is the link between this output and the inputs. Total Productivity is defined as the relationship between the quantity of the outputs, produced by the system during a time period and the quantity of resources (inputs) used for this during the same time period. Below are some illustration that researcher get about the definition of productivity.

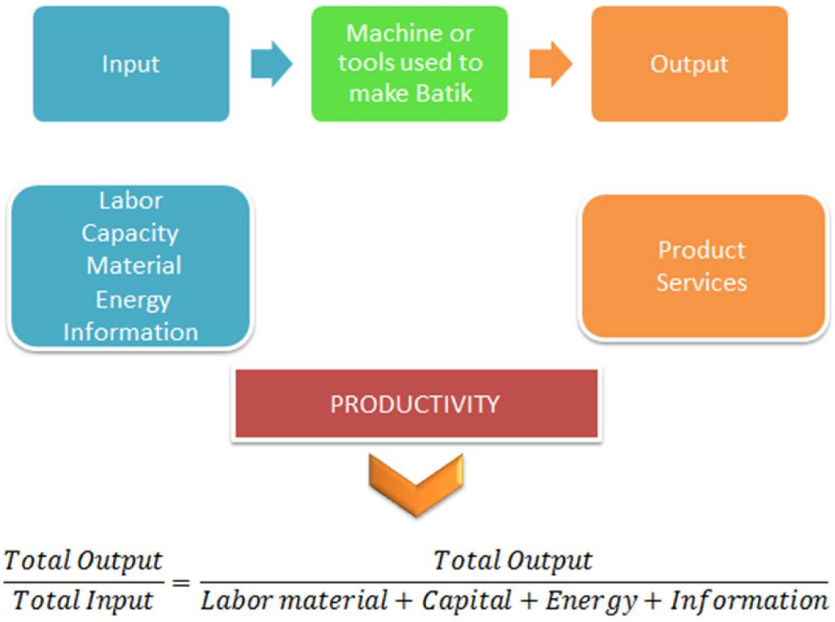


Figure 2.2: Illustration Definition of Total Productivity

2.5 CYCLE TIME

In each manufacturing industry, there will be a period required to complete one cycle of an operation or a task. This cycle of a task from its beginning to finish is cycle time. In the study of Dima Nazzal (2006), he pointed that the cycle time of a finished wafer is the time between the releasing of the wafer into the wafer fabrication facility (fab) and the time it is complete. However, in this study the cycle time of the assembly line in automotive industry is different than the wafer. In encyclopedia of management, time has become a key success measure in business. Different perspective will have different view of cycle time, those are:

i. An order processing cycle time, it is used in front office to determine the total time required to process an order.
ii. From a financial perspective, there are terms like cash-to-cash cycle time which is describing on the amount of time a company takes to recover its financial investment.
iii. Production cycle time, it is the time form when an order is released on the production floor until the completion and shipment to the customer.

2.5.1 Cycle Time Reduction Approach

Cycle time reduction is inherently different from traditional cost cutting approaches to profit improvement. It enables rather than diminishes an organization's ability to compete, by strengthening a company's core capabilities and by developing the dimension of time as a new strategic weapon. Slashing cycle time is the fastest and most powerful approach to profitability improvement, especially for companies who have already realized most of their core manufacturing efficiency improvement opportunities. Cycle time reductions will directly impact almost every contributor to costs within your operations.

2.5.2 Calculating Cycle Time

Cycle time describes how long it takes to complete a specific task from start to finish. This task may be to assemble a widget or answer a customer service phone call. Now, you can get fancy and segregate value added cycle time from non-value added cycle time if you'd like. Cycle time can be measured with a stop watch. Take the units required (demand or production rate) per day and divide it into the productive time available per day (in minutes or seconds). This operations gives us what is called the cycle time-namely, the maximum time allowed at each workstation if the production rate is to be achieved.

$$Cycle\ time = \frac{\text{Productions time available per day}}{\text{Units required per day}}$$

2.6 LINE BALANCING

Line Balancing (LB) is the problem of assigning the operations to workstations along an assembly line in such a way that the assignment be optimal in some sense. Line Balancing is leveling the workload across all processes in a cell or value stream to remove bottlenecks and excess capacity. A constraint slows the process down and results if waiting for downstream operations and excess capacity results in waiting and absorption of fixed costs.

2.6.1 Steps Involving in Line Balancing (LB)

In a study on the teaching and learning of mechanical engineering (Hazmil, 2008) based on G.Andrew (2006), there are some steps to solve linear balancing:

I. Drawing Precedence Diagram

Precedence diagram needs to be drawn a connection between a workstations. Certain process begins when previous process was done

II. Determining Cycle time

Cycle time is the long set time allowed at each workstation. This can be expressed by the formula of available time / desired output which means the products needs to leave the workstations before it reach its cycle time.

III. Assigning tasks to workstations

IV. The task allocations should be taken after completing a time cycle. It's good to allocate tasks to workstations in the order of longest task times.

$$Number\ of\ workstations = \frac{Sum\ Task\ time}{Desired\ Actual\ Time}$$

V. Calculating and Efficiency Line

This will carried out in next chapter to find how effectiveness the line. The formula is given by:

$$\text{Line efficiency} = \frac{Sum\ Task\ time}{(\text{Number of workstations}) \text{ x desired cycle time x } 100\%}$$

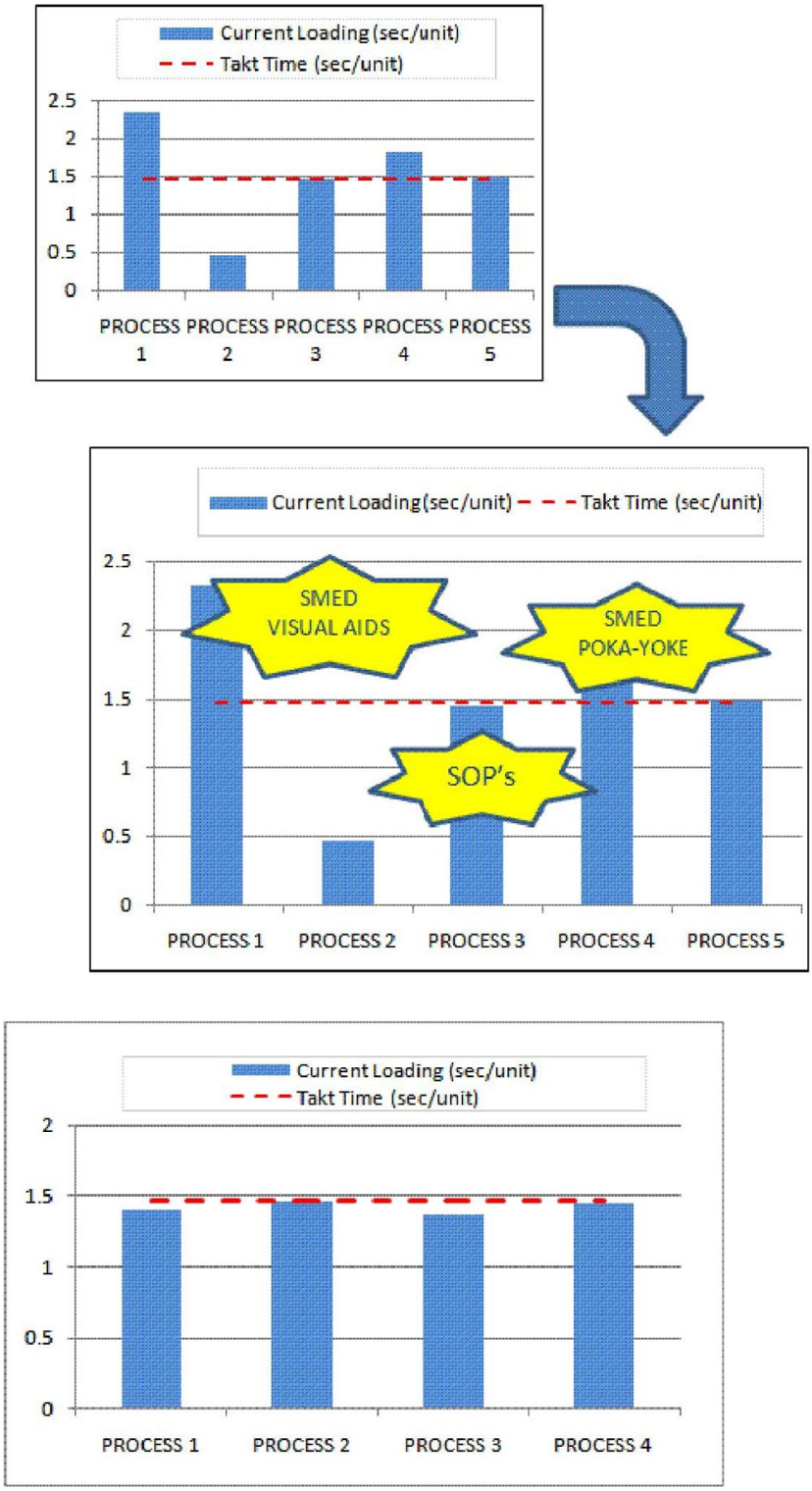


Figure 2.3: Example of Line Balancing

Source: Six-sigma-material.com / Line Balancing

2.7 Bottleneck and Theory of Constraints

In a production line or assembly line there will be a phenomenon of bottleneck. So, there is need for the company to emphasize the role of constraints in limiting the performance of an organization.

2.7.1 Definition of Bottleneck

A bottleneck is a phenomenon where the performance or capacity of an entire system is limited by a single or limited number of components or resources. It also can be defined as department, facility, machine, or resource already working at its full capacity and which,therefore, cannot handle any additional demand placed on it. It is the step, workstation, or stage which causes work in progress to build-up because it cannot be0processed at the same rate as the other steps or workstations or has the greatest cycle time in a one path process. Bottlenecks should be identified and addressed when planning capacity expansions. Potential process bottlenecks should be investigated in production planning, and0new facility planning. This can be achieved through preventive risk thinking and other problem analysis tools.

A simple example of a bottleneck can be observed below in Figure 2.4:

Figure 2.4: Bottleneck in a process

In Figure 2, the bottleneck in the process is process step 2 because it has the longest cycle time among the different steps. Between process step 1 and process step 2 there is a Work in Process (WIP) or work in progress buffer. This is where inventory accumulates because it cannot be processed at the same rate it is produced or supplied to this step.

Bottlenecks not only slow or limit the capacity of a process but also cause to other problems in a process which are:

1) Processing Blocking

   Occurs when there is no more room to store WIP or buffer stock before the bottleneck process. This will cause the production line to bank up and stop until the WIP is cleared or processed. In the example above process can become blocked when the WIP area cannot take any more material until process step 2 processes some.

2) Process Starvation

   Occurs when the steps after the bottleneck step are forced to stop or idle because of no material process until the bottleneck process can supply materials to this next step. In the example above process step 3 can become starved because its cycle time is less than the previous step and will be forced to idle while it waits for materials or WIP. This limits the capacity utilization of the whole process.

2.7.2 Definition Theory of Constraints (TOC)

The theory of constraints (TOC) is a concept that emphasizes the role of constraints in limiting the performance of an organization. TOC drives managers to attack constraints in order to reach their primary goal to make money. Elegant in concept and design, TOC focuses management's attention on the factors that impede system performance. TOC emphasizes the optimization of performance within the defined set of constraints of the existing processes and product offerings. TOC provides an action framework that combines the activities of managers a round a few highly visible system elements. TOC represents a tremendous change in management, focus, and direction. It is a transition shaped by several fundamental concepts that can be used to build a profitable foundation for any organization. These concepts include:

- A new measuring system;
- A process of continuous process improvement;
- A fundamental decision process focusing on global rather than local issues;
- A new method for analyzing the relationships between resources and processes and determining where to focus the company's efforts;
- New methods for analyzing policy problems to arrive at simpler solutions;
- A new management approach for providing strategic and tactical direction

The concept of the TOC can be summarized as every system must have at least one constraint. If it were not true, then a real system such as a profit making organization would make unlimited profit. A constraint therefore, is anything that limits a system from achieving higher performance versus its goal (Goldratt, 1988). Another concept is the existence of constraints represents opportunities for improvement. Contrary to conventional thinking, TOC views constraints as positive, not negative. Because constraints determine the performance of a system, a gradual elevation of the system's constraints will improve its performance.

Figure 2.5: Five Focusing Steps of TOC

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discuss the methodology of this research. Furthermore, in this chapter states the overall objectives in the stage of research methodology used in this research. In addition, the research methodology involving the type and method of collecting data is explained. Plus, data is analyzed at the end of the research.

3.2 RESEARCH DESIGN

According to Henning (2004) define a research design as an argument for the logical steps that will be taken to link with research questions and issues to analysis, data collection and interpretation in a coherent way. In addition, the research design in my study is involves the plan for study that will be used as guidelines in measuring, collecting and analyzed the data. Furthermore, the research will be consider on how to perceive the research design through the utilization of quantitative or qualitative study. In this study is design to use qualitative approaches to collect data and information. Meanwhile, for the data analysis will use some mathematical tools that are also utilized to proceed to the further stage.

3.3 RESEARCH METHOD—CASE STUDY

According to G. Thomas (2011), the case studies are analyses of events, decisions, persons, periods or others systems that are studies holistically by one or more methods. In addition, case studies are rather than using samples and following a rigid protocol to examine limited number of variables while case study methods are longitudinal examination of a single instance or event, a case. Furthermore, a case study is an intensive analysis of an individual unit such as a person, event or group stressing development factors in relation to content (Bent Flyvbjerg, 2011). On other word, a case study also provides a systematic way by look at the events; collect the data, analyzing information observed and reporting the results.

In addition, the case studies actually start with a problem background that company facing. Furthermore, to overcome the problem from that situation, Kaizen and others tools approach are used to find the root cause and directly will re-cat the current situation in order to find the situation. Besides that, this study will present the case study in a local SME company which are from Batik RM which it is small and medium enterprise company in producing batik in Kuantan, Pahang.

Furthermore, there are many problems occur on this Batik RM company. For example, quantities of batik output in traditional manufacturing produced are limited. When the process is not smooth, the profit received also will not be encouraging. Besides, there are problems in the layout for this small and medium enterprise. They have limited space but they need to produce a lot of output daily. In addition, this problem will make the customer dissatisfaction issues were increased because the product cannot deliver in time to customers. In conclusion, this problem will directly get a bad influence to the company.

3.4 DATA COLLECTION METHOD

Data collection is the process of preparing and collecting the data for further advancement in this study. In addition, the data collection is an important aspect of any type of research study because it provides the information about the specific research or topic. Furthermore, the data is usually obtained in early of this study. If the data is inaccurate it can impact the results of a study and directly lead to invalid result. Data collection usually can be collected using two methods that is the quantitative data and the qualitative data. The qualitative data usually obtained where the numerical and measurement rely on random sampling. While, for the qualitative data methods play an important role in impact the evaluation by providing information useful to make the researcher understand the process behind observed result and assess change in people perception of their well-being. In addition, the data consists of two types which are primary and secondary data.

1) Primary data

In this study, primary data is the data that involve the getting data immediately. The data is collected by survey, interview and look at the process. Furthermore, for the primary data is obtained through firsthand from such sources as historical documents, literary texts, experiments, surveys, artistic works and interview whereas for secondary information. Collecting the data by this technique must be consider because it guarantees for it relevant, precise, valid and reliable data. Primary data which is the data gathered by the researcher. Results from the discussion with my supervisor, a specific data need to be obtained to get the desire results. Those data will be obtained from Batik RM which it is small and medium enterprise company in producing batik in Kuantan, Pahang.

2) Secondary data

Secondary data is obtained from reading books, journal, article, academic materials and online information. The data actually has been published. In addition, the secondary data is the data that have been collected by others researcher than the current study.

3.4.1 INTERVIEW---PRELIMINARY RESEARCH

According to Kahn and Cannell (1957), an interview is purposeful discussion that has occurred between two or more people that will result in obtain the reliable and valid data that is relevant to this objectives study. In addition, interview is described as a conversation with a purpose. Meanwhile, an interview has some advantages to the researcher. The advantages of the interview is such as researcher can elicit more in depth response and can fill in information if participant does not meet an understanding. Furthermore, interview is a convenient ways for the respondent and it can certainty about who answered the questions. Besides that, during interview the body language also can guide the interviewer and to be help interpret the comments.

In this study, to getting the information and the data on the performance of the company is using preliminary search. In addition, the manager of the SME company that has been chosen in this study will be interview. In this research, the interview will be conduct to get the detail information about the Batik RM and other data such as performance of the previous layout and previous cycle time of the production line of batik be collected.

The main purpose is to pinpoint the records of the data on the cycle time at the production of batik. Furthermore, interview is straight forward and has a standard set of questions from the interviewer that will be used to ask the interviewee. It will make the process of interview become easier. Besides that, this interview method is more appropriate as to focus in obtain the cycle time data. In addition, the data collection method will be essential in enhancing research understanding and will produce the good and accurate in information and document. The interview in this study is conducted about 2 times separately with the proprietor/manager of the Batik RM and the entire question is answer by him. In addition, the manager has provide the raw data and gives a further explanation about the batik process to help completed the research study.

3.4.2 OBSERVATION

In this study, the method of investigation the practical theory in the SME company and allowed the documenting process of methodology will be adopting during Kaizen implementation and doing line balancing on the process of batik at this company. For this method is a quantitative study.in addition, the primary data is collected by using the observation technique. This observation of technique will be done and conducted in the Batik RM which is SME company. The process step in the producing of 'batik' is observed. Furthermore, the data from the real study is more valid and reliable because it totally involve in the study area. Meanwhile, the data collection will be focus on before and after Kaizen activity. After that, the data such as cycle time of workstations and movement will be collected.

This method of observations is divided into 2 phases where the phases 1 is focuses on to identify the critical process in the producing of 'batik' at assembly line process flow and the phase 2 will be focuses at the layout improvement of production process. The observation will be focuses during the interview with the manager of the Batik RM. At the observation, the situation of the company was observed and the problems facing during the process in the producing batik is discussed.

3.5 METHOD OF DATA ANALYSIS

According to Stephen D. Berkowitz (1997), data analysis is a body of methods that are help to develop explanations, detect facts, patterns and the hypothesis test. Furthermore, data analysis also involve in all of the sciences, in administration and in policy.

In reaching the objectives of this study, it involves the collection of productivity batik cycle time data. The first step in conducted the method of data analysis is involves continuous reading to journal and articles. When the information is obtained, structure interview will be conducted to get the data which is the main element to this study. In addition, the cycle time of process in the production of batik was calculated by doing time study. Meanwhile, observation is necessary to obtain the workload of each operator in the line. By the way, the bar chart analysis is conducted in this study to show which line is not balance.

The bar chart is a chart that is a simple and invaluable visual tool that helps to identify the tasks that have involved in the process (process flow of produce batik) and the time that each of the tasks takes such as some task will be necessary or others less. This will help in find where waste is so can eliminate it and to find the imbalance in work and directly will reduce the balance.

Thus, after doing the line balancing the production line of batik, new process flow and new workload were get to affect the production line. In addition, after the line balancing the new cycle time is reduced. Lastly, to develop the work standardization to measure the line is working at smoothly condition and save time.

3.6 MICROSOFT EXCEL SOFTWARE

Microsoft software which is Microsoft Excel is software that will be used further in this study. In addition, the reason why this software will be used in this study is because it is simple to be used and plus the function itself that directly implement results created into a graph. Furthermore, it is recommended for someone to learn basic things before using other complicated software like Minitab, etc. Besides that, Microsoft Excel is easier to explore than other software. In addition, the objective of this study can be achieved by using this software.

3.7 SUMMARY

This chapter provides a lot of details about methods that are used by the researcher and the research design that has been proposed for this study. In addition, this research is to study to identify the critical process in the producing of 'batik' and to propose improvement that can increase productivity in producing 'batik' by using Kaizen. In this chapter, interview with the Batik RM manager is conducted. Besides, line balancing and standardization are two main issues that need to be focusing for these kaizen attempts. Basic mechanisms for Kaizen approach are making any possible improvements under PDCA (plan-do-check-act) cycle. Standardizes the improvements and continues for another PDCA cycle will be able the action that need to be listed out in order to ensure the implementation parallel with the objective.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 INTRODUCTION

This chapter presents the key research findings, as a result of the data analysis and explanations on the results and findings based on the method that were described in the previous chapter as well. This description is in order to provide a clearer view of where is actually this study is about and what is actually happening in the assembly line.

Besides, line balancing and standardization are two main issues that need to be focusing for these kaizen attempts. Basic mechanisms for Kaizen approach are making any possible improvements under PDCA (Plan-Do-Check-Act) cycle. Standardizes the improvements and continues for another PDCA cycle will be able the action that need to be listed out in order to ensure the implementation parallel with the objective.

In this study, the data are gathered from Batik RM which it is small and medium enterprise company in producing batik in Kuantan, Pahang. This analyzing of data is carried out in Microsoft Excel that has been mentioned in previous chapter.

4.2 PROCESS DESCRIPTION

The product is batik which it is a famous traditional silk among Malaysians. This research deals with the movement producing process of the hand setting to produce the silk of batik. The major process steps in producing batik are sketched in the below figure. 8 stations with a continuous material flow compose the assembly line. Each workstation have their desire cycle time. The process flow of producing batik is show on the figure below.

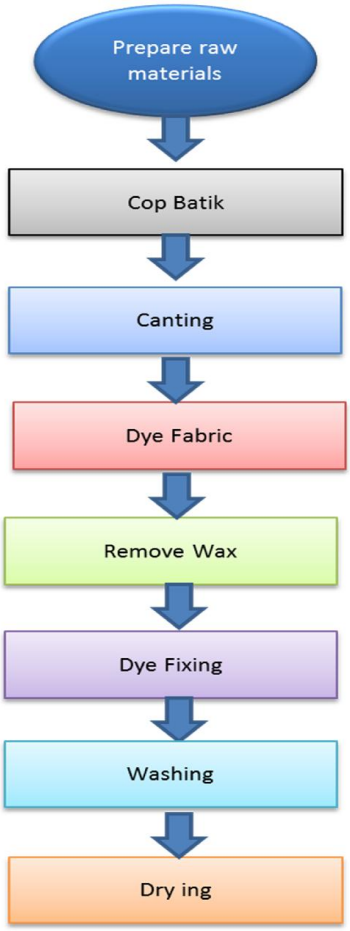
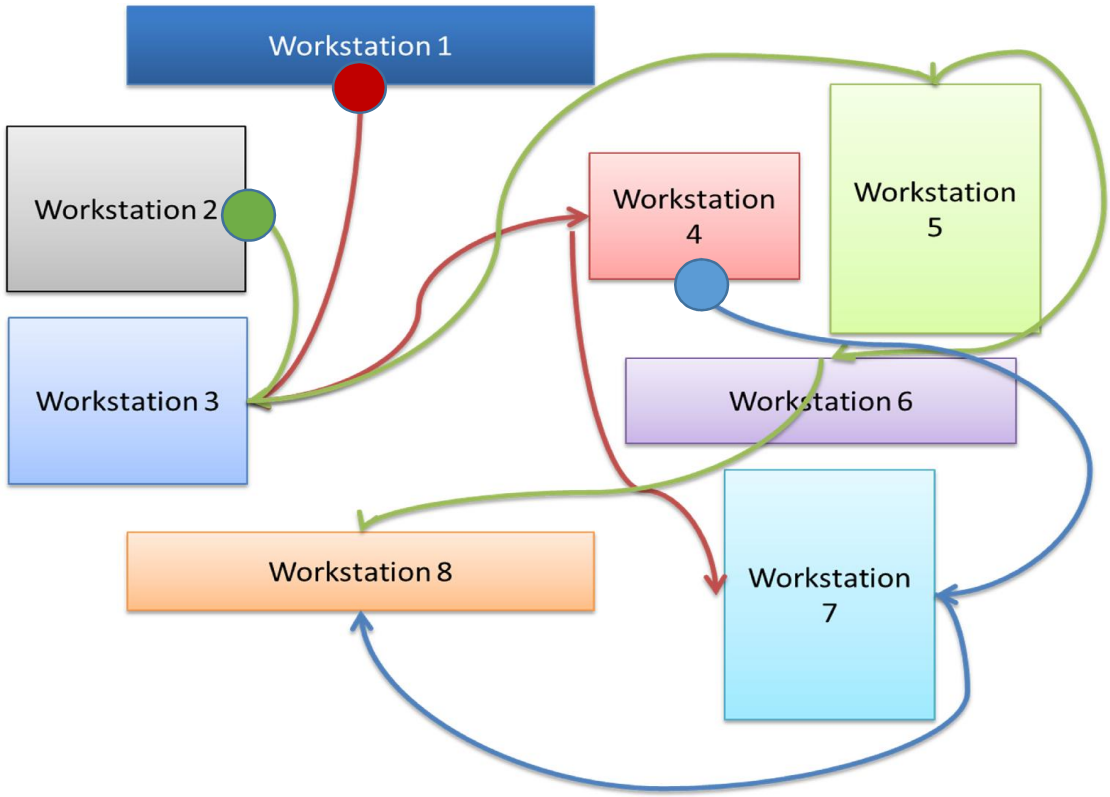


Figure 4.1: Process Flow Chart of Producing Batik

4.3 PRODUCTION LINE

Production line is a production system in which parts or components of the end product are transported using workforce through a number of different sites at each of which a manual or machine operation is performed on them without interrupting the flow of production. Each workstation performs a subset of operations or tasks necessary for producing the products and steady or intermediate movement of the line, each product unit remains at each station for a fixed cycle time. Hence, production line is a line of machines, equipment, workers, and others in a company that builds a product by passing work from one station to the next until the product is finished.

Figure below will show the current layout and movement of the worker for producing batik.



Movement of Workers

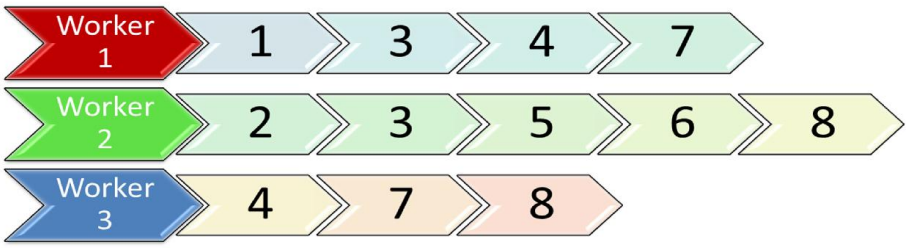


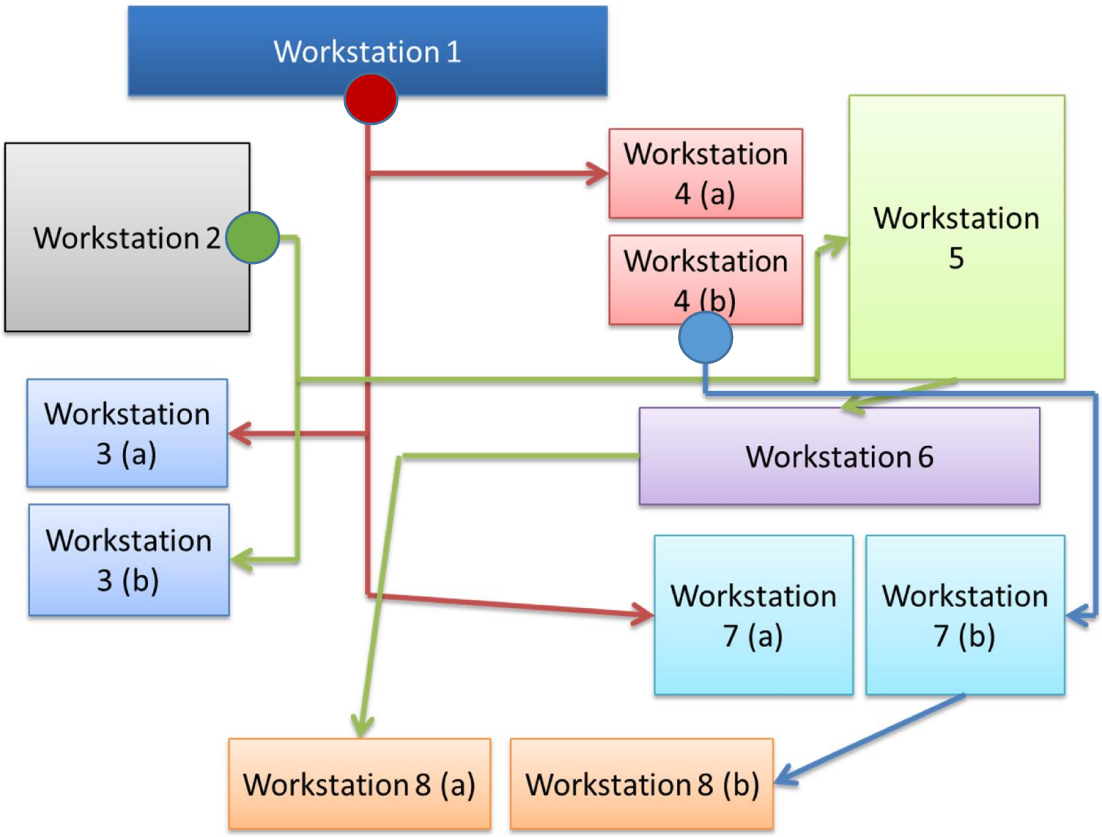
Figure 4.2: Initial layout and production line

4.4 IMPROVING THE PROCESS FLOW

Due to the initial situations, Kaizen attempts had been done to the process for continuous improvement to improve the condition. Kaizen is an excellent way to formalize some simple improvement activities that are not always run in an optimal format. Kaizen also avoids the stigma of a formalized project that may be drawn out over several weeks or months. Most importantly, Kaizen provides just-in-time process improvements.

4.4.1 KAIZEN 1: RE-LAYOUT

Worker is constantly moving in their own way because of a poorly designed plan, the results can be frustrating and deleterious to the company bottom line. An efficient layout will allow each station in the company to function independently from one another. Logically, if the worker is walking another extra steps to produce the products, that would be a waste of time. If the company layout allows functioning with two employees rather than three, or three rather than four; the labor savings will add up quickly. By re-layout the design and additional of equipment, the process time to produce batik will be reduce. Besides that, reduce the movement that does not add value can increase the productivity of the products. Figure 4.2 and figure 4.3 below will show the effectiveness of movement by the co-worker after re-layout the design.



Movement of Workers

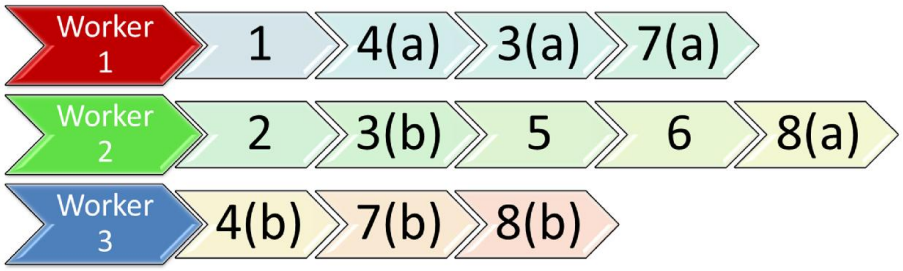


Figure 4.3: After Re-layout

Previous condition of production line is using batch production. It means the interval Work In Progress (WIP) are more than one piece between the processes with the next process. So, line balancing is implemented and to process the fabric being added with new re-layout design. Before re-layout, the route to other workstation quite messy and inefficient result waste in time. However, after re-layout with maximizing the space the equipment being added and arranged such in figure 4.3.

In previous layout, there are queuing times for each of the worker to do their tasks. Automatically, there will be queuing time to complete the process of producing batik. So, with new re-layout, there is much better movement. Poor process design, poor standard work practice and poor work area layout can be improved.

KAIZEN 2: COMBINE WORKLOAD

Combine load is similar to job sharing where each worker shares the tasks between each other to complete the process. Job share arrangement is a form of regular part-time work in which two people share the responsibilities of one regular, full-time position. Besides that, job sharing can provide many benefits, including reduced absenteeism, improved recruitment and retention of valued staff who may not want full-time employment, improved scheduling and continuity, increased breadth of skills and experience, allowance for unusual schedule needs of staff, and experience in working as a successful team.

An employer will need to carefully assess the situation to ascertain whether a job share would work well in the particular circumstances in question. They'll need to make sure that whether the work is clearly assigned and divided between the employees. The workload must be regularly monitored to ensure that an imbalance work is not occurring between the two parties. Besides that, clear job scope and decision making must be drawn up to avoid any confusion around who takes the lead on specific tasks. The job sharers' skill-sets and knowledge must complement each other and offer an effective combination of expertise. Excellent channels of communication must be in place between the employees undertaking the job share. Excellent communication will be needed to avoid misunderstandings, inaccuracies or a failure to relay important information so that there will be a continuous improvement to produce batik.

4.5 RESULTS

After the Kaizen activity, the results will be showed in below. For the same time, evaluation in productivity to ensure either the cycle time to produce batik is reduce or not will be discussed below. The raw data of the can be refer to the appendix at the end of the report.

4.5.1 Improvement for Re-layout

	Foot Step	
Process Step	**Before**	**After**
1. Prepare fabric / material	30	20
2. Hot up the wax	-	-
3. Stretch the fabric	25	20
4. Cop the fabric using batik block	-	-
5. Take the fabric to canting area	20	15
6. Stretch the fabric	25	20
7. Canting the fabric using a canting tool	25	15
8. Take the fabric to dye area	60	45
9. Dye fabric using naphthol (fixal)	-	-
10. Bring the fabric to remove wax	5	5
11. Remove wax by soak the fabric into hot water	-	-
12. Bring to other work station for dye fixing process by using Sodium S	80	55
13. Wash using clear water	-	-
14. Drying the fabric	5	5
Total	275	200

Table 4.1 Footsteps analysis

Improvement

$$\frac{Value\ Before - Value\ After}{Value\ Before}$$

$$= \frac{275 - 200}{275}$$

$$= 0.2727$$

$$0.2727 \times 100\% = \mathbf{27.27}\ \%$$

From the analysis that has been run, the footsteps before and after re-layout is been reduced from 275 footsteps to 200 steps. There are 27.27% improvements of footsteps by re-layout the area. This shows that it already eliminate waste by 27.27% through Kaizen activities.

4.5.2 Improvement for Combine Workload

Before	Cycle Time (s)	After	Cycle Time (s)
1. Prepare fabric / material	133.18	1.Prepare fabric and hot up the wax simultaneously	750
2. Hot up the wax	750		
3. Stretch the fabric	45.4	2. The process from stretch the fabric and then cop using batik block, can be done at canting area.	800
4. Cop the fabric using batik block	390.92		
5. Take the fabric to canting area	39.4		
6. Stretch the fabric	90		
7. Canting the fabric using a canting tool	453.04		
8. Take the fabric to dye area	60.58	3. Then bring the fabric to undergo dye process.	180
9. Dye fabric using naphthol (fixal)	138.88		
10. Bring the fabric to remove wax	17.18	4. After that, bring fabric to remove the wax.	45
11. Remove wax by soak the fabric into hot water	30		
12. Bring to other work station for dye fixing process by using Sodium S	550	5. Dye fixing process by using Sodium S	550
13. Wash using clear water	36.7	6. Wash using clear water	36
14. Drying the fabric	2800	7. Drying the fabric	2800
Total Cycle Time	**5535.28**	**Total Cycle Time**	**5161**

Table 4.2: Workload Analysis

Improvement

$$\frac{Value\ Before - Value\ After}{Value\ Before}$$

$$= \frac{5535.28 - 5161}{5535.28}$$

= 0.06762

$$0.06762 \times 100\% = \mathbf{6.76\ 2}\%$$

From the cycle time results, the total cycle time before and after the combination of workload is reduced from 5535.28 to 5161. From the analysis, there are about 6.762% improvements after the load of work is being combining and also by reducing waiting time. This shows that it already balance workload by 6.762% through Kaizen activities.

4.5.3 Calculation

Takt time is the frequency of production units necessary to meets customer orders. Calculation of takt time makes capacity calculations really easy through a complex flow. It can easily determine what each and every process must be capable of. It can determine the necessary speeds of machines and other capital equipment. It also determines minimum batch sizes when there are changeovers involved. It can look at any process and worker quickly determine the optimum number of people required to make it work, plus see opportunities where a little bit of kaizen will make a big difference in productivity.

Time available (per shift) – 10a.m – 6p.m (9 Hours)

Opening – (15 minutes)

Break (afternoon) – (30 minutes)

Break (evening) - (15 minutes)

Total time per day - 8 Hours

- Available Hours

$8 \times 60 \times 60 = 28{,}800$ second per day

Daily Demand – 30 pieces per day

$$Takt\ time = \frac{Total\ work\ time\ available}{Units\ required}$$

$$= \frac{28800}{30}$$

= 960 seconds

$$\approx 16\ minutes$$

During the collection of data, there are also queuing time and idle time that can be analysis and calculated from the raw data.

Workstation	Total Cycle time (sec)	Queuing Time	Idle time
1	133.18	0	0
2	390.92	0	79.24
3	453.04	0	119.10
4	138.88	56.9	0
5	30.00	17.79	0
6	550.00	0	66.12
7	36.70	19.89	0
Total (sec)	1732.72	94.58	264.46

Table 4.3: Queuing and Idle Time

4.5.4 Bar Chart

Bar chart is essentially a stacked bar chart which displays the balance of cycle times between a set of operators, for example on an assembly line. There are free templates available online. Bar chart helps to identify the tasks involved in the process flows at the time that each of those tasks taken, some tasks will be necessary and others. Besides that, bar chart helps to see where there's waste, so that elimination can be taken to identify imbalances in work.

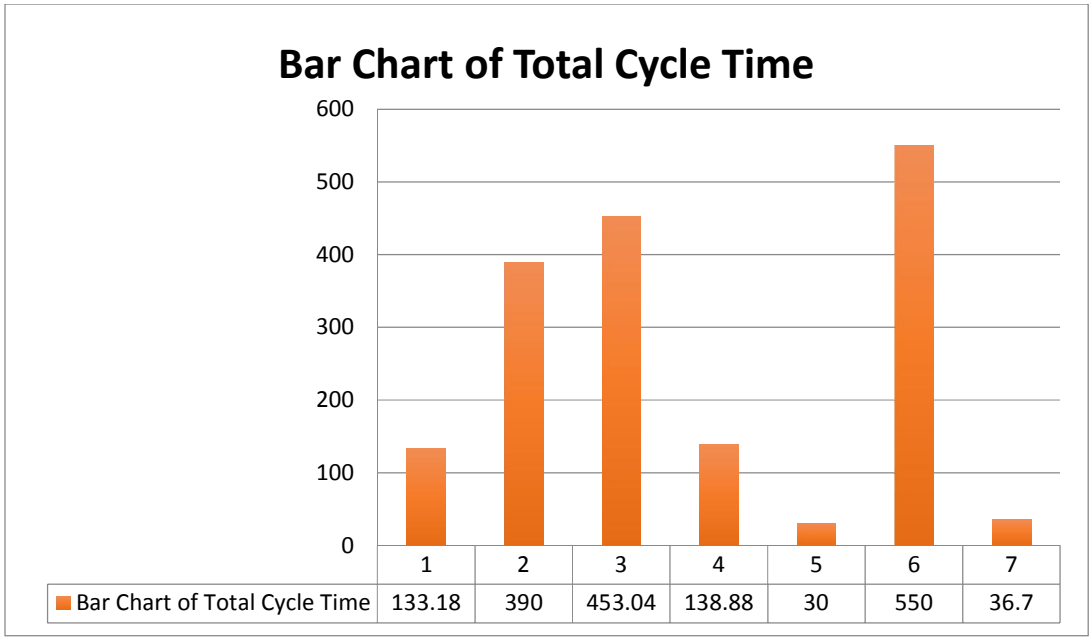


Figure 4.4: Bar chart before line balancing

From the bar chart, it can help to determine what each and every process must be capable of. It can determine the necessary speeds of machines and other capital equipment. Besides that, it can determine minimum batch sizes when there are changeovers involved. Moreover, it can also look at any process and quickly determine the optimum number of people required to make it work.

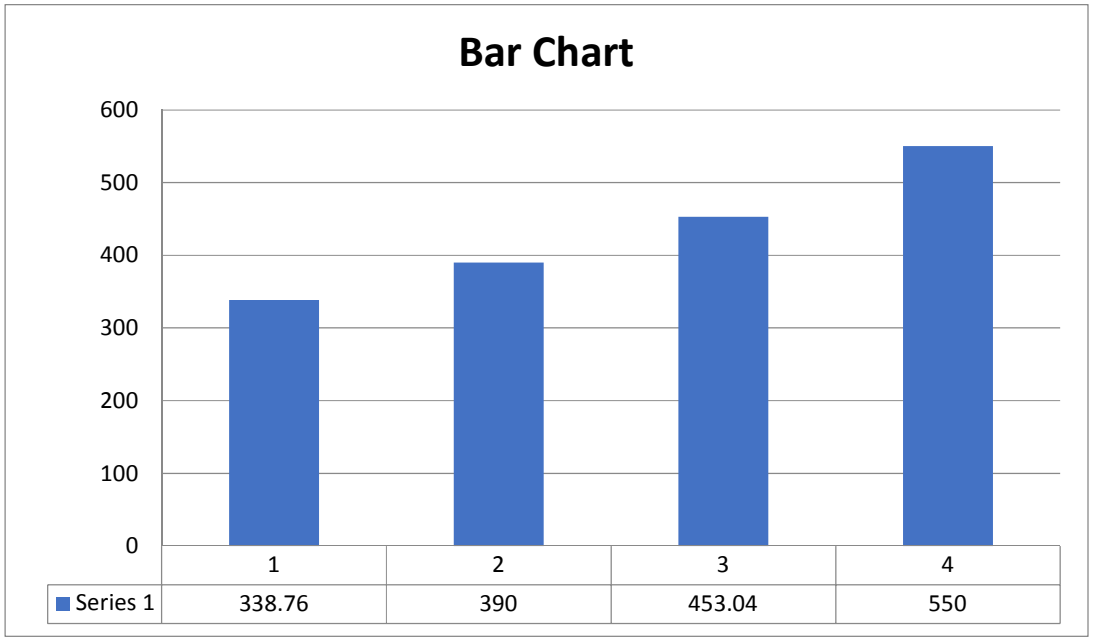


Figure 4.5: Bar chart after line balancing

The cycle time of each process is quite huge in number. Meanwhile, workload of each operator is more balance compared to before line balancing. From 14 steps of process flow, there are 7 steps that cannot be taken to analyze the data because it will affect the text originality and quality of batik. After line balancing, workload of each operator is more balance compared to before line balancing. The bar shows figure 4.4 the workload is not balance. Figure 4.5 shows after line balancing, each work being combined and divided equally which help to reduce the cycle time and balance the workload.

4.5.3 DETERMINE LINE EFFICIENCY

The efficiency of a line balance is by dividing the total task time by the product of the number of workstations required times the assigned (actual) cycle time of the longest workstation:

$$\text{Efficiency} = \frac{\text{Sum of tasks time}}{(\text{Actual Number of workstations}) \times (\text{Largest actual cycle time})}$$

Data can be seen at the appendix behind the chapter.

Before Efficiency:

$$= \frac{1732.72}{5 \times 550}$$

$$= 0.6301$$

$$0.6301 \times 100\% = 63.01\%$$

After Efficiency:

$$= \frac{1732.72}{4 \times 550}$$

$$= 0.7876$$

$$0.7876 \times 100\% = 78.76\%$$

Line Efficiency = 78.76% - 63.01%

Improvement

= 15.75%

From the above calculation shows the line efficiency. The comparison of both before and after results shows that it can manage to increase line efficiency from 63.01% to 78.76% which improvement is 15.75%

4.6 SUMMARY

From the results, it has successfully improved the layout and combination of workload that contribute to efficiency of line balancing. The new layout in the research is suitable for continuous flow. Besides, this layout saves 27.27% of the space than previous layout. Therefore, standardize the work for the line balancing by preparing standard work combination chart for the operator is developed.

In term of cycle time, the line balancing after cycle time is the best. The one piece flow it reduces space utilization and easy to detect work in progress. Combination of workload improves about 6.762% of productivity. It is very important to obtain the feasible and acceptable results which are to analyze and estimate the final results so that the best one can be implement.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In the previous chapter, the research result were analyzed and discussed. In the final chapter of this research, the discussion will focuses on the main conclusions, recommendations and limitations on the research. Final conclusion on reduce cycle time by using line balancing and Kaizen is achieved. Recommendations in this chapter were applied for further research and practical implementation will be suggested.

A final discussion will also be entertained will also be established whether the objectives of this research, as stated in chapter 1 are reliable.

5.2 IMPLICATIONS OF THE STUDY

From the interpretation of the results in chapter 4, the implications can be identified for which would be useful for the future researchers in the field of producing traditional batik. The specific implication from the findings reported in this research was managerial implications. The process step in making batik will be decrease.

Besides that, the cycle time to make batik also will be decrease. Cycle time is the total elapsed time required to complete the operation of batik process. Cycle time reduction has

become a key area of opportunity for organizations that are under increasing pressure to get more done with fewer resources in order to remain competitive. By reducing cycle time organizations can reduce cost, increase quality, and improve customer service.

From the results, it have successfully improve layout which saves 27.27 % of the space than previous layout. Therefore, standardize the work for the line balancing by preparing standard work combination chart for the operator is developed. Besides that, combination of workload improves about 6.762% of balance workload and demand of customer also can be met.

5.3 LIMITATIONS OF THE STUDY

When conducting the research, there are a few limitations that the researcher needs to overcome. The first limitations are based on outliers' data for the first observations. Outliers arise due to changes in system behaviour, fraudulent behaviour, human error or instrument error. An outlier may be due to the worker behaviour which the first collection of data, the worker gives deep explanations based on the process involved.

Besides, this research only focused on one SME company which is Batik RM in Kuantan area. The research only focus for one company which there are no comparison of results between other SME company. The third limitations is it is hard for the researcher to identify the job scope of each worker because there are not implemented Standard Operating Procedure (SOP). SOP is a set of fixed instructions or steps for carrying out routine operations. It seems like there are lack of SOP in producing batik for because production of batik for the customer demand and sales batik was produce simultaneously.

5.4 RECOMMENDATIONS FOR FUTURE RESEARCH

The recommendations focused towards researcher and company. For the future research, researcher needs to collect data of cycle time for each workstation more frequently than previous so that the results would be more accurate. Besides that, there is few kind of batik. The researcher can take cycle time for each type of batik that will be produce. The time taken for processing batik must be taken in separate data so that improvement that can increase productivity in producing batik can be achieved.

Then for the future research, it was really recommended for the company to re-layout the shop so that the space in the company will be use great as possible. An efficient layout will allow each station in the company to function independently from one another.

Besides that, the equipment can be added. Tools and equipment of batik can be added since there will be much better layout compared to the previous one. Addition of equipment will save time since there are less waiting time for the worker to do their tasks. All of the worker will do their job in for a maximum use.

Therefore, proper schedule and planning is need for the company so that everything will be organized much better. Besides that, the demand for customer nor weekdays or weekends can be fulfill the customer requirements.

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Gantt chart

APPENDIX B

Interview Sheet for Final Year Project

Dear Sir/Madam

I whole heartedly would like to invite you to contribute in this survey and thanking you in advance for your kind involvement. For your information, the present of my interview is related to proposed and survey the situation of cycle time in your production of batik. This research is to identify the problems on cycle time in batik production line in Batik RM.

I am thank you very much for your kind cooperation of this survey. Your kind cooperation and participation is highly appreciated. Should you have any further questions, please do not hesitate to contact us.

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Supervisor

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Undergraduate

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Question:

1. Describe the company profile.
2. Describe the products range in the company.
3. Describe the cycle time in Batik RM while producing batik.
4. What are the actual problems facing by your company in production line?
5. Describe the process workflow of producing batik?
6. What is the common problem facing on producing batik?
7. How many process involved in producing batik?
8. What are the tools using by Batik RM to reduce production line?
9. Kaizen is implementation on production line?
10. The production line of producing batik is balanced?
11. Describes the differences of cycle time before and after implementation of Kaizen.
12. Describes the differenced of cycle time before and after line balancing.
13. The significance and improvements?

APPENDIX C

Raw Data for Observation sheet for Final Year Project

		Cycle Time (s)					
Process	**Foot Step**	**1**	**2**	**3**	**4**	**5**	**Average Time (s)**
1. Prepare fabric / material	30	126.8	141.5	137.2	129.8	130.6	133.18
2. Hot up the wax		750	750	750	750	750	750
3. Stretch the fabric	25	41.4	40.8	46.3	50.9	47.6	45.4
4. Cop the fabric using batik block		356.3	410.1	435.5	383.5	369.2	390.92
5. Take the fabric to canting area	20	37.8	43.2	39.7	42.8	33.5	39.4
6. Stretch the fabric	25	90	90	90	90	90	90
7. Canting the fabric using a canting tool	25	402.3	498.5	456	422.1	486.3	453.04
8. Take the fabric to dye area	60	58.2	67	61	59.5	57.2	60.58
9. Dye fabric using naphthol (fixal)		140.3	131.5	147.2	139.9	135.5	138.88
10. Bring the fabric to remove wax	5	10	26.3	15.9	18.4	15.3	17.18
11. Remove wax by soak the fabric into hot water		30	30	30	30	30	30
12. Bring to other work station for dye fixing process by using Sodium S	80	550	550	550	550	550	550
13. Wash using clear water		35	47	38	33.5	30	36.7
14. Drying the fabric	5	2800	2800	2800	2800	2800	2800
				Total Average Time			5535.28

APPENDICES
APPENDIX A
GANTT CHART