OPTIMIZE FLOW LAYOUT AND ANALYSIS OF EFFECTIVENESS AT BI TECHNOLOGIES CORPORATION SDN. BHD

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ABSTRACT

Agilent Production cell 6 fosters inefficient production practices, is outdated for its existing process, and lacking in product flow. A plant optimization is applied to bring order, efficiency, and optimize flow in the production lines. Deliverables include a proposed process and material flow that decreases product travel distances, cross flow and increases productivity as well as effectiveness of the proposed optimization analysis. Major modification of the cell decisions include downsizing the existing cell, sorting to find waste in material handling and establishing a clear process/product flows. The proposed plant optimization was analysis and results yield 100% productivity. The percentage efficiency of the optimize flow layout is 80% compared to 67% in existing flow layout. The analysis of efficiency has been increased to 13% in the proposed process flow. The product travel distance also has been reduced from 93 feet’s to 20 feet’s.
ABSTRAK

Sel nombor enam di Agilent seksyen menjalankan pengeluaran secara tidak efisyen dengan mengamalkan proses yang sedia ada yang tidak relavan dan kekurangan dari segi pengaliran produk. Proses mengoptimumkan telah diaplikasi untuk mengubah susunan, kecekaan dan mengoptimumkan aliran sel dalam produksi dengan mencadangkan aliran proses dan material yang baru yang dapat mengurangkan jarak untuk mengangkut produk, rintangan/halangan aliran dalam sel seterusnya dapat meningkatkan produktiviti dan keberkesanan terhadap analisis pengoptimuman yang telah dicadangkan. Pengubahsuaian yang telah dilakukan termasuk meminimumkan sel yang sedia ada, melakukan kajian untuk megenalpasti dan menyingkirkan proses yang tidak berguna dalam mengendalikan material serta mewujudkan satu aliran proses yang lebih cekap. Pengoptimuman kilang yang dicadangkan adalah analisis dan keputusan yang menghasilkan 100% produktiviti. Peratus kecekapan juga meningkat sehingga 80% berbanding 67% di dalam sel nombor enam. Analisis kecekapan telah mengurangkan jarak produk daripada 96 kaki kepada 20 kaki.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPERVISOR’S DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>STUDENT’S DECLARATION</td>
<td>iii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iv</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vi</td>
</tr>
<tr>
<td>TRANSLATION OF ABSTRACT</td>
<td>vii</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xiv</td>
</tr>
</tbody>
</table>

## CHAPTER 1  INTRODUCTION

1.1 Background of Study 1
1.2 Problem Statements 6
1.3 Research Objectives 6
1.4 Scope of Study 7

## CHAPTER 2  LITERATURE REVIEW

2.1 Lean Manufacturing 8
2.1.1 Lean Production and Traditional Mass Production 10
2.1.2 Lean Manufacturing Principles 12
2.1.3 Lean Manufacturing Tools and Techniques 14
CHAPTER 3 METHODOLOGY

3.0 Introduction 21
3.1 Data Collection from Observation 21
3.2 Data Collection from Interviews Session 22
3.3 Material And Equipment In Cell 6 22
3.4 Collecting And Analyzing Data by Using Lean Manufacturing Tools
   3.4.1 Step 1: Understand the Process Flow 23
      3.4.1.1 Primary Bobbins 23
      3.4.1.2 Secondary Bobbins 24
      3.4.1.3 Overall Process Flow 24
3.4.2 Step 2: Identify the Layout Problems 25
3.4.2.1 Observe and List Down Problems 25
3.4.3 Step 3: Collecting Data 25
   3.4.3.1 Time Study Worksheet 26
3.4.3.2 Lean Manufacturing Worksheet 26
3.4.3.3 Bill of Material (BOM) 26
3.4.3.4 Operation Instruction Card (OIC) 26
3.4.4 Analysis of Data 27
3.4.5 Design the Proposed Flow Layout 29
  3.4.5.1 Technomatix Plant Simulation 29
    3.4.5.1.1 Basic Toolbar of Technomatix Software 30
3.4.6 Implementation of Plant layout Optimization 30

CHAPTER 4 RESULT AND ANALYSIS

4.1 Introduction 31
4.2 Data Analysis of Existing Flow Cell Layout by Using Lean Manufacturing
  4.2.1 Problem Solving Method 32
  4.2.2 Work Study 38
  4.2.3 Work Measurement 45
  4.2.4 Performance Analysis of the Assembly Line 46
    4.2.4.1 Precedence Diagram 48
    4.2.4.2 Workstation Cycle Time and Minimum Number of Workstation 49
    4.2.4.3 Balancing Workload 49
    4.2.4.4 Efficiency of the Existing Cell 6 52
4.3 Data Analysis And Results of Proposed Flow Cell Layout by Using Lean Manufacturing
  4.3.1 Optimization of the Proposed Process Flow Layout 53
  4.3.2 Proposed Optimization of Cell Layout 54
CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction 71
5.2 Conclusion 71
5.3 Recommendations for Improvements 72

REFERENCES 74

APPENDICES

A  Project Gantt Chart FYP 1 and 2 77
B1  Bi Technologies Plant Layout Schematic 78
B2  Agilent Production Department 79
B3  Agilent Production Cell number 6 80
C1  Time Study Worksheet Existing Process Flow 81
C2  Time Study Worksheet Proposed Process Flow 82
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Differences between Lean Production and Mass Production</td>
<td>11</td>
</tr>
<tr>
<td>3.1</td>
<td>List of Material and Equipment at Agilent Cell 6</td>
<td>23</td>
</tr>
<tr>
<td>4.1</td>
<td>Analysis Possible Causes (Material, Method, Machine, Environment and Man)</td>
<td>34</td>
</tr>
<tr>
<td>4.2</td>
<td>Mapping Task</td>
<td>37</td>
</tr>
<tr>
<td>4.3</td>
<td>Process Flow Chart of Existing Cell</td>
<td>41</td>
</tr>
<tr>
<td>4.4</td>
<td>Assembly Line Balancing of the Existing Flow Layout of Cell 6</td>
<td>47</td>
</tr>
<tr>
<td>4.5</td>
<td>Balancing of Existing Cell Work Load</td>
<td>50</td>
</tr>
<tr>
<td>4.6</td>
<td>Assembly Line Balancing of the Proposed Process Flow</td>
<td>56</td>
</tr>
<tr>
<td>4.7</td>
<td>Balancing the Proposed Plant Optimization Work Load</td>
<td>59</td>
</tr>
<tr>
<td>4.8</td>
<td>Process Flow Chart of Proposed Optimize Layout</td>
<td>62</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Overall Process Flow to Produce Transformer</td>
<td>24</td>
</tr>
<tr>
<td>3.2</td>
<td>Basic Toolbar in Technomatix Plant Simulation</td>
<td>30</td>
</tr>
<tr>
<td>4.1</td>
<td>Ishikawa Diagram 1</td>
<td>33</td>
</tr>
<tr>
<td>4.2</td>
<td>Ishikawa Diagram 2</td>
<td>36</td>
</tr>
<tr>
<td>4.3</td>
<td>Method Study Procedure</td>
<td>38</td>
</tr>
<tr>
<td>4.4</td>
<td>Operation Process Chart</td>
<td>40</td>
</tr>
<tr>
<td>4.5</td>
<td>Plant Layout of Agilent Production</td>
<td>43</td>
</tr>
<tr>
<td>4.6</td>
<td>Flow Diagram of Existing Layout</td>
<td>44</td>
</tr>
<tr>
<td>4.7</td>
<td>Precedance Diagram of Existing Cell 6</td>
<td>48</td>
</tr>
<tr>
<td>4.8</td>
<td>Precedance Diagram with Workstations</td>
<td>51</td>
</tr>
<tr>
<td>4.9</td>
<td>Dummy Test in Existing Operation</td>
<td>53</td>
</tr>
<tr>
<td>4.10</td>
<td>Precedance Diagram of the Proposed Process Flow</td>
<td>57</td>
</tr>
<tr>
<td>4.11</td>
<td>Precedance Diagram with the Workstations</td>
<td>60</td>
</tr>
<tr>
<td>4.12</td>
<td>Schematic Diagram of Cell Optimization</td>
<td>64</td>
</tr>
<tr>
<td>4.13</td>
<td>Flow Diagram of the Proposed Cell Optimization</td>
<td>65</td>
</tr>
<tr>
<td>4.14</td>
<td>Cycle Time of Existing Layout</td>
<td>67</td>
</tr>
<tr>
<td>4.15</td>
<td>Lean Cycle Time of the Proposed Cell Optimization</td>
<td>67</td>
</tr>
<tr>
<td>4.16</td>
<td>Schematic Diagram in 2 Dimensional</td>
<td>69</td>
</tr>
<tr>
<td>4.17</td>
<td>Simulation in 2 Dimensional</td>
<td>69</td>
</tr>
<tr>
<td>4.18</td>
<td>Proposed Process Flow Layout in 3 Dimensional</td>
<td>70</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OIC</td>
<td>Operation Instruction Card</td>
</tr>
<tr>
<td>PDCA</td>
<td>Plan-Do-Check-Act cycle</td>
</tr>
<tr>
<td>CNC</td>
<td>Computer Numerical Control</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Optimizing facility layout is an important problem for modern manufacturing systems and it plays a key role for designing the process and material flow. Manufacturing facilities design is the company’s physical assets to promote the efficient use of resources such as worker, material, equipment, time and cost. Facilities design includes plant location, process flow, plant layout and material handling systems. Only the proper process flow of layout can ensure the smooth and rapid movement of material, from the first stage of material until the end of process. Optimizing the flow layout also can reduced the wastes or non value added activities in the production lines and improve the overall effectiveness in the production.

In manufacturing industry, there are two main problems that need to be considering for the facility layout (Sahin et al., 2009). The first one is the quantitative approach aiming at minimizing the total material handling cost between workstations based on a distance function. Secondly is the approach aiming at minimizing the non value added activities. Material handling and process flow have close relationship in production. Material handling accounts for a significant portion of the total production cost. Workers and materials have to travel long distances in the course of the manufacturing process; this leads to loss of time and energy and nothing is added to the value of the product. Through effective plant layout analysis and design, much
material handling operations can be reduced or eliminated. The choice of material handling methods and equipment is an integral part of the plant layout design. Furthermore, by optimizing the process flow, it will maximize the closeness between the workstations and effectively reduce the cross flow cause by workers in the production lines.

Plant layout can be defined as a technique of locating and arrangement of the physical facilities such as equipment, machines, tools, furniture etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of the final product (Abha Kumar, 1999). According to (J. L. Zundi, 2000), Plant layout ideally involves allocation of space and arrangement of equipment in such a manner that overall operating costs are minimized. Plant layout encompasses new layout as well as improvement in the existing layout.

There are three types of the main layout which are process layout, product layout and fixed-position layout. All machines performing similar type of operations are grouped at one location in the process layout. Fixed-position layout is design for stationary project. Workers and equipment come to the site. In product layout, the machines and equipment are arranged in one line depending upon the sequence of operations required for the product. This project focus on the product layout which is same with the current layout of the cell because of the space available, the machines, the equipment and the process flow is suitable for this type of layout. In this cell, work is done in small amount at each of the workstations in the work unit. This means the cell is suitable with product layout because the total work must be dividable into small tasks that can be assigned to the workstations. In product layout, the stations are specialized in their tasks with specialized equipment and tooling, which leads to high proficiency, reduced cycle time and also leads to a higher production rate. Furthermore, from the opinion of the process engineer in the company, the type of layout will be the same as the current layout because the other Agilent productions are in the cell and also the limited of space in the cell. The shape of the current cell is used U- shaped. Generally a horseshoe or U-Shaped work area layout that enables workers to easily move from one process to another in close
proximity and pass parts between workers with little effort. After the equal allocation of tasks to each stage in the line was decided, the future shape of the layout can be chosen.

The principles of lean manufacturing have become state-of-the-art in modern manufacturing design and its implementation has become a vital pre-requisite in global competition (Matt, 2008). Lean production is most frequently associated with elimination of waste commonly held by firms as excess inventory or excess capacity (machine and human capacity) to ameliorate the effects of variability in supply, processing time, or demand. Lean manufacturing principles and tools are very important in designing the layout. Line balancing is one of effective tool in lean manufacturing to improve the throughput of assembly lines and work cells while reducing manpower requirements and costs. Assembly line balancing is the main problem of assigning operations to workstations along an assembly line. Line balancing is used in this study to achieve the minimization of the number of workstations and workers, the minimization of cycle time, the maximization of workload smoothness and work relatedness. One of the important tools in Lean manufacturing used by engineers in work measurements is time study and specifically stopwatch time study. Time study that originated by Taylor and developed by Gilbreths was used mainly for determining time standards and motion study.

In this project, BI Technologies Corporation Sdn. Bhd, the electronic company has been selected to perform the modification and improving the existing production flow layout. This company has been an innovator and leader in electronic components for more than 50 years. Initially, the company was established in 1976 as Pahang Electronics Sdn Bhd, a Pahang state agency with the commercial agreement that Astec International Hong Kong will provide technical assistant in the manufacturing of Modulators for the TV industry. The company then known as BI Technologies Corporation (M) Sdn Bhd. In 2000, the company becomes a wholly owned subsidiary of TT electronics. The company vision is to become one of the world’s largest manufacturers of passive electronic components and their mission is to become an integrated-business institution supplying the world’s leading
manufacturers in computing and industrial electronics markets. The company is a
global manufacturer of trimming and precision potentiometers, position sensors,
turns-counting dials, chip resistor arrays, resistor networks, integrated passive
networks, transformers, inductors, hybrid microelectronics and custom integrated
products. BI Technologies serving aerospace, defense, medical, industrial and
automotive markets and the markets served can be divided as follows:

I. Industrial (including Alternative Energy)

- AC/DC Power supplies
- DC/DC Converters
- Inverters

II. Aerospace

- Communications Power Supplies
- Engine Controls

III. Medical

- Monitoring
- Imaging
- Diagnostic
- Surgical
- Implantable

IV. Automotive (including Hybrid Vehicles)

- Inverters / electric motor
- Battery management
The electronic company can be divided into several production department/section such as Production Magnetic Line which focus on standard and customize design of transformers and inductors product, Production M44 Potentiometers which produce variable resistor 44 trimming potentiometers, Production CNC Area that have several CNC machines which capable to wind/form flat/rectangular wire and round wire air coil, Production Moulded Inductor that produces high power and performance SMD inductor with air coil molded into iron powder press and Production Agilent which consist of production cell that produces transformers. Agilent is high factory selling price and generated high profit margin for the company.

In this study, Agilent production cell have been chosen to perform the case study by improving the existing production process and material flow in the cell layout. In Production Agilent section, there have six cells which produce different types of transformer which differ in shapes and design. Only cell number six has been selected to conduct this case study (refer Appendix B2). The cell has been chosen to be improving because it is the new cell in Agilent production which does not have the proper flow of layout. Machinery, equipment and workers are placed in temporary in the cell and the appropriate flow layout will be made according to the process flow in Operational Instruction Card (OIC) which has been approved by process engineer. To optimize and analyze the process flow, Lean manufacturing principles is used as guidelines. Lean is the ability to achieve more with less resource by continuous eliminate waste and non value added activities. Furthermore, condition of the existing layout is not efficient and systematic and some transformation is needed to reduce waste in material handling and cross flow in production. Apart from that, it is also should produce safety condition. Currently, Agilent cell have 4.5 workers (4 in the cell and 1 in the testing area) and need to produce 76 pieces of output per day. When the customer demand is higher, the output increases to 120 pieces per day. The cell layout need some improvement to make productivity higher and can achieve the output target. In this cell, the process to make the transformer start by winding process for primary and secondary bobbins, assembly parts, tinning process, insert fuse, bending and lamination process. Finally, the product will go for vanishing, pre- test, final test and packaging.
For analysis of the problems existing in the selected production line, the Ishikawa diagram needs to be used to list down the possible cause. The time study and Lean manufacturing worksheet are used for taking the cycle time, calculation of the takt time and transfer the data into the graphs after making several company visits. For improvement of the system, various lean strategies will be used. Line balancing method is used to level the workload across all the processes and from the method, the number of operators required for the cell can be determined. Simulation software is used for visualizing the new process flow in the cell layout. After the implementation of the new process flow in cell layout, it takes at least one month to find out whether the new layout is suitable or not and to find out the productivity percentage.

1.2 PROBLEM STATEMENT

I. Waste of material handling in the Agilent production cell

In flow line production, the product moves to one workstation is not efficient and lots of waste in material handling. The some process was not followed the Operation Instruction Card (OIC) that provides by engineer to be followed by operators as a guidelines.

II. Poor layout makes a lot of cross flow in the Agilent production cell

The efficient of layout is when minimum of motion and cross flow in the cell. This will reduce the cycle time of the cell.

1.3 PROJECT OBJECTIVES

I. To propose an improved production flow by using Lean manufacturing method to achieve higher productivity, line efficiency and reduce cross flow in the work process.

II. To identify the non value added activities and reducing waste in material handling in the cell.
1.4 SCOPE OF STUDY

In this project, BI Technologies Corporation has been selected to perform the modification by improving the existing production flow layout which focuses on Agilent production cell. The cell 6 has been chosen to perform the modification and improvement because of the new cell in Agilent production and do not have the proper flow of layout but the machines and equipment are placed in the U-shaped.

This cell is currently has 4 workers in the cell and 1 at inspection. They need to produce 76 pieces of transformer per day. The production cell needs to be change because the higher customer demand which will increase to 120 pieces per day and to increase the productivity of the cell. Besides, it is also to reduce waste and ensure a safer condition. To conduct the research, Lean manufacturing principles and tools are use to optimize the process flow and analysis of effectiveness in Agilent production cell. The Lean manufacturing tools used in this project are Takt time, line balancing and time study. Line balancing is use to leveling the workload across all processes in a cell and time study method is use to determined the standard time in the operation.
CHAPTER 2

LITERATURE REVIEW

2.1 LEAN MANUFACTURING

Lean manufacturing is methodologies that have the systematic approach to process improvement in planning the process flow. The method is based on finding and reducing waste coupled with continuous improvement. It was first developed by Toyota (the Japanese car manufacturer), but has now been applied to many diverse industries and businesses. A few researchers gave an insight on how companies carried out their lean journey. In a research on Toyota Production System (TPS), Spear and Bowen (1999) described how this system that combines social and technical aspects has led Toyota to be the best manufacturer of the world. According to Scaffede (2002), a system which is integrated with the management’s vision and implemented by the entire production team is the key of how Donnelly Corporation has converted itself into a lean manufacturer. In particular, tools have been developed that help producers stay focused on finding and reducing waste. Lean manufacturing methods have been applied across entire firms, including engineering, administration, and project management departments, as well as manufacturing and construction. Its end purpose is to transform a company into an efficient, smoothly running, competitive, and profitable organization that continues to learn and improve. Most of Lean manufacturing benefits lead to lower unit production costs.
Effective use of space and equipment leads to lower the depreciation costs per unit produced, more effective used of labor results in lower labor costs per unit produced and lower defects which lead to lower cost of the good sold (Bosdogan, 2000). More specifically, some of the goals include:

i. Defects and wastages

Reduce defects and unnecessary physical wastages, including the excess use of raw material, preventable defects, and costs associated with reprocessing defective items and unnecessary products characteristics which are not required by customers.

ii. Cycle time

Reduces manufacturing lead time and production cycle time by reducing waiting times between production stages.

iii. Utilization of space and equipment

Use space and equipment with efficiently by eliminating bottlenecks and maximizing the rate of production through existing equipment while minimizing machine downtime.

iv. Labor productivity

By reduce the idle time of workers this will improve labor productivity and ensuring them not to doing the unnecessary tasks and motion.

v. Inventory levels

Minimize inventory levels at all stages of production and reduce work in progress. Lower inventories can lead to lower working capital requirements.
2.1.1 Lean Production and Traditional Mass Production

In this study, Lean manufacturing method and tools is used as a guideline to propose the new process flow in production. Lean manufacturing is different from other method or traditional manufacturing method. Lean manufacturing is based on the concept that production should be drive by the actual customer demands and requirements while mass production refers to a manufacturing process in which products are manufactured on a mass scale. Based on a journal entitled “Lean Production as The Dominant Model”, Womack et al. (1990) claimed that lean production would replace mass production and what was left of the crafts in all industrial sectors, becoming the global standard for the production systems of the twenty-first century. Some researchers agreed that Lean is distinctly different from conventional or “batch-and-queue” practices.

Traditional manufacturing processing, whether it is materials or information has many serious deficiencies including long lead-times, lower quality, higher cost products or services, customer dissatisfaction and poor information flow (Womack and Jones, 1996; Bowen and Youngdahl, 1998). Several case studies said that lean is transformation from conventional “batch and queue” mass production to product-aligned “one-piece flow” pull production. “Batch and queue” involves mass production of large lots of output in advance based on potential or predicted customer demands, a “one-piece flow” system rearranges production activities in a way that processing steps of different types are conducted immediately adjacent to each other in a continuous flow. In the following table show the summary differences between lean production and mass production:
### Table 2.1: Differences between Lean Production and Mass Production

<table>
<thead>
<tr>
<th>Lean production</th>
<th>Mass production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean production process focuses on producing as per the latest market demand.</td>
<td>A mass production process focuses on large-sized production. The idea is to manufacture the maximum number of products in one lot.</td>
</tr>
<tr>
<td>A Lean production process generally supplies based on customer demand.</td>
<td>The mass production process requires the company to stock the products in a warehouse.</td>
</tr>
<tr>
<td>Planning the organization using lean manufacturing is easier because it is based on market demand. Figures and statistics are known and the production schedules are easy to plan.</td>
<td>Planning for mass production is based on a variety of complex factors like market price, competition, inventory levels and time taken for distribution</td>
</tr>
<tr>
<td>Lean production is a “pull” process</td>
<td>Mass production is a “push” type of process</td>
</tr>
<tr>
<td>Lean production is demand-oriented.</td>
<td>Mass production is supply-oriented</td>
</tr>
<tr>
<td>Lean production facility produces minimal waste.</td>
<td>Huge volume of waste is generated in a mass production facility</td>
</tr>
</tbody>
</table>
2.1.2 Lean Manufacturing Principles

There are several key in Lean manufacturing principles that need to be understood in order to implement Lean. Lean manufacturing principles is important as a guide before to apply in the company. One of the most critical principles of Lean manufacturing is the elimination of waste. Any material, process and feature which is not required for creating value from the customer perspective is waste and should be eliminated. There are seven basic types of waste in manufacturing (Levantar, 2012):

i. Over production

Over production is the worst form of waste because it is the main root cause of many other wastes. Over production is a products being produced in excess quantities because they produced the products before the customer need them. This will lead to increase in inventory.

ii. Inventory

Excess inventory usually is not be used directly because they not produced based on the customer demand. Some suggest that a large inventory helps a company meet its customer’s demands but excess inventory is not something the customer cares about. Waste in inventory will result increase the space required, increase cost, excess in WIP and finished out-of-date product and increased deterioration.

iii. Motion

Motion can be considered waste when it is unnecessary in production. Excessive walking, reaching, bending and transfer of parts can all are considered wasted time and effort and can contribute to inefficiency. When trying to reduce waste of motion, movements should be kept small wherever possible. Waste of motion is cause by poor part placement, poor process flow and poor work station layout.
iv. Transportation

Waste of transportation is the unnecessary distance which traveled by workers to place the materials. Excessive handling and moving of materials from one place to another could result in increase lead time excess costs, storage space and damaged goods. This type of waste was caused by poor work area layouts and parts storage.

v. Waiting

Waiting is periods of inactivity in downstream processes that occur because an upstream activity does not deliver on time. This could be caused by having to wait for loading or unloading, waiting for repair work, waiting for equipment to process, or even waiting to use a tool. Results of waiting are over production, over processing and non-value added activities.

vi. Over processing

Over processing is producing more than is required. When focusing on eliminating waste of over processing, the main thing is to look for a better method to produce product.

vii. Defects/ Repair/ Rework

Products or aspects of the production processes that do not conform to specifications or to the customer’s expectations. This is cause by scrapped parts, wrong or defective tools or machines, wrong or missing processes, poor problem solving and unclear standards.
Another principle of Lean manufacturing is to produce standard processes. Lean required a standard work to be a production guideline to give details in timing, the content and outcome. Lean also aims for the implementation of a continuous reduction flow free of bottlenecks, backflows or waiting which can reduce the cycle time. In Lean principle, Just-In-Time is important to produce only what is needed and when it is needed. It is a Pull production which means production is pulled by the downstream workstation so that each workstation should only produce what is required by the next stations. Lean also aims for reduce defects and eliminate at the source.

2.1.3 Lean Manufacturing Tools and Techniques

The Lean production system is supported by simple processes and tools that help associates eliminate waste and consistently deliver the value that customers seek in the products and service. (Imai, 1997; Rother and Shook, 1999; Emiliani et al., 2003). Most of the researchers agreed that the intent of these processes and tools is to simplify work and the workplace to be more systematic, quality improvement, reduce lead-time, and focus workers on performing only value added activities. Importantly, employees will be realize their responsibility and be able to respond with positively to improve themselves and the organization. Both Ohno (1988) and Shingo (1989) concentrate on explaining the use of lean tools whereas Spear and Bowen (1999) argue that observers confuse these tools with the system itself. Drickhamer (2004) moreover asks to forget everything one knows about the tools as they are not a substitute for a good strategy to become lean. After identified the wastes to be removed, the next step is to finding the solution for the root causes of the wastes. Once the companies analyzed the wastes, tools in lean manufacturing such as just-in-time, standardization of work and others will help to guidelines through corrective action so as to eliminate wastes. There are numerous tools that organizations use to implement lean production systems. Some of the important tools are described briefly below. The tools include: