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IMPLEMENTATION OF JUST-IN-TIME PRODUCTION SYSTEM IN

AUTOMOTIVE MANUFACTURING COMPANY OF ETHIOPIA AND ADDIS ABABA BOTTLE & GLASS FACTORY

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ABBRIVIATIONS

All abbreviations in the text are first introduced next to their full titles e.g. just-in-time (JIT).

AABGF: - Addis Ababa Bottle and Glass Factory.

AMCE: - Automotive Manufacturing Company of Ethiopia.

APICS: - American Production and Inventory Control System.

EDI: - Electronic Data Interchange.

FMS: - Flexible Manufacturing System.

GT: - Group Technology.

Heijunka: - the Japanese word for production smoothing.

JIT: - Just-in-Time.

JITP: - Just-in-Time Purchasing.

Kanban: - Not strictly an abbreviation, the Japanese for card used in pull system.

Kaizen: - Systems of continuous improvement.

Muda: - the Japanese word for waste.

NUMMI: - New United Motor Manufacturing Inc.

SGIAs: - Small Group Improvement Activities.

SMED: - Single Minute Exchange of Die.

Takt: - German for rhythm or beat.

TMC: - Toyota Motor Company.

TPM: - Total Productive Maintenance.

TQM or **TQC**: - Total Quality Management or Control.

US: - United States.

WIP: - Work-in-Progress.

EBQ:- Economic Batch quantity.

[ ]:- The numbers in [ ] indicate the reference materials on page 146

ABSTRACT

Traditionally, a manufacturing business competes on price, variety, and after service. Now, these conditions are merely prerequisites. Few businesses exist today without offering this requirement, and the key competitive factor has become speed. Major businesses have been trying to adopt new business initiatives in order to stay alive in the new competitive market place, and there is no question that the elimination of waste is an essential ingredient for survival in today's manufacturing world. Companies must strive to create high quality, and low cost products that can get to the customers in the shortest time possible. Just-in-time production system is one of these initiatives that focus on cost reduction by eliminating non-value added activities. The tools and techniques of JIT have been widely used in both discrete and process industry starting with the introduction of the original Toyota production system.

This thesis addresses the implementation of Just-in-Time production system with focus on AMCE and AABGF. The goal of this research is to investigate how JIT can be implemented in these companies. This thesis attempts to introduce JIT from its conception, and many collaborative JIT concepts, components, elements, and tools that are used for the elimination of wastes are addressed. To develop the implementation model first the status of the companies were investigated and then the problems are identified and

formulated. The JIT implementation guidelines developed by APICS and others have been seen to develop the line implementation model of JIT for the companies. It has been seen that only a hybrid (Push-Pull) JIT systems is applicable to both companies. In the implementation model developed, Value stream mapping was used as a tool. The companies can use it to identify various types of waste in the value stream of the company and try to take steps to eliminate them. Finally the conclusions and recommendations are provided for the thesis.

Chapter-1

General Introduction

1.1 Back Ground of the Thesis

This thesis addresses the implementation of just-in-time production system concepts to the discrete production sector and the continuous production/process sector with the focus on Automotive Manufacturing Company of Ethiopia (AMCE) and Addis Ababa Bottle & Glass Factory (AABGF). After World War II, Japanese manufacturers, particularly in the automotive industry, were faced with the dilemma of shortages of material, financial, and human resources. Eiji Toyoda and Taiichi Ohno at the Toyota Motor Company in Japan pioneered the concept of the Toyota production system, or what is known today in the US as "Just-in-time manufacturing." The basic idea behind the system is eliminating waste. Waste is defined as any thing that does not add value to the end product from the customer's perspective. The primary objective of JIT production system is to assist manufacturers who have a desire to improve their company's operations and become more competitive through the implementation of different JIT system tools and techniques [1, 2, 5, 62].

Quickly following the success of JIT production system in Japan, other companies and industries, particularly in the US, copied this remarkable system. The term "JIT" as Womack and Jones (1994) define, it denotes a system that utilizes less, in terms of all

inputs, to create the same out puts as those created by a traditional mass production system, while contributing increased varieties for the end customer. JIT is to manufacture only what is needed by the customer, when it is needed and in the quantities ordered. The manufacture of goods is done in a way that minimizes the time taken to deliver the finished goods, the amount of labour required, the floor-space required, and it is done with the highest quality, and usually at the lowest cost [62].

1.2 Problem Statement

Traditionally, a manufacturing business competes on price, quality, variety, after service, etc. Now, these conditions are merely prerequisites. Few businesses exist today without offering this requirement, and the key competitive factor has become speed. Major businesses have been trying to adopt new business initiatives in order to stay alive in the new competitive market place. Just in time production system is one of these initiatives that focus on cost reduction by eliminating non-value added activities. These tools and techniques of JIT have been widely used in both discrete and process industry starting with the introduction of the original Toyota production system.

The production system of Ethiopian industries in today's global market including the industries in focus (AMCE & AABGF) has been suffering from a lot of challenges. Most of the problems are internal, but some external problems also exist. In general the problems like:

- ✓ High production cost.
- ✓ High concentration of waste.
- ✓ Inflexibility of the process and workforce.

- ✓ High inventory costs.
- ✓ Lower employee involvement for the overall improvement of the factory, and
- ✓ High defects and reworks are few due mentioned.

While it seems that some JIT tools are difficult to adapt in our industries, it is possible to implement most of JIT techniques at first and implement the difficult tools gradually. Therefore, in order to compete in today's global competitive market our industry, AMCE & AABGF also needs to look for more ways to gain a competitive edge. The researcher believed that JIT implementation in this factory would lead them on the competitive and leading line of the country.

1.3 Objective of the Study

The objective of the thesis is to justify the implementation of just-in-time production system for Automotive manufacturing Company of Ethiopia (AMCE) and Addis Ababa Bottle and Glass Factory (AABGF). Other things will include analysis of JIT system from its conception to its success today, basic components and tools of JIT, and specific requirements for implementing JIT systems for the industries in focus.

The general objective is to:

- Implement Just-in-Time (JIT) production system in Automotive manufacturing Company of Ethiopia and Addis Ababa Bottle and Glass Factory.

The specific objectives are to:

- Systematically demonstrate how JIT philosophy is used for the reduction of wastes.
- Study the benefits gained through the implementation of JIT systems.
- Know the implementation requirements of JIT.
- Develop the implementation model of JIT for the companies in focus.

1.4 Methodology Used

The methodologies implemented to achieve the above listed objectives are:

Literature survey on the subject matter: the sources used at most are books, journals, and websites.

Consultations: Consultations was held with my advisor, and representatives of AMCE and AABGF (General Manager, plant manager, production department head, purchasing department head, supervisors, and foremen).

Data collection: data is collected from AMCE and AABGF through different methods like structured questionnaire, interviews and observations were used. Electronic retrieval of the relevant sources is used from the company.

System analysis: the data collected is systematically and logically analyzed to reach a better end result and draw conclusions and recommendations.

Model development: The implementation model of JIT will be developed.

1.5 Limitations of the Study

The research is limited to the two companies, and the study was undertaken in view of AMCE assembly plant and Addis Ababa Bottle and Glass Factory. The model developed also works only for them. Other limitations include the absence of any company that practice JIT principles at the moment, due to this fact the JIT implementation and practices taken to justify the research successfulness were taken from abroad.

Chapter-2

BACKGROUND AND LITERATURE REVIEW

2.1 The History of Just-In-Time Production System

Just-in-time had its beginning at Toyota Production Company not in a mere recession but in a genuine corporate crisis [52].

After World War II Japanese manufacturers were faced with the dilemma of vast shortages of material, financial, and human resources. The problems that Japanese manufacturers were faced with differed from those of their western counterparts. These conditions resulted in the birth of the "JIT" production system concept. Toyota Motor company (TMC), led by its president Toyoda recognized that American automakers of that era were out-producing their Japanese counterparts; in the mid- 1940's American companies were out performing their Japanese counter parts by a factor of ten [13, 62]. In order to make a move toward improvement early Japanese leaders such as Toyoda Kiichiro, Shigeo Shingo, and Taiichi Ohno devised a new, disciplined, process-oriented system, which is known today as the "Toyota production system", or "Just -in-Time manufacturing." Taiichi Ohno, who was given the task of developing a system that would enhance productivity at Toyota, is generally considered to be the primary force behind this system [17]. Ohno drew upon some ideas from the west and particularly from Henry Ford's book "Today and Tomorrow." Ford's moving assembly line of continuously flowing material formed the basis for the Toyota production system. After some experimentation, the Toyota production system was

developed and refined between 1945 and 1970, and is still growing today all over the world. The basic underlying idea of this system is to minimize the consumption of resources that add no value to a product.

In order to compete in today's fiercely competitive market, many manufacturers have come to realize that the traditional mass production concept has to be adapted to the new ideas of JIT manufacturing. A study that was done at the Massachusetts institute of Technology of the movement from mass production to wards JIT manufacturing, as explained in the book "The machine that changed the world" (Womack, Jones and Ross, 1990), awoke many companies from their sleep [62]. The study underscored the great success of Toyota at NUMMI (New United Motor Manufacturing Inc.) and brought out the huge gap that existed between the Japanese and western automotive industry. The ideas came to be adopted in the US because the Japanese companies developed, produced and distributed products with half or les human effort, capital investment, floor space, tools, materials, time, and overall expense [1, 13, 62].

2.2 What Is JIT Production System

The new uprising in the manufacturing goods and service sector has created great challenges for an industry [1]. The customer driven and highly competitive market has rendered the out-fashioned managerial style an inadequate tool to cope with these challenges. These factors present a big challenge to companies to look for new tools to continue moving up the ladder in a global, competitive, growing market while some companies continue to grow based on economic constancy, other companies struggle because of their lack of understanding of the change of customer mind sets and cost

practices [26]. To get out of this situation and to become more profitable, many manufacturers have started to turn to Just-in-Time manufacturing principles to elevate the performance of their firms.

The basic ideas behind the JIT production system, which have been practiced for many years in Japan, are **waste elimination**, **cost reduction**, and **employee empowerment**. The Japanese philosophy of doing business is totally different than the philosophy that has been long prevalent in the other country. The traditional belief in the west had been that the only way to make profit is to add it to the manufacturing cost in order to come up with a desired selling price (Ohno, 1997) on the contrary; Japanese approach believes that customers are the generator of the selling price. The more quality one builds into the product and more service one offers, the more the price that customers will pay. The difference between the costs of this price is what determines the profit [42, 45]. The JIT manufacturing discipline is to work in every facet of the value stream by eliminating waste in order to reduce cost, generate capital, bring in more sales, and remain competitive in a growing global market. The value stream is defined as "the specific activities with in a supply chain required to design, order and provide a specific product or value"[1].

The term "JIT" as Womack and his colloquies define, it denotes a system that utilizes less, in terms of all inputs, to create the same outputs as those created by a traditional mass production system, while contributing increased varieties for the end customer [1, 62].

This business/manufacturing philosophy goes by different names like: Agile manufacturing, lean manufacturing, synchronous manufacturing, world-class

manufacturing, Toyota production system, zero inventory production system, stock-less production system, and continuous manufacturing system [1, 13, 62].

"JIT" focuses on abolishing or reducing Muda (“Muda", the Japanese word for waste) and on maximizing or fully utilizing activities that add value from the customer's perspective. From the customer's perspective, value is equivalent to anything that the customer is willing to pay for in a product or the service that follows. So the elimination of waste is the basic principle of JIT production system. For industrial companies, this could involve any of the following [45, 53, 62]:

- **Materia**l: convert all raw materials in to end products. Try to avoid excess raw materials and scrap.
- **Inventory**: keep constant flow to the customer and to not have idle material.
- **Over production**: produce the exact quantity that customers need, and when they need it.
- **Labor**: Get rid of unwanted movement of people.
- **Complexity**: Try to solve problems the uncomplicated way rather than the complex way. Complex solutions tend to produce more waste and are harder for people to manage.
- **Energy**: utilize equipment and people in the most productive ways. Avoid unproductive operations and excess power utilization.
- **Space**: Reorganize equipment, people, and workstations to get a better space arrangement.
- **Defects**: make every effort to eliminate defects
- **Transportation**: Get rids of transportation of materials and information that does not add value to the product.

- **Time**: Avoid long set ups, delays, and unexpected machine down time.
- **Unnecessary motion**: Avoid excess bending or stretching and frequently lost items.

In general all of these wastes are categorized into seven major types and it is summarized in table 2.1 [3, 5, 12, 13, 17].

Table 2. 1 The seven categories of waste

Waste	Description
1) Over production	Producing to much or too soon, resulting in poor flow of information or goods and excess inventory
2) Defects	Frequent errors in paper work, product quality problems, or poor delivery performance.
3) Unnecessary inventory	Excessive storage and delay of information or products, resulting in excessive cost and poor customer service
4) Inappropriate processing	Going about work processing using the wrong set of tools, procedures or systems, often when a simpler approach may be more effective
5) Excessive transportation	Excessive movement of people, information or goods resulting in wasted time, effort and cost.
6) Waiting	Long periods of inactivity for people, information or goods, resulting in poor flow and long lead times
7) Unnecessary motion	Poor workplace organization, resulting in poor ergonomics, e.g. excessive bending or stretching and frequently lost items

All the waste sources described above are all related to each other and getting rid of one source of waste can lead to either elimination of, or reduction in others. Perhaps the most significant source of waste is inventory, work in process and finished parts inventory do not add value to a product and they should be eliminated or reduced. When inventory is reduced, hidden problems can appear and action can be taken immediately. There are

many ways to reduce the amount of inventory, one of which is reducing production lot sizes, reducing lot sizes however, should be followed by a set up time reduction so as to make the cost per unit constant as the famous economic order quantity formula states [1]. At Toyota, Shingo developed the concept of single minute exchange of dies (SMED) to reduce set up times (Shingo, 1997); for instance, setup times in large punch presses could be reduced from hours to less than ten minutes. This has a big effort on reducing lot sizes. Another way to reduce inventory is by trying to minimize machine downtime [53]. This can be done by preventive maintenance. It is clear that when inventory is reduced other sources of waste are reduced too. For example, space that was used to keep inventory can be utilized for other things such as increase facility capacity. Also, reduction in setup times as a means to reduce inventory simultaneously saves time, thus is reducing time as a source of waste.

Transportation time is another source of waste. Moving parts from one end of the facility to another end does not add value to the product. Thus, it is important to decrease transportation times within the manufacturing process. One way to do this is to utilize a cellular manufacturing layout to ensure a continuous flow of the product. This also helps eliminate one other sources of waste, which is energy. When machines and people are grouped into cells, unproductive operations can be minimized because a group of people can be fully dedicated to that cell and this avoids excess human utilization. Another source of waste is defects and scrap materials. Total productive maintenance is one way to eliminate defects and scrap. Manufacturing parts that are fault free from the beginning has profound consequences for productivity [13, 62].

There is no question that the elimination of waste is an essential ingredient for survival in today's manufacturing world. Companies must strive to create high quality, and low cost products that can get to the customers in the shortest time possible. There are sets of JIT components, tools, and techniques that were developed at Toyota and that can be utilized to eliminate or at least reduce the sources of waste and these parts are discussed later.

2.2.1 Goals of Just-In-Time Production System

JIT Manufacturing tries to smooth the flow of materials from the suppliers to the customers, thereby increasing the speed of the manufacturing process. The objective of JIT is to change the manufacturing system gradually rather than drastically [24]**.** JIT can help organization remains competitive by offering consumers higher quality of products than their competitors, it is very important to ensure survival in the market place. These major objectives are suitable for all organizations. But each organization is unique in some way; adjustments of JIT objectives for each form should be made in order to complement the overall production process [13]. JIT production system therefore seeks to achieve the following goals [17, 26, 46]:

***Zero Defects*:** In manufacturing, traditionally people thought that zero defects producing were not possible and not necessary. Not possible because of the fact that people thought that at some level of production it would be no longer possible to produce without defects and not necessary because although there were defects, the product did reach customers expectation. With the aim of JIT there will be no longer any cause of a defect and therefore all products will meet (far more) than the expectations. This is also related to a part of Quality Management.

***Zero Set-up Time*:** Reducing the set up-times leads to a more predictable production. No set-up time also leads to a shorter production time/production cycle, and less inventories.

***Zero Inventories*:** Inventories, including work-in-progress, finished goods and sub-assemblies, have to be reduced to zero. There will be no more sub-assemblies, no work-in-progress and no finished goods.

***Zero Handling*:** Zero handling in JIT means eliminating all non-value adding activities.

***Zero lead-time*:** Zero lead time is a result of the usage of small lots and increases the flexibility of the system. When there are no lead-times, the possibility to make planning which do not rely on forecasts becomes bigger and bigger.

The JIT philosophy recognizes that in some markets it is impossible to have zero lead-times, but makes clear that when a firm focuses on reducing lead-times, this firm can manufacture more flexible than other manufacturers in the same market.

***Lot Size of one*:** A lot size of one makes it possible to adapt when demand is changing. The use of Kanban systems is one way to reach the goals producing in JIT seeks to achieve. The full explanation of Kanban is given on page 20 of this work.

Given the fact that the JIT philosophy has a wide range of goals, it's not strange that with JIT we get a view on the total manufacturing picture [46].

2.2.2 Benefits of Just-In-Time Production System

The goals of a successful business are continual improvement of customer satisfaction and minimal costs; both overhead and capital. Conventional attitudes toward lot size, production time and inventory can actually increase costs. The JIT philosophy strives to minimize cost and wasted time by producing exactly what is needed when it is needed. With JIT inventory planning, the only inventory is in transit; this results in lower capital costs. Furthermore, JIT production results in tighter bonds between the customer and the supplier because suppliers are considered partners. The underlying concept of JIT inventory is elimination of waste. JIT strives for an ideal lot size, where less is better. The idea is to drive all queues toward zero in order to: minimize inventory investment, shorten production lead times, react faster to demand changes, uncover any quality problems [58]. Karlene (1988) has described five major benefits potential of JIT manufacturing system, these benefits are the following [9, 23, 60, 61]:

REDUCTION IN INVENTORY: Inventory protects the organization against problems such as uncertain equipment breakdowns, late deliveries, demand fluctuation etc. High inventory creates problems viz., high setup time, quality defects, equipment down time, production planning deficiencies, and etc. There should be a continuous drive from top to bottom to minimize all types of inventories: work-in-process, raw material, finished goods, component parts, and so on. A significant amount of inventory can be reduced the inaccuracies of demand predictions at different points of production flow. Electronic data interchanges can be used implying other JIT techniques to lesson inventories. A forecast can be generated based on daily basis.

QUALITY IMPROVEMENT: JIT systems offer an organization the means to produce more usable products. The quality of product or service reflects the health of organization and its potential for growth. Quality adds value to the products and is a never-ending process to exceed customer expectations now and in the future.

INCREASED PRODUCTIVITY: increase in periodicity means increasing the volume of production from given resources. Increase in productivity lowers the cost of product. Productivity is the ratio of out put to the value of input.

$$\textbf{Productivity} = \frac{\textit{Value of output}}{\textit{Value of input}}$$

The outputs may be products or services and the inputs or resources may be land, materials, plant machineries, tools and a human resource. The change in productivity may come by altering the denominator of the objective function; i.e., the resources of inputs.

INCREASED PROFIT MARGIN: profit is the ultimate measure of the success of an organization. Profit equalization can be written down as:

Profit = sales realization-all costs.

Profit = sales volume * unit price (value) - all costs.

Profit can be increased by boosting the sales of products, increasing the value/quality of the products, and reducing the cost of production by means of increasing productivity.

INCREASED COMPETITION POSITION: develop, produce and sell new products faster than your competitor. Competitive edge can be built-up only if your organization works harder and performs better than your competitors.

2.2.3 JIT and the Choice of Manufacturing Strategy

A company, which is developing its manufacturing strategy, must start by considering customer needs in the market place and competitor activity. Manufacturing and marketing strategy issues are linked by identifying how products win orders in the market place, and by using such order-wining criteria to become the task for manufacturing to achieve [5].

Table 2. 2 JIT and Competitive Advantage

JIT Capability	**Competitive advantage derived from JIT capability**
WIP reduction	- Lower-cost manufacture
	- Reduced order to delivery lead time
Increased flexibility	- Responsive to customer demands
Raw materials reduction	- Lower-cost manufacture
Increased quality	- Higher-quality products
	- Lower-cost manufacture
Increased productivity	- Lower-cost manufacture
Reduced space requirements	- Low cost manufacture
Lower overheads	- Lower-cost manufacture

The relationship of JIT to manufacturing strategy development can be considered in terms of both of its impact on customer needs and of matching-or improving on- competitor activities. Table 2.2 shows how JIT benefits can be used to provide different forms of competitive advantage [5].

A company, which has already decided on the major aspects of its manufacturing strategy, can match this strategy to the particular capabilities of JIT. Table 2.3 shows how this can be done.

Table 2. 3Company Strategies and JIT

Competitive Strategy	JIT Capability supporting Strategy
Rapid response to customer needs	- Flexibility
	- WIP reduction
Compete on quality	- Increased quality
Compete on price	- WIP reduction
	- Raw material reduction
	- Increased productivity
	- Reduced space requirements
	- Lower Overheads

A competitive strategy of rapid response to customer needs can be supported by the JIT capability of flexibility and WIP reduction and so on.

One popular misconception of JIT is that it is limited to the flow line/large batch environment of the automotive industry. Historically this is where JIT began. Even within the automotive industry, however, there exists such a variety of batch sizes and output volumes that it is difficult to proscribe what constitute 'repetitive' manufacturer. Once an automotive company has started along the JIT route, there seems to be no area or section which does not benefit from JIT principles like the elimination of waste. JIT applies very well to the job shop as it does to the assembly line. Techniques for eliminating waste can be applied to good effect outside manufacturing as well, such as in sales and distribution.

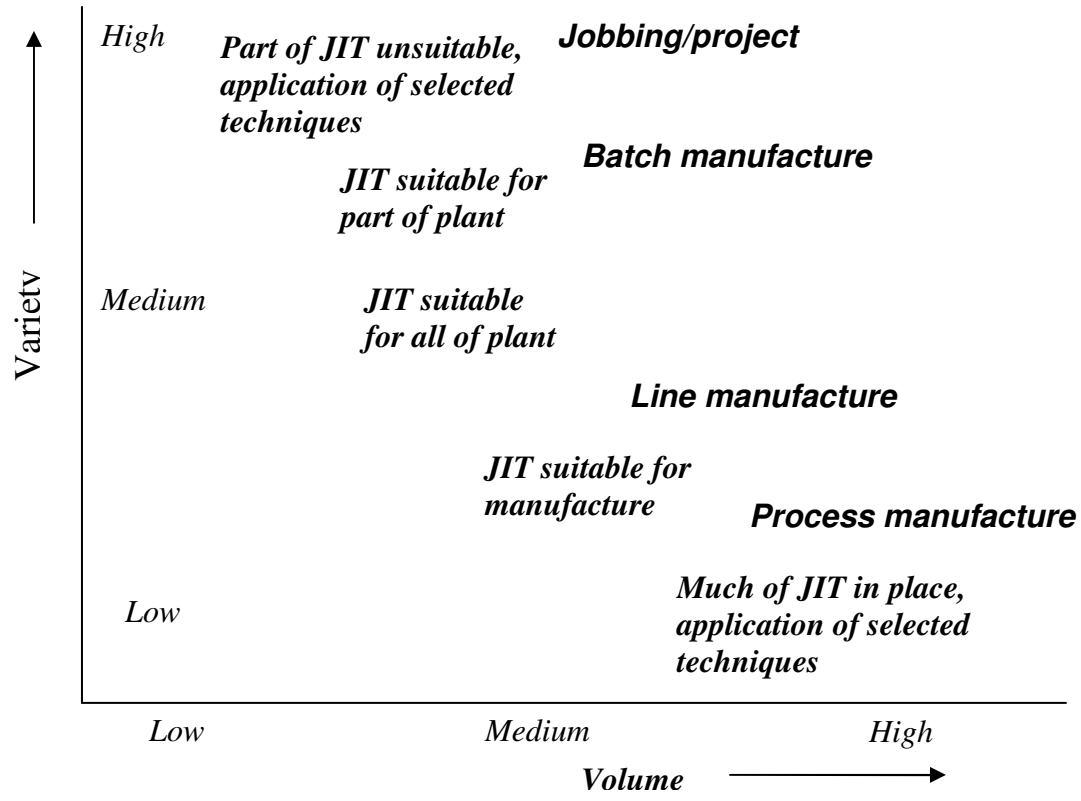


Figure 2. 1 JIT and choice of the process

It is simply that there is a difference in emphasis on which techniques are used in the pursuit of excellence. Figure 2.1 illustrates the suitability of JIT for a range of process choice environments. Those at the center of the diagram are prime candidates for JIT manufacturing. Those at the top left or bottom right will be suitable for selected applications. In the case of Job shops, such applications may include total quality, work force flexibility, and the promotion of flow in manufacturing: In fact, the message is similar for all types of manufacturing. JIT is about the pursuit of excellence in manufacturing and it has the power to provide a holistic approach to the improvement process [5].

2.3 Concepts of JIT Production System for the Reduction of Wastes

The basic approach to the Just-in-Time production system is to reduce product costs through the elimination of Wastes. The operations planning and control system is an information system running throughout the manufacturing environment. Systems run in different ways in different environments. Manufacturing environments can be changed to make planning and control systems simpler and more effective. Just-in-time is not only a control technique, but also a way to improve the manufacturing environment. JIT control systems are only effective in JIT environments. JIT Control can be incorporated into a production system as a control part with a condition that the system has to be in a JIT environment. The JIT philosophy guides the development of the JIT environment. The JIT environment provides the foundation for implementing the JIT control techniques [15, 24].

2.3.1 JIT Production System guiding principles with basic Elements, Tools, and Control Techniques

2.3.1.1 Pull Production System

JIT philosophy utilizes what is known as a "**pull system**" customer demand as opposed of a "push system", which is the generator of the order sends, the first signal to production. As the result, the product sets pulled out of the assembly process. The final assembly line goes to the preceding process and pulls or with draws the necessary parts in the necessary quantity at the necessary time [42] .The process goes on as each process pulls the needed parts from the preceding process further up stream. The whole process is coordinated through the use of a kanban system. Shipments under JIT are in small, frequent lots. A kanban is used to manage these shipments. Figure 2.2 shows the operation of pull production system under JIT conditions [23].

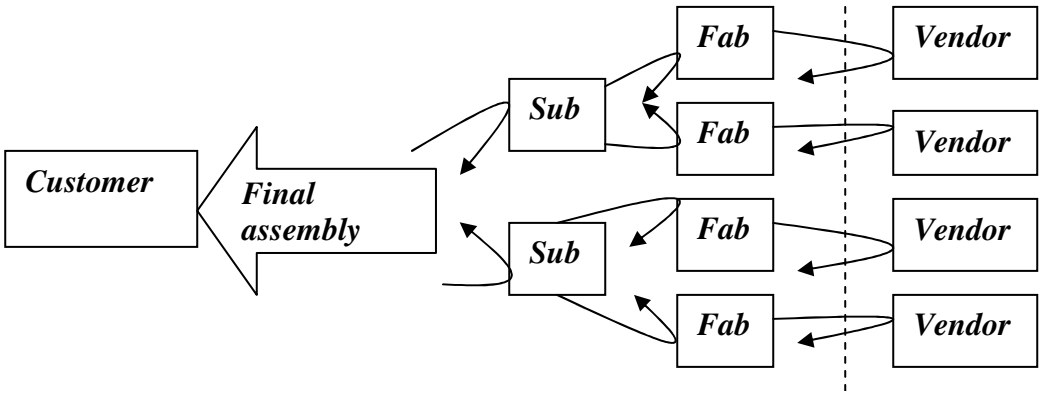


Figure 2. 2 Pull production systems

2.3.1.2 Kanban Production System

Kanban is an information system that is used to control the number of parts to be produced in every process as shown in figure 2.3 [42] .The most common types of kanbans are the withdrawal kanban, which specify the quantity that the succeeding process should pull from the preceding process, and the production kanban, which specifies the quantity to be produced by the proceeding process [42].

A supplier kanban is another type of kanban that is used between the supplier and the manufacturer under JIT. In order to achieve JIT delivery, suppliers have to adjust from the traditional run sizes to smaller lot sizes. The supplier kanban circulate between the manufacturer and the supplier [42].

By utilizing a kanban system under JIT, smaller lot sizes and huge inventory reductions can be achieved. Under this production system raw material, subassemblies and finished product inventory are kept to a minimum and the JIT production principles are followed to eliminate inventory as a source of waste.

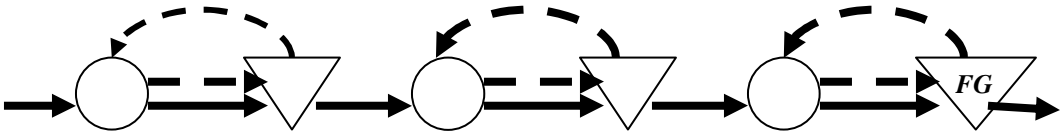


Figure 2. 3 Kanban card circulations

Key: The sold line represent movement of parts, the broken lines represent the circulation of kanban, the circle represents the machines and the triangle represents the buffers.

Another type of waste that is eliminated under JIT production is over production since every process is producing at a pace no higher than that of the subsequent process requirements, the need to produce more than what is diminished [1,42].

2.3.1.3 Continuous Improvement (Kaizen)

JIT improves the manufacturing system gradually rather than drastically. This gradual continuous improvement is defined by APICS Dictionary as “one less at a time”: a process of gradually reducing the lot size of the number of items in the manufacturing pipeline to expose, prioritize, and eliminate waste [24].

The Japanese refer to continuous improvement as kaizen. To the Japanese, kaizen means to strive relentlessly to increase quality, efficiency and effectiveness in all areas of life. Although this concept definition may sound somewhat individualistic, the Japanese emphasize small incremental, but cumulative holistic improvements. The continuous improvement approach is illustrated by the Shewhart-Deming plan-do-check or study-action (PDCA or PDSA) cycle that appears in Figure 2.4. The PDCA cycle involves using a variety of statistical tools and is a never-ending activity for companies that embrace the continuous improvement methodology. Some of the statistical tools used in the continuous improvement cycle include: Pareto diagrams, Fishbone or cause and effect diagrams, Histograms, charts, Control charts and related techniques.

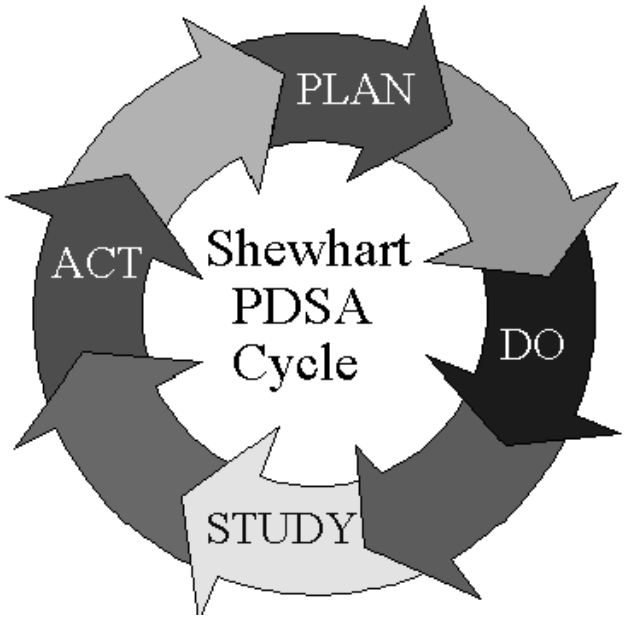


Figure2. 4 PDCA Statistical Tools

Pareto diagrams:-show the causes of problems in bar chart format. The idea is to graphically display opportunities for potential improvement.

Fishbone diagrams: - show a sketch of the relationships that may contribute to a particular problem.

Histograms: - show the distribution of a performance measurement such as the number of shortages, or the number of defects, over a period of time.

Control charts and scatter diagrams: **-** are perhaps the most important statistical tools available to aid in the PDCA continuous improvement effort, and they were given considerable attention. Control charts are used to determine when a process is stable and whether or not it is in control. Control charts are also used in the check step to reveal the success of the plan and do steps in improving the mean outcome or in reducing the variability of the process. Scatter diagrams and the related regression and correlation techniques are powerful tools for identifying cause and effect relationships [6, 31]

2.3.1.4 Total Quality Control (TQC)

TQC, also known as Total Quality Management (TQM), is a management tool for improving total performance. TQC means organized Kaizen activities involving everyone in a company - managers and workers - in a totally systemic and integrated effort toward improving performance at every level. It is to lead to increased customer satisfaction through satisfying such corporate cross-functional goals as quality, cost, scheduling, manpower development, and new product development [6, 18, 36].

In Japan, TQC activities are not limited to quality control only. Elaborate system of Kaizen strategies has been developed as management tools within the TQC approach. TQC in Kaizen is a movement aimed at improvement of managerial performance at all levels. According to the Japan Industrial Standards, "implementing quality control effectively necessitates the cooperation of all people in the company, including top management, managers, supervisors, and workers in all areas of corporate activities such as market research and development, product planning, design, preparation for production, purchasing, vendor management, manufacturing, inspection, sales and after-sale services, as well as financial control, personnel administration, and training & education. Quality control carried out in this manner is called company-wide quality control or total quality control (TQC)"[36, 43]. JIT requires high quality in every aspect of production [18].

Table 2. 4 Main Differences between TQC Practices in Japan and the West [36]

Japan	The West
• deals with quality of people	• deals with quality of products
• customer-oriented	• manufacturer-oriented
• upstream	• downstream
• process-oriented, aimed at improving the total performance	• product-oriented, aimed at detecting and eliminating defective parts
• company-wide, everybody's responsibility	• responsibility of quality control managers

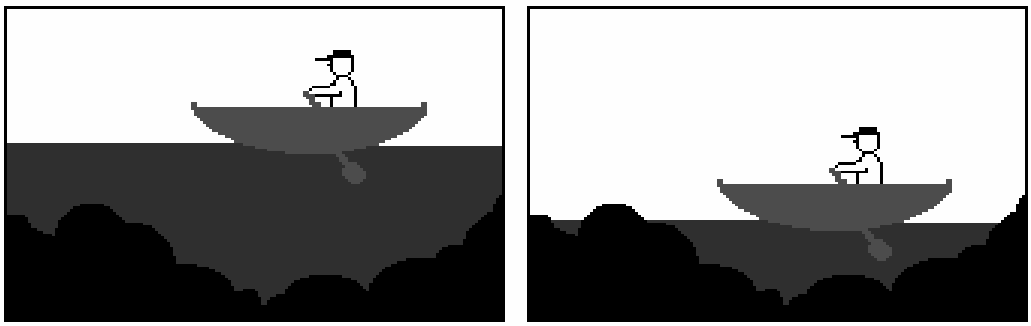
There are countless points to emphasize when considering TQC; some of the stronger areas to concentrate on are as follows:

- Seeking long-term commitment to quality efforts will ensure that efforts will be maintained throughout the life of the company [6].
- Quality must be a higher priority than cost [6, 41].
- Minimizing Waste in production consists of more than minimizing losses of time and resources [41].
- Eliminate Quality Inspectors, Make Quality everyone's responsibility, and doing the job right the first time [6].
- Total Quality Control" is one of the fundamental goals in JIT manufacturing [29].
- **Quality is an integral part of a JIT program [29].**

2.3.1.5 Inventory Management

The main emphasis in JIT manufacturing is the goal of Zero Inventory; to achieve this goal the safety stock must be eliminated. A reduction in WIP will reduce the number of defects in the event of a problem. JIT is not an inventory control system; it is a philosophy for continuous improvement of quality that puts emphasis on prevention rather than correction. Reduction of Inventory will also open up more space in the factory [31, 58].

Next is an analogy of how reducing inventory will aid in overall performance. Inventory hides problems in a process, if you reduce it, then problems in the system becomes clearer. If we look at the figure 2.5, in the first picture the boat is clearly above all rocks in the water, and no problems clearly exist. In the second picture the water level lower and the rocks have now become a problem for the boat [41]. The water level represents inventory, the rocks represent problems in the system, and the boat represents the company's operations.



If inventory is reduced, problems in the system become clearer from the operations standpoint [31].

2.3.1.6 Total Productive Maintenance (TPM)

Machine breakdown is one of the most important issues that concern the people on the shop floor. The reliability of the equipment on the shop floor is very important since if one machine breaks down the entire production line could go down. An important tool that is necessary account for sudden machine breakdowns is total productive maintenance. In almost any lean environment setting a total productive maintenance program is very important [1, 5].

There are three main components of a total productive maintenance program: **preventive maintenance, Corrective maintenance and maintenance prevention**. Preventive maintenance has to do with require planned maintenance on all equipment rather than random checkups. Workers have to carry out require equipment maintenance to detect any anomalies as they occur. By doing so sudden machines breakdowns can be prevented, which leads to improvement in the throughput of each machine. Corrective maintenance deals with decisions such as whether to fix or buy new equipment. If a machine is always

down and its components are always breaking down then it is better to replace those parts with newer ones. As a result the machine will last longer and its up time will be higher. Maintenance prevention has to do with buying the right machine. If a machine is hard to maintain (e.g., hard to lubricate or bolts are hard to tighten) then workers will be reluctant to maintain the machine on a regular basis, which will result in a huge amount of lost money invested in that machine [1].

2.3.1.7 Total Employee Involvement

A successful JIT environment should have the cooperation and involvement of everyone in the organization [40]. People are managers when they have a hand in planning their job activities and measuring the results of what they have done. The total employee involvement philosophy includes [47]:

Teaming: This involves putting employees into teams and making their brains work as well as their hands. Employees are asked to be part of a team, to communicate problems, and to search for solutions. These teams are formed across all disciplines so that we have engineers, shop floor employees, and accountants all working on teams together.

Empowerment vs. Top-down management: Empowerment involves the giving of decision power to the employees. If the employee team makes a decision, they have the power to implement the decision. Decisions flow upward as opposed to the traditional top-down management.

Shorter organizational charts: The communication linkage between top management and the line worker needs to be shortened with empowerment and teaming the span of control for each manager can be much greater, and the current number of middle management levels is no longer necessary.

Gain sharing: The motivation behind the teaming concepts is gain sharing. Employees benefit from the involvements they generate by sharing in the gains of the organization.

Job security: A fundamental principle behind proper motivation and improvements in quality is that employees need to have their primary concern eliminated, which is that they might lose their jobs. If employees are afraid to make suggestions because they may work themselves out of a job, or if they are afraid to speak up because they may offend some one and get fired, many of the improvements, which could be made, will never be made. To avoid this problem, employees are guaranteed their job for the life of the corporation.

Cross training and Job rotation: Employees are rotated out of their job every two years and trained into a new job. They are not only trained on how to do the job, but they are also trained about the quality and maintenance issues that go along with the job. The principle here is that an employee with a well-rounded background about how the company operates will be valuable to the company in making improvements.

2.3.1.8 Production Smoothing

In a JIT manufacturing system it is important to move to a higher degree of process control in order to strive to reduce waste. Another tool to accomplish this is production smoothing. Heijunka, the Japanese word for production smoothing, is where the manufacturers try to keep the production level as constant as possible from day to day [1, 12, 62]. Heijunka is a concept adapted from the Toyota production system, where in order to decrease production cost it was necessary to build no more cars and parts than the number that could be sold. To accomplish this, the production schedule should be smooth so as to effectively produce the right quantity of parts and efficiently utilize manpower. If the production level is not constant this leads to waste (such as work in-process inventory) at the work place.

2.3.1.9 Poka-yoke (Fool Proofing)

Pokayoke is a Japanese word, which has come into regular use within the lean manufacturing vocabulary. It is the use of simple mechanisms that stop mistakes being made by manufacturing operators without requiring concentration by the operators. Most often these Pokayoke's or fail-safe devises are very simple and often inexpensive visual prompts that prevents the defect in the product occurring. Either the operator is alerted that a mistake is about to be made, or the device actually prevents the mistake from being made. The important point of these types of mechanism is that 100% of the parts are checked with out the need for concentration from the operator. The term "Poka Yoke" was popularized by Shigoe Shingo through his book "zero quality control": source inspection and the Pokayoke system". Shingo points out that mistakes will always be made (we're only

human after all!), but if Poka Yoke's are implemented then mistakes can be prevented from becoming defects (mistakes that reach the customer) [28].

Pokayoke's are an effective and relatively inexpensive way of reducing manufacturing defects and therefore the quality costs, however thought should be given as to why it was possible to make the mistake in the first place and therefore need Poka Yoke's. A long-term aim might be to eliminate the source of problem not just prevent it from occurring; this might be best achieved in the design stage [32].

2.3.1.10 Standardization of Work/ Work simplification

A very important principle of waste elimination is the standardization of worker actions. Standardized work basically ensures that each job is organized and is carried out in the most effective manner. No matter who is doing the job the same level of quality should be achieved. At Toyota every worker follows the same processing steps all the time. This includes the time needed to finish a job, the order of steps to follow for each jobs, and the parts on hand. By doing this one ensures that line balancing is achieved, unwarranted work-in-process inventory is minimized and non-value added activities are reduced [5, 24, 43]**.** A tool that is used to standardize work is what called "Takt" time. Takt "German for rhythm or beat) time refers to how often a part should be produced in a product family based on the actual customer demand. The target is to produce at a pace not higher than the takt time [1]. Takt time is calculated based on the following formulas [16]:

$$\text{Takt Time (TT)} = \frac{\textit{Available working Time per day}}{\textit{Customer demand per day}}$$

2.3.1.11 Manufacturing Flexibility

The ability to rapidly shift production from one item to another is a function of many factors, 'including setup times, work rules, worker flexibility, and equipment flexibility. Recently, labor unions have been more receptive to changes in work rules that allow workers to perform operations previously restricted to a specific worker classification. These changes combined with training workers to perform various operations are essential to increased flexibility. When production quantities do not justify dedicated equipment, equipment flexibility can often be increased substantially with minor equipment modification [59]. A flexible manufacturing system (FMS) is a highly automated GT machine cell, consisting of a group of processing workstations (Usually CNC machine tools), interconnected by an automated material handling and storage system, and controlled by a distributed computer system. The capabilities that a manufacturing system must possess to be flexible are: The ability to identify and distinguish among the different part or product styles processed by the system, Quick changeover of operating instructions, and Quick changeover of physical setup [18].

In this sense, flexibility is an attribute that applies to both manual and automated systems. In Manual systems, the human workers are often the enablers of the system's flexibility.

2.3.1.12 Cellular Manufacturing

Cellular manufacturing is one of the cornerstones when one wants to become JIT. Cellular manufacturing is a concept that increases the mix of products with the minimum waste possible. A cell consists of equipment and workstations that are arranged in an order that maintains a smooth flow of materials and components through the process. It also has assigned operators who are qualified and trained to work at the cell [1].

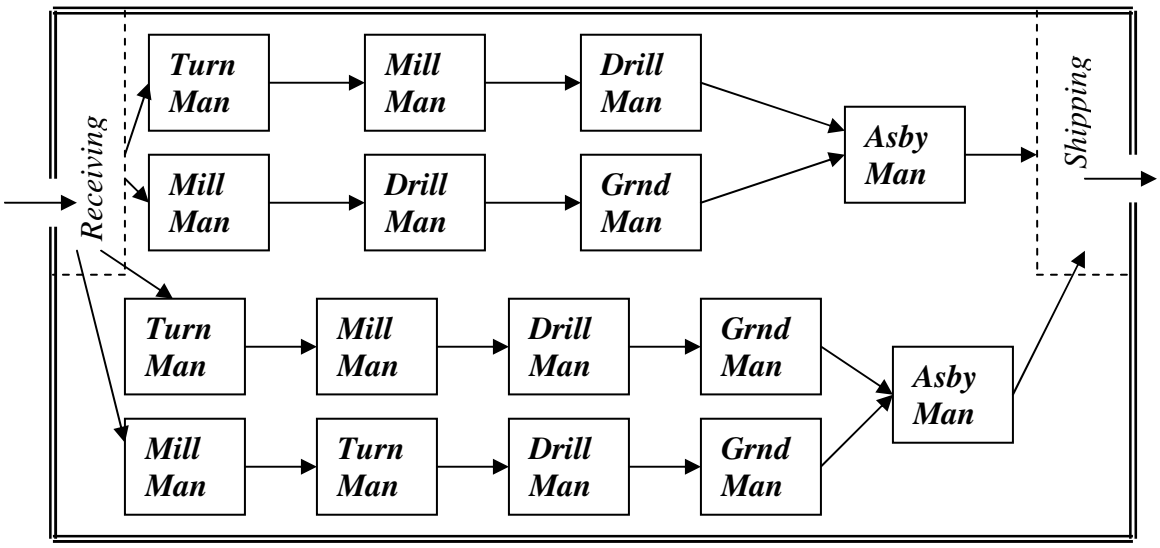


Figure 2. 6 Group technology lay out (source: Groover; 2001)

Key: "Turn"= turning, "Mill"= Milling, "Drill"= Drilling, "Grnd"= Grinding, "Asby"= Assembly, "Man"= Manual operation; arrows indicate workflow in machine cells.

Figure above shows that each cell is organized to specialize in the production of a particular pert family.

The inter-relation between JIT and cellular manufacturing is twofold; first, in many cases, a cellular layout is developed with the express purpose of exploiting JIT methods for production control; and second, JIT considerations can be seen to play an important role in

deriving optimization objectives for the cell design process [56]. Arranging people and equipment into cells has great advantage in terms of achieving JIT goals. One of the advantages of cells is the one piece flow concept, which states that each product moves through the process one unit at a time without sudden interruption, at a pace determined by the customer's need. Extending the product mix is another advantage of cellular manufacturing. When customers demand a high variety of products as well as faster delivery rates, it is important to have flexibility in the process to accommodate their needs. This flexibility can be achieved through grouping similar products into families that can be processed on the same equipment in the same sequence. This will also shorten the time required for change over between products, which will encourage production in similar lots. Other benefits associated with cellular manufacturing includes: Inventory (especially WIP) reduction, reduced transport and material handling, better space utilization, lead time reduction, identification of causes of defects and machine problems, improved productivity, enhanced teamwork and communication, and enhanced flexibility and visibility [1, 56]:

2.3.1.13 Performance Measurement

For what ever we seek to improve or waste we seek to eliminate, measurement is necessary to know exactly where we are, where we have been, and where we are going [43]. JIT organizations utilize the measurements in ways unlike many traditional measurement systems. One key to JIT's success stems from the feedback mechanisms developed including the 35 measures of improvement [40].

Table 2. 5 Performance measures for JIT operations

1. **Quality**- usually measured in terms of percent yield, defects, scrap or rework; sometimes in terms of customer returns or complaints.
2. **WIP**- work in process inventory from getting through final assembly.
3. **Manufacturing flexibility**- Number of different models or products producible per unit of time.
4. **Turns**- Number of times inventory turns per year.
5. **Lead (or through put) time**- time between order entry or start of production and delivery; sometimes expressed as cycle time.
6. **Value added (or production) time**- amount of time material or product is being subjected to change.
7. **Throughput ratio**- ratio of value added time to throughput time.
8. **Set up (Changeover) time**- amount of time from last good piece to first good piece.
9. **RM & FG inventory**- amount of raw material or finished goods in stocks.
10. **Floor space**- square feet of floor space to accommodate operations.
11. **Flow distance**- total material travel distance through operations.
12. **Cycle time**- time to complete a unit, subassembly, total product, batch, or customer order; sometimes order turnaround time or customer lead time.
13. **Transit time**- time required moving inventory from one operation to another.
14. **Queue time**- time material waits to be worked on.
15. **Down time**- amount or percent of unplanned and/or scheduled time equipment down for repair or maintenance.
16. **Inspection delay**- any checking time, especially time required to subject product to simulated aging and stress conditions.
17. **On-time performance**- every thing done when said.
18. **Suppliers**- number of suppliers; or certified suppliers who furnish inventory without incoming inspection.
19. **Forklifts**- number of or amounts of time forklifts are in operation.
20. **Employee versatility**- ability to actually change tasks on short notice.

21. **Suggestions**- number of accepted suggestions generated by employees.
22. **Team work**- organized and spontaneous cooperative effort.
23. **Motivation**- enthusiasm and attentiveness with which people respond to challenges and responsibility.
24. **Turn over**- rate at which people are replaced.
25. **Absenteeism (or tardiness**) – time away job when needed.
26. **Morale**- usually expressed in terms of percent favorable responses to pivotal item in attitude survey.
27. **Real work**- percent time worked with out instructions by complexities.
28. **House keeping**- work area clean, uncluttered, and orderly.
29. **Labor costs**- many spent for direct/indirect labor.
30. **Margins**- sales price minus production costs.
31. **Capital expensive**- money spent for capital equipment.
32. **Operating expense**- cost of converting inventory to sales.
33. **Cash flow**- timely receipt of money generated through sales.
34. **ROI**- return on investment, money received (before taxes) as percent of money spent.
35. **Profit**- absolute bottom line net return after distribution of income to employees, shareholders and government.

Measurement establishes priorities for workers, departments, and the organization [43]. In JIT organizations, the standardized measures listed above are being used by people at all levels and in all functions as bridges between factory performance and bottom-line measures. While the performance measures given above are not a universally applicable list, it is illustrative of criteria each organization can develop with the help of its members [40]. However, just having a list of performance measures leaves an important question unanswered the responsibility of individuals. This is accomplished using accountability grid that is to be developed by workshop participants, as illustrated in table 2.6.

Table 2. 6 Accountability grid for performance measures

	Opr	Supr	Mai	C	Mat. m	Ind. eng	Mfg. er	Γ	Data proc	Accou	pers	Purchasi	Mfg	Plant manager
1.Quality	AR	AR	A	AR	A	A	A	AR	A	A	A	A	AR	AR	AR
2.WIP	A	A	A	A	AR	A	A	AR	A	A		A	AR	AR	AR
3. Manufacturing flexibility	A	A	A			A	AR	A	AR			A	A	AR	A
4. Lead time			A			A						A	AR	A	A
5.Value added time	A	A				AR	A	AR						A	A
6.Throughput ratio	A	A				AR			A					AR	A
7.Changeover time	AR	A	A			AR	A							A	A
8. RM & FG inventory					AR				A	A		AR	A	A	A
9. Floor space		A				AR								A	A
10. Flow distance		A			A	AR								A	A
11. Cycle time		AR				AR			A					A	A
12. Transit time	A	A			A	AR								A	A
13. Queue time	A	A			A	AR								A	A
14. Down time	AR	A	AR			A								A	A
15. Inspection delay	AR			AR	A	A							A	A	A
16. Suppliers				AR	A							AR		A	A
17. Employee versatility	AR	A				A					AR			A	A
18. Suggestion	AR	A	A	A	A		AR	A	A	A	A	A	A	A	A
19. Team work	A	A	AR	A	A	AR	A	A	A	A	A	A	A	AR	A
20. Motivation		AR									A			A	A
21. Turn over		AR									AR			A	A
22.Absenteeism		AR									AR			A	A
23. Morale		A									AR			A	A
24. Real work	AR	AR				A								A	A
25. House keeping	AR	A	A		A	A	AR							A	A
26. Labor costs		A								A	AR			A	A
27. Margins										AR			A	A	A
28. Capital expensive						A	AR			A				A	A
29. Operating expense	AR	A	A	A	A	A	A	A	A	AR	A	AR	A	A	A
30. Cash flow										A			AR	A	AR
31. Profit										A					AR

Key: A=Accountability, **AR=** Accountability and reporting

2.3.1.14 Lead Time and Cycle Time Reduction

Lead times reduction in a JIT environment will enable a company to respond quickly to customer needs simply by reducing the time required to make products and have them available to customers [13]. In manufacturing, lead time was considered starting from design until deliver the products or services to the customers. Thus, the lead time consists of the following time elements: Product Development (Design) leads time, Sourcing (purchasing) lead time, Manufacturing (production) lead time, Order processing lead time, Distributions lead time, Other (e.g. decision making, coordination) lead time, clearly, production lead time is only a small portion of the whole lead time, but it is the only component which is controllable by production function. Manufacturing lead time consists of the following five elements [13]:

1. **Waiting time**: - The time subsequent to the completion of operations.
2. **Moving time**: - The duration required moving between machine operations.
3. **Queuing time**: - The time period to the commencement of operations. In many organizations, queue time is responsible for approximately 80-90% of the total manufacturing lead time.
4. **Machine set-up times**: - The amount of time required completing machine changeovers and set-ups.
5. **Running time**: - The time required for work in-process parts to complete a machine operation.

Efficient management of lead time reduction can be achieved through the use of a ‘closed loop’ system [13].

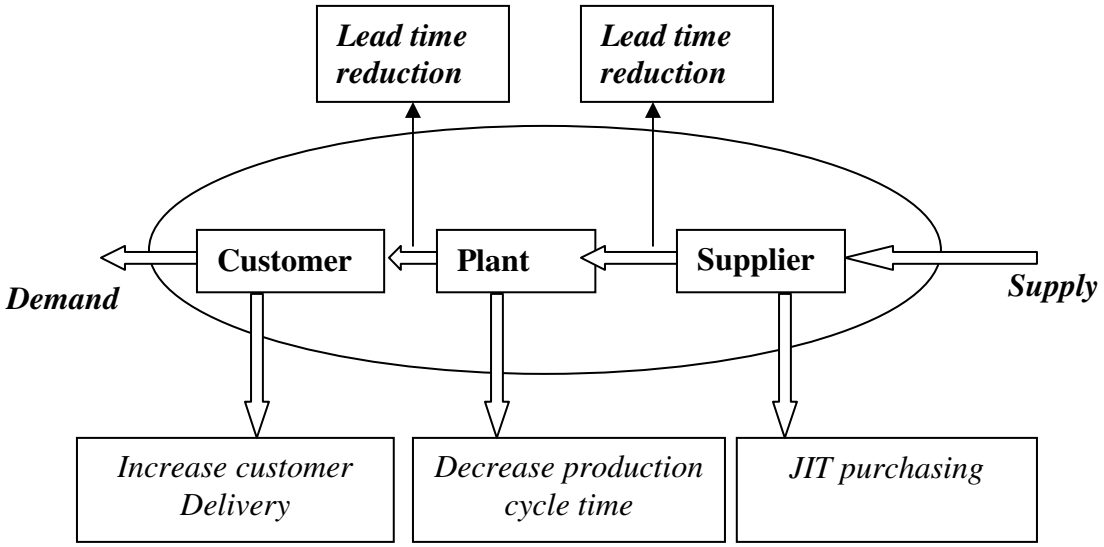


Figure2. 7 The closed loop system (Source: Schultz, 1987)

The closed loop system is capable of adjusting to changes and providing compensations between supply and demand, customers, plants and suppliers. Reducing the cumulative lead-time or the sum of lead times for purchasing materials, manufacturing operations and product assembly allows a company to reduce planning horizon for production. Reducing the planning horizon allows the company to increase the accuracy of its demand predictions. Reducing the inaccuracies of demand prediction diminishes the amount of buffer inventory that would otherwise be required.

2.3.1.15 Set-Up Time Reduction

Setup time is time spent in preparation to do a job. In manufacturing, set-up time is the elapsed time between when the last unit of one lot is produced and when the first good unit of the next lot is produced [43]. Set up or changeover reduction has been an important

element of lean thinking for a number of years. However, changeover and set up time are actually different things. Changeover is the time between good product and good product at the right speed, this includes set-up time and Run-up time as shown in figure 2.7 [32].

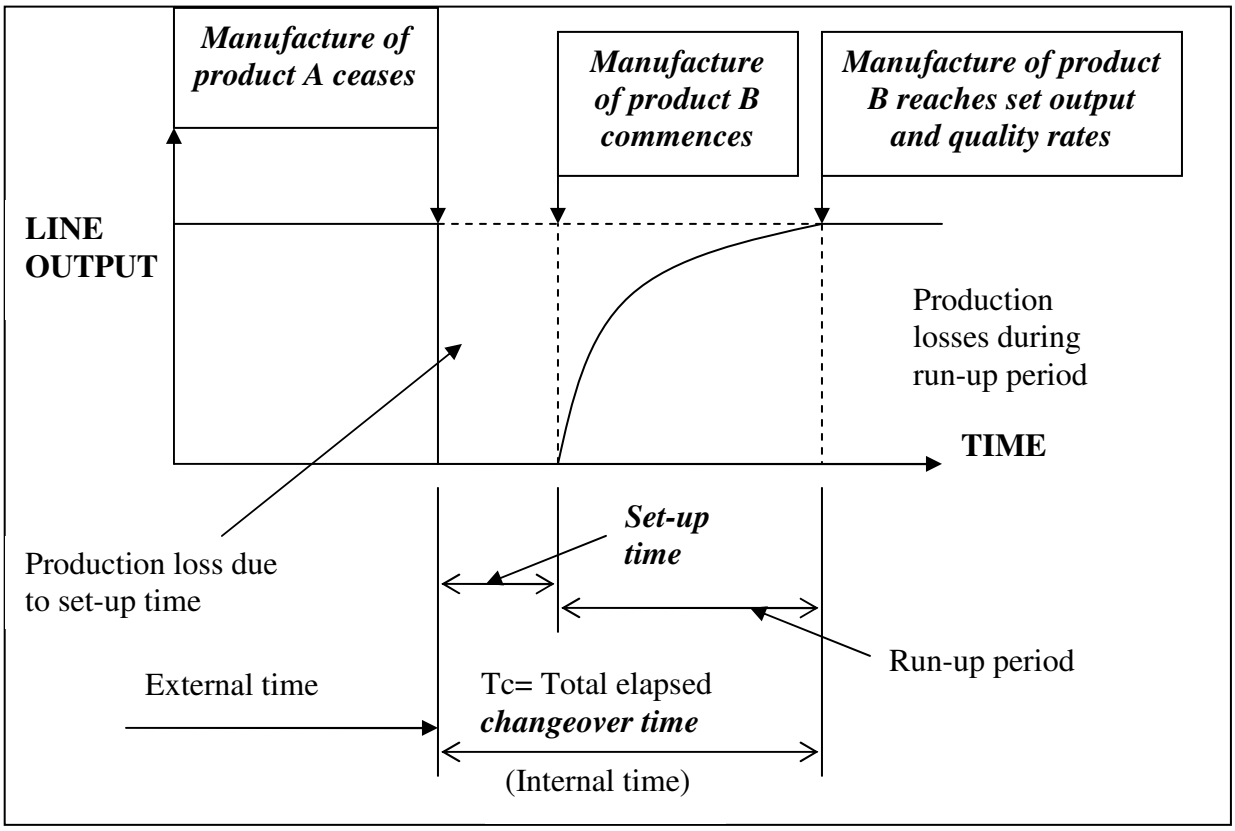


Figure2. 8 Change over time and set-up time

Set-up time refers to the time taken to physically make the change to the line in order to run the new product, run-up time is the time taken to make adjustments to the line in order to produce products of the specified quality at the specified production speed. Set-up reduction may bring the following impacts to the shop floor: lot-size can be reduced, help to reduce inventory, reduce the cost of setup labor, increase the capacity on bottleneck equipment, help to eliminate the set up scrap, and reduce the potential quality problems and

obsolescence [10]**.** There are a number of potential advantages to reducing the time taken to changeover a production line, these include: increased efficiency, reduced stock requirement, increased capacity, reduced work in process, increased flexibility [32].

***Set-up Reduction Methodology*:** Probably the foremost authority on setup reduction is Shigeo Shingo. Shingo, over many years working as a consultant to Toyota and other Japanese Manufacturers, developed a methodology to analyze and reduce the change over time for dies on huge body molding presses. With the methodology, which he called SMED for single minute exchange of dies; Shingo was able to achieve astonishing improvement [43].

SMED Methodology for set- up Reduction

Stage 1: Identify Internal and External steps: - An internal setup is a step that must be performed while the Machine or operation is stopped; it is the same as down time. An external setup is a step that can be performed while the operation is running.

Stage 2: Convert Internal steps to External: - The initial principal objective of setup improvement is to reduce internal setup time. The more setup steps, decisions, adjustments, whatever, that can be done on external time, the better. To that end, wherever possible setup steps formerly done while the operation is stopped are now done while the operation is running

Stage 3: Improve all aspects of the setup operation: - Converting internal steps to external steps reduces setup time considerably, although usually not enough to be in the single minute range (less than 10 minutes). It also does not usually reduce the actual labor

or material cost of the setup. As long as the average total internal and external setup time exceeds the average run-time, the setup time constrains the number of lots. Setup reduction efforts must thus focus on both internal and external activities, or at whichever most constrains the minimum lot size for a particular operation.

Stage 4: Abolish setup: - Beyond one touch exchange of die brings the ultimate setup improvement. Complete abolishment of the setup: Some ways of eliminating setups are reduce or eliminate differences between parts, make multiple kinds of parts in one step., and dedicate machines to making just one item.

There are many techniques for setup reduction. The following are procedures and techniques for setup improvement according to the stage of the SMED process [5, 32, 43].

1. Measure.
2. Separate “External” and “Internal” activities.
3. Convert Internal to External activities.
4. Reduce the time to carry out internal tasks.

There are other important suggestions relating to SMED which include; Video a change over then get the team of operators and technicians which carryout the changeover to watch and analyze it see where operations can be improved. Alternatives for setup reduction other than SMED are: Production planning, Group Technology/cell formation, Design standardization, Use standard Module, Work Simplification, Mechanization or automation – an expensive option [10].

2.3.1.16 Lot/Batch Size Reduction

Small batch production and delivery is a principal feature of JIT manufacturing [5, 12, 43]. The elimination of excess is accomplished partly through the reduction of work in progress (WIP). Reduction in lot/batch production can occur in a constant manner. Small lot sizing is consistent with JIT in terms of producing smaller amounts more frequently [13]. Batch size calculations like the following equation; relate machine setting up costs, stock holding costs, component demand and machining costs. In a batching environment, this equation is often used as a guide to the batch sizes loaded onto machines, and it minimizes the total cost of meeting the demand.

$$Tc = PD + HQ/2 + FD/Q$$

Where P = unit machining cost excluding setting

D = total demand per the time period.

H = holding cost per unit

F = the cost of setting up for each batch.

Q = the optimum size of each batch.

Tc = total cost of job.

Q is found with the following derivative:

$$Q = \sqrt{2FD/H}$$

If the holding costs "H" are reduced, "Q" the optimum batch size grows. If setting costs "F" rise, batch sizes also rise. If holding costs rise, optimum batch fails. The cost time taken to change from one job to another is a crucial element that tends to push up the sizes of batches [7, 14,]. Followers of JIT argue that this type of equation ignores hidden costs

associated with large batches and WIP [7]. These includes the possibility of producing many faulty components, the cost of rework, the possibility of storing defects for the future, the opportunity cost of space occupied by large batches, and Loss of flexibility whilst the machine is making the batch.

Batching principles are contrary to JIT definition as they suggest that batches should include parts not needed for some time. JIT requires that batch sizes, and all stocks, be reduced. To facilitate this, setup time and costs must be minimized. Effect of setup time and cost minimization on lot size reduction is illustrated in figure 2.8 [5].

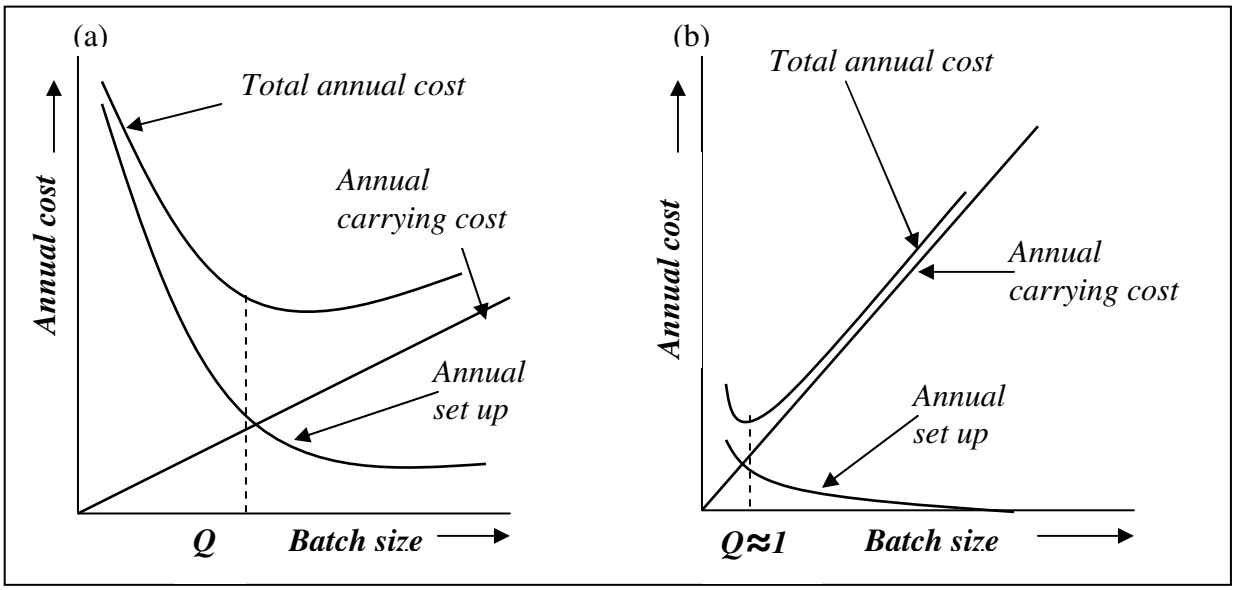


Figure2. 9 (a) Traditional EOQ (b) Effect of set up reduction on EOQ (JIT case)

This emphasis is based on the logic of batching; setup and the costs of stocks must be minimized to allow lot size reduction. The JIT approach is concerned with setup time and the hidden costs of stocks rather than the visible that the batch calculation uses. Reducing the setup time and run quantities of a Machine allows higher utilization and increased flexibility [5].

2.3.1.17 Good House Keeping

Japanese companies widely use the concept of '5s', which refers to housekeeping [5]. The author further explained that 5s is the basic to an excellent company, and they are inter-related as shown in figure 2.9. Pride quickly develops, encouraged by using high standards of house keeping as a strong feature of the company to show off on customer visits. Further, 5s's forms a logical sequence of progress: improve workplace organization by sorting and orderliness that clean it and keep it clean. The 5s's should be implemented company wide and this should be part of a total improvement program [5, 22].

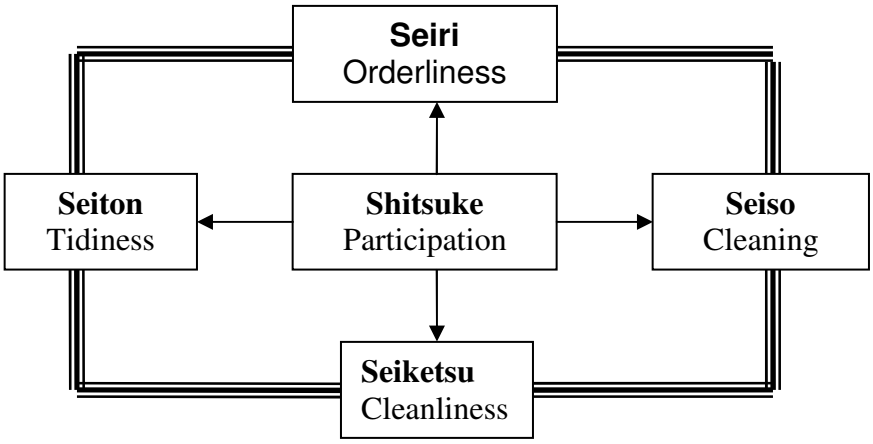


Figure2. 10 Housekeeping principles: the 5 Ss'

Seiri (Proper arrangement): Eliminating everything not required for the work being performed.

Seiton (orderliness): Efficient placement and arrangement of equipment and material.

Seiso (Cleanliness): Having a clean workplace, equipment, etc.

Seiketsu (Cleanup): Ongoing, standardized, continuously improving Seiri, Seiton, Seiso

Shitsuke(Discipline): Means following the rules and making them a habit (discipline with leadership) .

The basic process of house keeping is examined by splitting in to tidiness, cleanliness, safety, and discipline [5], and it is shortly put as tidiness costs nothing, cleanliness costs money, safety is the company's most important welfare provision, and without discipline, it is impossible to maintain consistent standards in a manufacturing firm.

2.3.1.18 Small-Group Improvement Activities (SGIAs)

SGIAs involve groups of shop floor personnel combined with any necessary technical people who are assigned specific projects to work on. The group regularly reports to management or a steering committee during the life of the projects, and is disbanded when the project has been completed. Overtime, every one could be associated with at least one project team. Supervisors are responsible for the SGIA in their own area, and normally lead team meetings [5]. SGIAs encourage cross-communication, and claimed benefits are:

- Generation of improvement ideas by production personnel, and involvement in their implementation,
- Improved ownership of the process,
- Increased morale due to job enrichment,
- Improved teamwork by removal of barriers,
- Easier implementation of change and improved respect through participation in management led projects.

The design of SGIAs overcomes the charge, which is often leveled at quality control circles that too much latitude is allowed to the teams in problem selection. Farther SGIAs promote greater cross-membership because teams are formed around projects rather than the other way round [5].

2.3.2 Supply Chain Management

The greater expectation of customers, the fierce competitive market and the flow of materials to the market with shorter lead-times have forced many companies to focus more on their supply chain management. A typical supply chain consists of raw material suppliers, manufactures, distributors, and end customers. Raw materials are shipped to the production facility where they get converted to end products and then those end products are shipped to the end users (customers). In order to minimize cost and waste throughout the system, effective supply chain management and integration are required starting from the raw materials and finishing with the end customer.

Supply chain management is "a set of approaches utilized to efficiently integrate suppliers, manufactures, warehouses, and stores, so that merchandise is produced and distributed in the right quantities to the right locations, and at the right time" [1]. Here "integrated" means that coordination and cooperation must be achieved in each and every part of the enterprise as a whole, opposed to looking for individual pieces only, so as to reduce the cost of the whole system. The following section examines how integration can be best done at the front, middle, and back of the supply chain.

2.3.2.1 Customer Integration

In today's flexible and speedy market, greater weight is given to customer value and satisfaction. Companies today can no longer rely only on financial metrics to check their status but must also look for other metrics such as customer satisfaction and value. Customer satisfaction is the concept of how well the current customers are utilizing the company's product and what their feelings are of its service [1]. By evaluating current customers the company can gain insight in to areas that need improvement and generate ideas for service and product satisfaction. Another important concept is customer value. Customer value is how the customer perceives the whole spectrum of what the company offers in terms of products and services [54]. Basically, customers are always looking for better product quality, lower prices, value- added services, more flexibility, and shorter lead time.

One of the principles of supply chain management is the ability to respond to customer requirements in a fast and flexible way. This response includes the physical distribution of the product and the status of an order, and access to this information. Customers are always concerned with their order status, and sometimes they value that even more than a reduced lead time [54]. Permitting customers to have access to their order status can develop more trust between them and the company. Allowing customers to participate in the initial design process can also improve the customer value. Value-added services could play a big role in relationships between customers and companies, it is no longer enough to have a quality product; this should be followed by quality service. Support and maintenance are very important from a customer perspective especially those technical products that require

constant service after purchasing. Having good value- added services can generate more revenue (e.g., charging a small fee for customer service support) and in addition, it closes the gap between the company and its customers. A company can gain more insight in to improving their service and support, and this is another benefit of value-added services [54]. Access to information is one of the value-added services.

2.3.2.2 Supplier Integration

One of most important components of the JIT operating company is the front end of the supply chain. Suppliers are an important factor contributing to the success of going JIT production system. Given the material costs account for over half of the cost of goods sold for most firms, companies cannot view their suppliers as strangers; rather they should be viewed as a part of the team [19].

Supplier integration was introduced first in the automotive industry and one of the pioneers in this was Toyota. In 1950 Toyota started a new move toward development of components supply. Toyota structured its suppliers in to different functional tiers with suppliers in each tier having different responsibilities. Toyota's first-tier suppliers were assigned the task of working with the product development team. The suppliers were told to develop a specific product in a car to meet given performance specifications. Toyota then asked its suppliers to present a trial product for testing, and if the product worked as specified the suppliers would get the production order. The Toyota philosophy was to encourage all the first-tier suppliers to communicate and share information with each other so as to improve the design process. Suppliers were not share information with each other because each supplier

specialized in different types of components, and thus they did not have to compete with each other [62].

Level of integration: Depending on how deeply the company wants its suppliers to be involved there are different levels of supplier integration. A study that was conducted by the University of Michigan identifies different levels of supplier integration as follows [17, 54]:

None: The supplier is not involved in design; material and subassemblies are supplied according to customer specifications and design.

White Box: This level of integration is informal. The buyer "consults" with the supplier informally when designing products and specifications, although there is no formal collaboration.

Gray Box: This represents formal supplier integration. Collaborative teams are formed between the buyer's and supplier's engineers. And joint development occurs.

Black Box: The buyer gives the supplier a set of interface requirements and the supplier independently designs and develops the required component.

2.3.2.3 Just-in-Time purchasing

Just-in- time purchasing (JITP) is defined as the purchase of goods such that their delivery immediately precedes their demand, or as they are required for use. Under JITP activities such as supplier selection, product development and production lot sizing become very critical [1].

Customer- supplier relation ships are a very important part of JITP. Under JITP it is necessary to have small number of qualified suppliers. Having quality- certified suppliers shifts the inspection function of quality and piece-by-piece count of parts to the manufacturer's plant [54, 60].

Electronic data interchange (EDI) is very important under JITP. The ultimate goal of JITP is to guarantee that production is as close as possible to a continuous process from the raw material reception until the distribution of finished goods [1]. EDI can support JITP by reducing the transaction processing time and meeting the specialized needs of buyers by helping them to synchronize their material movement with their suppliers. Although under JITP the carrying cost of materials is increased due to frequent small lots, this cost is offset by a decrease in the cost of processing a purchase order and by the decreased inventory holding cost. Some of the benefits of JITP are eliminating unnecessary work-in-process, this results in reduction of inventory costs, since units are purchased only when needed, quality problems can be detected early, since inventory is reduced, the waste of storage space will be reduced, and preventing excess production can uncover hidden problems [1].

2.3.2.4 Manufacturing Integration

The connecting link between the supplier and the customer in the supply chain is the manufacturer. Most of the core processes in term of the actual production take place the manufacture's site. As mentioned previously the main goal of a supply chain is to reduce the system wide costs and waste. It is in this middle portion of the supply chain where most of the wastes exist. For example, inventory holding and set-up costs, transportation costs and lead time create a big challenge to the supply chain in terms of how best these should

be managed. Integration between the supplier, manufacturer, and distributor are required to effectively manage inventory in the system. In order to minimize the inventory at the manufacturer, an effective inventory policy will depend on the specific nature of the supply chain. For example, if an electronic data interchange (EDI) system is in use, it must be designed so that the supplier, manufacturer, and distributor can share data. If information is shared the variability in the system is reduced, better demand forecasting is achieved, and inventory (particularly at the manufacturer) is reduced. Another important waste that exists in the supply chain is long lead times. To satisfy their customers the manufacturer (or the retailer) must have a short lead-time and precise delivery [54]. One way to reduce the lead-time is to have an efficient EDI system where all parties involved in the supply chain are linked; this can cut the portion of lead time that is related to order processing, paperwork, and transportation delays [54].

By having an integrated supply chain many of the wastes that occupy the system can be eliminated or diminished. This includes inventory in all of its forms. Overproduction at the manufacturer's site, long lead time and many others; minimizing these wastes will have a significant effect on minimizing the system –wide cost.

2.3.3 Value Stream Mapping

A value stream is a collection of all actions value added as well as non-value added that are required to bring a product or a group of products that use the same resources through the main flows, from the raw material to the arms of customers [51]. These actions are those in the overall supply chain including both information and operation flow, which are the core of any successful JIT operation. Value stream mapping is an enterprise improvement

tool to assist in visualizing the entire production process, representing both material and information flow [1]. The goal is to identify all types of waste in the value stream and to take steps to try and eliminate them [51]. Taking the value stream viewpoint means working on the big picture and not individual processes, and improving the whole flow and not just optimizing the pieces. It creates a common language for production process, thus facilitating more thoughtful decisions to improve the value stream [1, 51]. While researchers and practitioners have developed a number of tools and techniques to investigate individual firms and supply chains, most of these tools and techniques fall short in linking and visualizing the nature of the material and information flow in an individual company. At the level of the individual firm many organizations have moved toward becoming JIT system by adapting different JIT components and techniques such as, set up reduction, 5s, TPM, Kanban, etc. In many of these cases firms have reported some benefits; however, it was apparent that there was a need to understand the entire system in order to gain maximum benefits. Value stream mapping can serve as a good starting point for any enterprise that wants to follow JIT production system. Rother and shock (1999) summarize other benefits of value stream mapping as follows [51]:

- It helps you visualize more that just the single process level in production. You can see the entire flow.
- Mapping helps you not only see your waste but also its source in the value stream.
- It provides a common language for talking about manufacturing process.
- It ties together JIT concepts and techniques.

- It forms the basis for an implementation of JIT plan. By helping you design how the whole door-to-door flow should operate. A missing piece in so many lean efforts value stream maps becomes a blue print for JIT implementation [1, 51].

Value stream Mapping is a pencil and paper tool, which is created using a predefined set of icons (Shown in figure2.10).

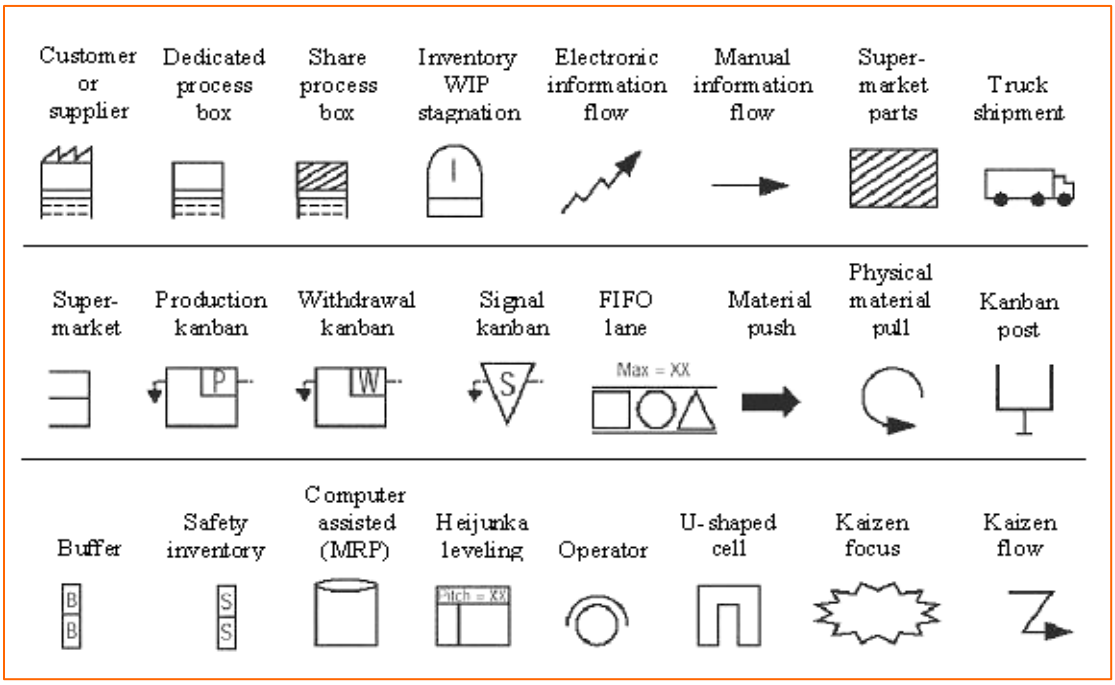


Figure2. 11 Icon used far value stream mapping (source: M. Roother and J. shook, 1999)

Also, the process of quickly drawing and redrawing a map acts as a plan-do-check-act cycle that deepens our understanding of the over flows of value or lack the rest. The first step in value stream mapping is to choose a product family as the target for improvement. Customers care only about their products and not all products. So that it is unrealistic to map every thing that passes through the shop floor. After choosing a product family the first step is to draw a current state map to take a snapshot of how things are being done

now. This is done while walking along the actual pathways from the actual production process. Drawing material flow on the current state map should always start with the process that is most linked to the customers, which in most cases is the shipping department, and then working ones way up to the upstream processes. The material flow is drawn at the lower portion of the map. At each process all the critical information including lead-time, cycle time, changeover time, inventory levels, etc. are documented.

The second aspect of the current state map is the information flow that indicates how each process will know what to make. The information flow is drawn on the upper portion of the map. The information flow is drawn from right to left on the map and is connected to the process boxes to indicate the production lead-time, which is the time that a particular product spends on the shop floor from its arrival until its completion. A second time called the value added time is then added. This time represents the sum of the processing times for each process. The third step in a value stream mapping is to create the future state map. The purpose of value stream mapping is to highlight the source of waste and help make target areas for improvement visible. The future state map is nothing more than an implementation plan that highlights what kind of JIT components /tools/ techniques are needed to eliminate the waste and where they are needed in the product value stream. Creating a future state map is done through answering a set of questions with regards to issues related to building of the future state map, and technical implementation related to the use of JIT components. Based on the answering to these questions, one should mark the future state ideas directly on the future state map. After creating the future state map the last step is to carry it out by trying to implement the different ideas generated by the future state map on the actual value stream [1, 51].

Chapter - 3

Data Collection and Presentation

3.1 Introduction

In order to implement JIT in Ethiopian industries, first the status of the existing practice should be thoroughly analyzed. After the extent of knowledge and the extent of the use of JIT techniques together with the effectiveness of each technique, are investigated to some extent a line implementation model will be developed to the companies in focus. Therefore, in this chapter the data collection methods used, the presentation of the data and some of the discussions for the data are presented along the way.

3.2 Data Collection Methodology

In order to attain the objectives of the research, some means of collecting data must be developed. Here, the methodology used must incorporate the advantages of most data collection techniques. Therefore, it is aimed to use open guided interview, structured questionnaire, document review and direct observation of the actual working environment and the condition of the shop floor. The structured questionnaire was distributed to the two companies to the focused groups. The samples taken to fill the structured questionnaire were those who have the technical knowledge and some managerial skills. In general, a total of 34

questionnaires were distributed in AMCE and only 30 questionnaires were backed up and 26 questionnaires were distributed to AABGF and only 22 questionnaires were backed up. Some of the survey questionnaire is backed with interviews. The questionnaire survey is given in **Appendix 1**.

3.3 Data Presentation and Discussion

The aim of data analysis is to communicate the results of the information gained through data collection. These data should be analyzed in a way that one can convey the raw data and analyzed data to the conclusion drawn from it. Therefore, a standard statistical means of analyzing the data have to be developed. In this work, the response of the respondent is tabulated and the count (frequency) and percent of the population and sample is built in the explanation. Wherever required, graphs are used to illustrate the relationship between attributes and to show the trends. For some textual (open-ended) questionnaire an explanation of the respondents' response is presented. To give more figurative results, the data are analyzed using factory analysis on the scale 0-100. To get the result first the weight for the scores is built, the aggregate mean is found for each attributes, and then the mean is converted to the rating scale of 0-100. All the attributes considered in the analysis part refer to **appendix 1**.

3.4 Case study-1: Automotive manufacturing company of Ethiopia (AMCE)

3.4.1 Background of AMCE

3.4.1.1 Establishment

The Automotive manufacturing Company of Ethiopia (AMCE) Share Company is located in Addis Ababa near Megenagna. Back in 1930 the Italian car manufacturing company FIAT (Fabrica Italiano De Automobile Torino) introduced in Ethiopia truck models Fiat 261 and 634, which gradually gained popularity in the country. Apparently, encouraged by the promising result from the venture, FIAT decided to open an assembly plant in Ethiopia. Thus, the company was founded in May 1970 with a share capital of 1.5 million Birr which then two years later increased to 3 million Birr of which 70% is owned by IVECO (Industries of Vehicle Corporation) and 30% by the Ethiopian government. The company assembles trucks from CKD (Completely knocked down) and SKD (Semi- Knocked Down) parts. The market share of its product had progressively increased to reach almost 85% of the total market of commercial vehicles running in the country, but it is progressively declining in today's market.

The production/service capacity of AMCE in one shift is:

- CKD trucks and buses assembly: 700 units.
- Spare parts distribution: 20,000 lines.
- Service: 350vehicles/month.

The average annual turnover of AMCE Company is 120 million Birr and its total land holding is 137,000 meter square. The company started its actual operation with a work force of 75people.

Though the plant was designed to operate at a capacity of about 700units per year in one shift, during its first year of operation, 1975, the company was able to assemble 232 units. Since 1980, the company grew in manpower, reaching 250people; developed its technological capability. Up to 1988, with available resources allocated by the Government to AMCE in foreign currency, the company has contributed in assembling and distributing about 4400 different vehicles and 370 Trailers to be added to the existing fleet of vehicle running in the country.

In1988 spare parts distribution and service workshop were added for: Trucks and Trailers of varying capacity, Buses of varying capacity, Tankers, and tipping bodies.

Starting from its establishment to date AMCE has assembled and distributed 6030 vehicles; this observation is for 30 years back, this figure gives the evidence that the average production of AMCE is 201units of vehicles per year.

In general, the establishment of AMCE has created not only job opportunities for some Ethiopians but also has laid down the basis for the transfer of technology in the development of the automotive industry in the country. AMCE is progressively expanding its activities by upgrading its technological capability in assembling industrial vehicles, manufacturing components and giving efficient services.

3.4.1.2 Objectives

The company's main objectives during establishment were:

- Assembling of commercial vehicles including buses of all ranges of FIAT brand and assembling of agricultural Machines,
- Manufacturing of Bus bodies,
- Manufacture of spare parts of vehicles and Agricultural machines or accessories
- Importation of all materials, accessories, machine tools, pertaining to the assembling, manufacturing and/or trading as specified above, and
- Sales and trading of products and manufactures of the company.

3.4.1.3 The Organizational Chart

The Automobile Manufacturing Company of Ethiopia (AMCE) has five departments that directly report to the General Manger. The organizational chart of the company is presented in **Appendix 2**.

3.4.1.4 Work Flow in the Assembly Line of AMCE

In AMCE's assembly plant, the inputs are automotive component items & subassemblies and the out put is the complete automotive vehicle/ trucks. The detailed assembly work flow is given in Figure 3.1.

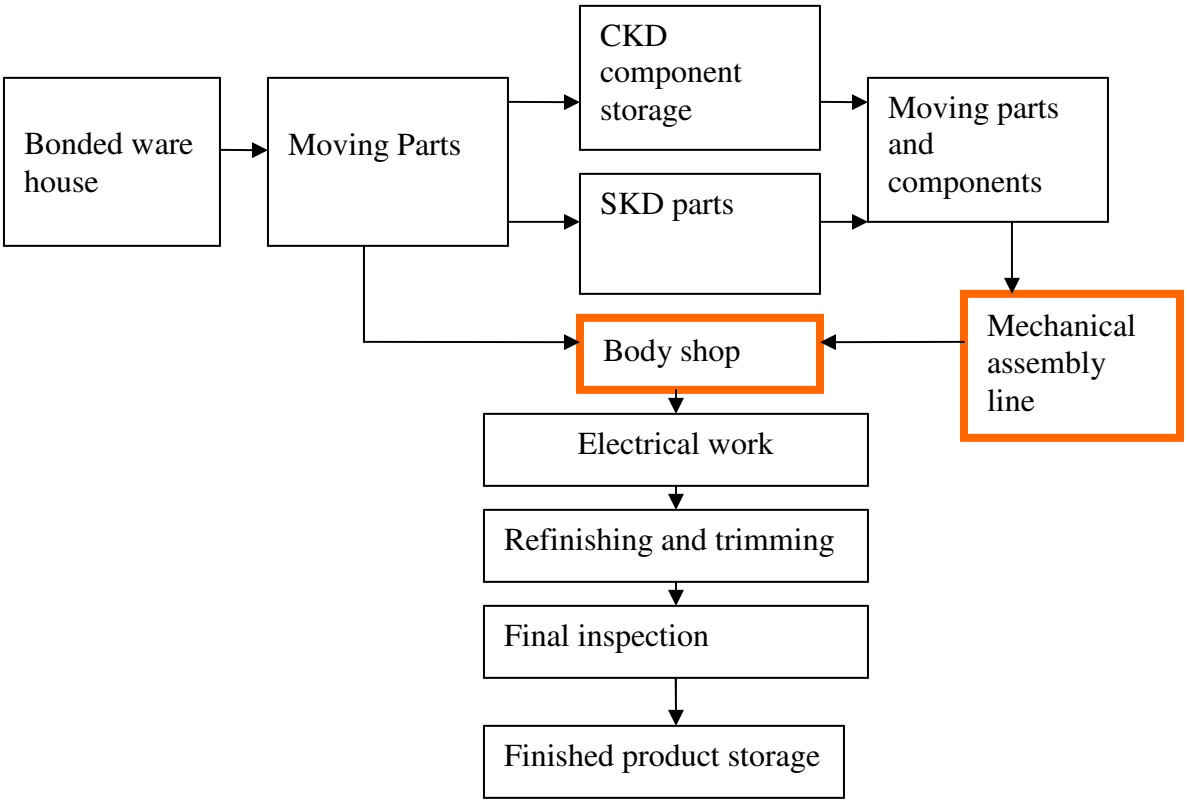


Figure 3. 1 Assembly Production flow line for AMCE's company

3.4.1.5 Major problems of AMCE

The major problems of automotive manufacturing company of Ethiopia in today's global market are:

- ✓ Increased cost of truck assembly production.
- ✓ Inability to compete local competitors among Scania, Volvo and Nissan in terms of price.
- ✓ The imported vehicles are available at the lower price than ACME's products.
- ✓ Higher raw materials and work-in-process inventories.
- ✓ The assembly process is a pure push-production system.

3.4.2 Data Collection and Analysis of AMCE's Company

1. Application of JIT manufacturing practices in AMCE

To apply the JIT techniques every employee of the Company should know and understand about JIT. Regarding the application of JIT in the company it has tried to obtain Prier knowledge of employee about JIT, whether the company is implementing or planning to implement some aspects of JIT, nature of JIT efforts in AMCE, and practices of JIT production systems in the company. The data obtained from the structured questionnaire combined with observations and guided interview are presented as follows.

a. Prior knowledge about JIT

Only 30% of the respondents know JIT, and 70% of the respondent doesn't know about JIT. As it was tried to interview the respondents those who have prior knowledge of JIT are those who has taken training abroad and they are those of higher managers like, plant manager, production manager, logistics head and some supervisors. Therefore, the company should prepare a training program to update the knowledge of its workers especially to this innovative system.

b. Implementing some aspects of JIT

From the responses of the respondent, 63.33% respond as if AMCE is already implementing some aspects of JIT and 33.67% respond no. They reasoned that if

JIT and any system are tried in this company it is easy, but the critical constraint of the company that is the absence of local component production must be solved. The evidence shows that their system is traditional, therefore; they have to continuously improve their systems and work on requirement of JIT implementations in the company.

c. Nature of JIT efforts in AMCE

56.67% of the respondents are in favor of accepting JIT, 20% respond it is under research and 13.33% of the respondent said their effort is nil.

The majority of the respondent agrees that the company is ready to accept. But the company should have to implement some aspects of JIT to say that it is ready. The evidence that I have seen is that the plant manager plans a 5s program and start implementing on the shop floors. This is an encouraging fact and they have to prepare and implement also another JIT techniques one after the other like a pilot project.

d. The level of JIT Production system practices in AMCE

This questionnaire was prepared to assess the environment of AMCE, to get information about suitability to implement JIT, and justify other important attributes for the implementation of JIT in the company.

From the analysis made, 21.78% of the respondent respond that the techniques described are highly practiced, 47.33% of the respondent respond

Medium/moderately practiced, 17.78% respond they are less practiced and 12% respond not at all. As some of the respondent explained about those techniques it is aimed to have flexible work force, production simplification, preventive maintenance, statistical process control, set-up time reduction and parallel line production. But, there is no evidence that shows the practice of all the prescribed aspects in the company. Therefore, the company should prepare a plan and implement them gradually one after the other until they achieve a reasonable results on them. The only encouraging practice of AMCE are the flexibility of the work force, preventive maintenance, standard containers and parallel line production, they have to keep on these practices and embrace the other important techniques too.

Ranking of aspects of JIT techniques as they are practiced in AMCE according to the result of the respondent is given in table below.

Table 3. 1 Ranks of aspects of JIT techniques according to their level of practice in AMCE as perceived by the respondent

Rank for the aspects	Mean (max=100)	Standard deviation
1. Flexible work force	72.22	.7
2. Work team quality control	69.99	.66
3. Parallel line production	65.55	.76
4. Work in progress (WIP) reduction	65.55	1.13
5. Total Preventive maintenance	65.51	.94
6. Manufacturing flexibility	64.44	.83

7. Smoothed line production	63.33	.92
8. Product simplification	63.33	.84
9. Standard containers	58.33	.93
10. Statistical process control	55.55	.84
11. Continuous improvement	54.44	.89
12. Group Technology	54.44	.93
13. JIT purchasing	53.33	1.1
14 Set-up time reduction	48.88	.97
15. Kanban card information circulation system	42.85	.98

2. Assessment of JIT philosophy in AMCE

a. Waste reduction

42.67% of the total population said that the company's waste concentration is moderate, 23.67% respond less concentration, 18% respond high concentration, 30% respond not at all, and only 2% respond very high concentration. Further the result of the respondents for each waste type is summarized as follows.

***Overproduction waste*: -** Overproduction waste is occur when the product is produced too early or too much of the subsequent process or customer. To assess the status of the existing practice of the company, the questionnaire is distributed among the randomly selected members of the company, hence, 43.33% of the respondent responds less concentration of over production, 30% respond not at all, 16.67% respond the concentration is moderate, and 6.67% of

the respondent respond high, and only 3.33% respond very high concentration. Some of the respondents were asked about it, and almost all of them respond that there is no overproduction of the final product this is because their capacity of production is below the market demand. But, the assembly line is not balanced. Due to this it is up to the foreman and supervisor to arrange priorities of the work, due to this the process is some times produce more than needed by the subsequent process. Therefore, the company has to:

- Increase its production to reach the actual demand of the market, through identification and concurrently solving the existing problems.
- Balance its assembly line to equalize the flow of jobs.
- By flow-charting the operation they can assign a standard time.

***Waiting time Waste*: -** 63.33% of the respondents' respond, the waiting time is moderate, 20% respond less, 10% respond not at all, and 6.67% of the respondent said high. The information gained from the respondent shows that some times there are a waiting time by component parts, operating machines, and the workforce. Therefore the company should try to minimize those waiting times to attain the objective of zero idle time.

***Lead time Waste*: -** 60% of the respondent respond moderate, 20% respond less, 16.67% respond high, and 3.33% respond not at all.

Most of the respondents of the company agree that there is long lead time. According to those respondents, it is only minimized if the company tries to:

- Minimize (purchasing) lead time especially for oversea suppliers.

- Minimize order processing lead time.
- Minimize the set up times especially for spot welding and cabin assembly.

But the production lead time is relatively short. Therefore, the company should work to minimize those problems in order to get a total shorter lead time.

***Processing time Waste*: -** 33.33% of the total respondent said there is less processing time waste, 30% respond high processing time, 23.33% respond moderate, 10% respond not at all, and 3.33% respond very high. The observation shows that there is no bad process design like wrong type or size of machine. The company has special service tools, machines, and fixtures, but this does not mean that improvement of the process is not required. Since there is always a room for improvement the company should plan and improve their process to have a better processing time.

***Transportation Waste*: -** 40% of the respondent said there is medium/moderate transportation waste, 26.67% respond high, 20% respond less, 6.67% equally respond not at all and very high.

From my observation of the transportation system, they use overhead cranes, Trolleys, standard containers for components, forklifts for major transportation of materials. There is no system that delivery the materials to the point of use. It was observed that some materials are handled unnecessary and many times. Therefore, in addition to the existing material handling system, it is better to design a system that delivers materials to the point of use. This may need consideration of the existing systems.

***Motion Waste*: -** 40% of the respondents respond this waste is moderate, 36.67% respond less, 16.67% respond high and 6.67% respond not at all. The observation shows that there is a good housekeeping practice in the company, and the lines are closer to each other. In general, there is no evidence that shows waste of movement. The plant manager also prepared a 5s programme and start implementing. I hope this will contribute a lot for the improvement of movement at the shop floor level.

***Defects Waste* -** 40% of the respondent responds that there are no defective goods at all, 33.33% respond the concentration is moderate, and 26.67% respond less concentration.

From the result it seems that all products of AMCE were done right the first time and every time. From the interview and observation of the working environment there are defects but those defects are corrected on line, but there are many reworks and replacement of missing parts. Therefore, to attain a zero defect and smooth flow of materials in production line the sources of defects should be identified and corrective action must be taken to continuously minimize defects.

***Inventory Waste*: -** 50% of the respondents respond there is a moderate/medium inventory in AMCE, 23.33% respond high, 13.33% equally respond less concentration and not at all. From the result we can see that there is a high inventory built up in AMCE. The reason sited for this is the suppliers for the major components are from IVECO; because of this they order at least one lot at a time.

According to the AMCE police one lot of each item contains 4 items. Therefore, the components of 4 vehicles reach the company at a time.

***Vendor time*: -** From the respondents' response, 43.33% said the vendor time is medium/moderate, 33.33% said high, 13.33% response less processing time, and 3.33% respond as if there is no vendor time waste. The average vendor time of AMCE is 4 month for oversea and 5 days for local suppliers. The processing time for vendor is the major problem in AMCE. Especially they strongly blame the processing time of the custom. As some respondents and document shows it require 2 to 3 months processing time. Therefore, the government must support the company and arrange the possibility of delivery of materials to the point of use.

***Set-up time*: -** 56.67% of the total respondent responds that the change over time or set-up time in AMCE is moderate, 20% respond high, 10% respond less, 6.67% equal respond very high and not at all. The maximum set-up time observed in AMCE Company is the spot welding process of cabin & body and the riveting process of the chassis frame. For other works they have standard jigs and fixtures that facilitate an easy set up time. In general the relative concentration of wastes in AMCE is briefly shown in figure 3.2.

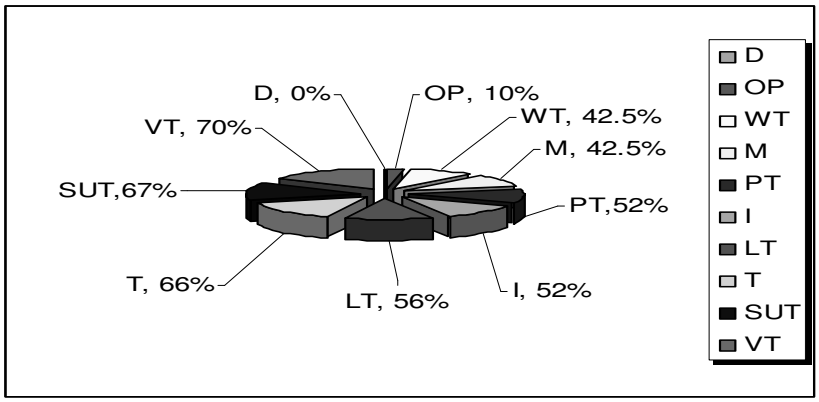


Figure3. 2 Relative percentage concentration of waste in AMCE as perceived by the respondent

Key: on the scale of 0-100 they measured D (defect)=27.5, OP (over production)= 41.67, WT (Waiting Time)= 41.67, M (motion)=41.67, I (inventory)= 45.83, LT (Lead time)=47.50, T (Transportation)= 51.67, SUT (set-up-time)= 52.5, and VT (vender time)= 53.57.

b. Aspects of Continuous improvement program on some JIT techniques

The efforts of AMCE on continuous improvement of the JIT techniques obtained from the respondents are analyzed as below.

From the total population of the responses, 34.22% respond AMCE is working moderate on improving their works, 29.11% respond high effort, 16% respond less, 13.78% respond very high, and 4.22% respond no improvement is shown by the company. On the scale of 0-100 the mean of each effort shows that the company

is working on some techniques, but some are still given little emphasis. The results are as presented below.

Attributes for improvement	Mean	St. dev
Inventory reduction	62.07	.95
Setup time reduction	45.83	1.12
Lot-size reduction	53.45	1.11
Increased flexibility of process and personnel	52.50	.92
Paper work reduction	51.79	.9
Material handling reduction	49.11	.88
Movement distance reduction	50.89	.74
Transport cost reduction	51.67	.87
Increased quality of product and process	74.17	.81
Increased preventive maintenance	56.67	.74
Decrease in number of suppliers	50.00	1.08
Quantity of part number reduction	60.83	1.01
Increase links to other departments	65.18	1.13
Increase links to supplier	68.33	1.28
Increase links to customers	78.33	1.11

As some of the respondents said:-

- There are large amount of raw material and work-in-progress inventories that can be minimized.
- Large lot-size exists both in production line and purchasing.
- High set-up time of machines between job changes, and
- High machine breakdowns that can be minimized by TPM.

To continuously improve the quality of their product and increase competitiveness, AMCE must prepare a programme on continuous improvement of those techniques, as they are preconditions to implement JIT. Also to use and appreciate JIT production system the company must incorporate a continuous improvement program, and each worker of the company must be trained to the basic tools and techniques, to use them effectively.

c. Analysis of Benefits of JIT Implementation for the company

The benefits gained through the implementation of JIT are too many and depends on the nature of the organization. Some of the benefits that may be close to AMCE is asked and the results obtained from the respondents are ranked.

According to the respondents' response, the ranks gained with JIT implementation to the company is as follows.

Rank of the benefits	**Mean (Max. = 100)**	**Standard deviation**
1.Increase links to customers	76.67	.98
2.Increase profit or reduced cost	75.86	.82
3.Reduce lot-size	75.83	.67
4.Increase quality of product and process	72.50	.71
5.Reduce Transport cost	70.69	.93
6.Reduce movement distance	70.69	.71
7.Reduce Material handling cost	70.00	.92

8.Paper work reduction	68.97	.83
9.Inventory reduction	68.10	.65
10. Increase links to suppliers	67.50	.99
11. Increase flexibility of process and personnel	65.00	.97
12. Increase links to each department In the factory	64.17	1.17
13. Set-up time reduction	63.33	.82
14. Increase the use of preventive maintenance	61.67	1.11
15. Quantity of part number reduction	59.17	1.13
16. Decrease number of suppliers	55.83	.86

The reason sited for lower quantity of part number reduction and decrease the number of suppliers is that the components of vehicles are increasing overtime and the number of suppliers for major materials is fixed to IVECO.

3. Justification for Characteristics of JIT in AMCE

They are asked about the following JIT characteristics with respect to AMCE

- Parts are made only when needed by the subsequent processes
- The Company is working to continuously minimize work that does not add value to the end product.
- Workers can stop the line and issue if they experience a problem on the shop floor.
- The company entrust the work force with functional and decision related responsibility, and

- They belief that every problem offers some new opportunities for improvement.

On the scale they measured 55, 56, 35.34, 72.42, 60.71 respectively, and from a population of 150 responses, 13.33% of the respondents strongly disagree, 5.33% disagree, 19.33% moderately agree, 32.67% agree, 16% strongly agree about the various requirements of JIT, and 3.33% has not responded. From the responses of the respondent it seems that AMCE plant can fulfill the characteristics of JIT. But the observation and the guided interview gives the evidence that the company does not see problems as an opportunity, this is because the employees do not want to reveal problems rather they try to solve by their own or try to hide from their supervisor. Again there is no system that can stop the line if an employee experiences a problem on the shop floor. The employee are asked about the need of making a product, it is not because of the need by the subsequent process but the work is pushed to their working area, and they have been confused between the work in process and final product. Their responses regarding parts are made only when needed by the subsequent process is with respect to when need by the external customer. Therefore, even if it is one requirement the internal customers that are very important for the process are missed. In general, the evidence shows that those characteristics of JIT are partially practiced in AMCE. Therefore, the Company should work or arrange their facility to attain reasonable characteristics of JIT.

4. JIT purchasing /supplier partnership

To analysis this part the data about suppliers of AMCE are collected and tabulated.

Table 3. 2 The materials used by AMCE and how they are supplied to the company along with their respective lead-time

S. No:	Raw materials used by AMCE	Suppliers of the Raw material	Location	Way of shipment	Lead time
1	▪ Cargo body ▪ Tipping body ▪ Bus body components ▪ Press and formed sheet metals ▪ Semi-trailers	▪ Maru metal industry ▪ Teshale Haile general mechanic S.Co ▪ Mesfin Industrial engineering(MIE)	Addis Ababa ” Mekele	uses forecast technique and Customer demand	5 hrs average 6days for MIE
2	▪ Steel sheet metal ▪ Furniture tubes ▪ Rounded hallow sections	Kality Metal industry	Addis Ababa	“	5hrs
3	▪ Tires ▪ Rubber mud guards	Addis Tire Factory	‘’	“	5 hrs
4	▪ Zinc chromates ▪ Final paints	▪ Dil paint Factory ▪ KADISCO	‘’	“	5hrs
5	▪ Leaf springs	Ethio Spring Factory	‘’	“	5hrs
6	▪ Cast components	AKaki spare parts S.Co (ASPSC)	‘’	“	Not known
7	▪ All other components	IVECO	Italy	1 or 2 times per year	Aprx. 4 month

Relationship of AMCE with its suppliers: - Most of the respondent, 33.33%, agree the relation ship of AMCE with its suppliers is based on mutual trust, cooperation, and long-term commitment.

Emphasis of purchasing decision given by AMCE:-

- Most of the respondents, 66.67% said AMCE gives moderate emphasis on price to make purchasing decisions
- According 56.67% of the respondent the emphasis given for purchasing decisions to delivery time/schedule by AMCE is high.
- 50% of the respondent respond very high emphasis is given to quality, and
- 40% respond high mutual trust is considered.

The average lead time of oversea vendor is 4 months and the average lead time of local suppliers is 5 days. According to most of the respondent, 83.33% agree that the useful supplier to AMCE is oversea (import) - from IVECO. The reason for this is that:

- Local suppliers cannot fulfill the demand of AMCE.
- Absence of domestic component production.
- Absence of ties of local suppliers with the supply chain in the country.
- The government of Ethiopia has also given less attention to the company because Ethiopia has only 30% share.
- Most of the respondent, 56.67% said if local suppliers are agree to make mutual trust with AMCE, the importance is medium/moderate, and only 13.33% said low.
- 66.67% of the respondent agrees that a close relationship with a few suppliers is required to implement JIT production system.

Degree of Internet use in the company: - According to most of the respondent, 50%, use of Internet in the company is very high and 20% said moderate. As most of the respondent said the use of Internet is limited to information communication especially for higher-level management, but their use for purchasing process is very less. In JIT environment the use of Internet facilitates the order processing time that in tern minimizes the vendor lead time. Therefore, AMCE should initiate the use of Internet in purchase or procurement process.

5. Dignity/respect of individuals in the AMCE

From the analysis of the survey questionnaire made, most of the respondent about 34% of the total population moderately agrees that AMCE gives high respect to individuals, 32% agree about this issue, 18% highly agree, 13% disagree, and 3% strongly agree about this issue. On the scale the attributes shown in appendix 1 measured 71, 58, 61, 50, 70, 69, and 50 respectively. All of them are essential for the successful implementation of JIT and they have to be embraced by the company.

6. Customer Focus of the Company

Most of the respondents, 43.33% moderately agree about: The values that customers give are the only real values, and all products are customer driven. 40% of the respondent also moderately agrees that all system such as product design, material procurement, fabrication, assembly, and distribution to after service focus

the customer. For the attributes considered in appendix 1 a mean of 60.83, 44.17, and 52.50 are obtained on the scale of 0-100.

7. Aspects of Quality control orientation in AMCE

The result of the survey questionnaire shows that:

- 46.67% of the respondent highly agrees about, defects are investigated at the source, and defects are screened out immediately after they occur.
- 46.67% of the respondent agrees about, quality comes from good design, and for purchased parts, the inspection is completed before delivery.
- 40% disagree that quality does not come from inspection, and
- 36.67% agree that the operators them selves at each step of the line before the parts are passed to the following process execute inspection.

The result shows that a mean of 81.03, 38.33, 59.17, 72.50, 79.17, and 81.67 for the attributes considered in appendix 1. It seems all the results are satisfactory, but most of them believe on final inspection of the product. The reason sited for this is that:

- Most employees are not trained to a higher standard.
- The system of the shop floor does not allow investigating all sources of defects/errors on line.
- The customer wants to test the function of all parts and components with the cooperation of quality assurance from AMCE.
- Because of the many number of components, some times the vehicle is passed with missed parts.

Therefore, to attain a high quality practice in the company, doing right the first time, AMCE has to work hard to attain the goal of zero defects in the system.

3.5 Case study-2: Addis Ababa Bottle and Glass Factory (AABGF)

3.5.1 Background of AABGF

Addis Ababa Bottle and Glass Factory is one of the oldest in the region and so far the only glass manufacturing plant in the country was established in 1973.

The company is situated in the suburb of Addis Ababa some 8.5Km from the center along the road to Ambo. This location with a very high access to the market is a tangible resource verifying the competitive advantage of the company. In 1992 with the appearance of the new economic policy assets were revaluated and it started operation with a paid up capital of ETB 15.4 million. The new economic atmosphere was truly favorable partner to the beverage sector and the cosmetic industries. The resolute attitude to progress and the remarkable success achieved are both backed by the rich and time-tested experience of the workforce.

3.5.1.1 Objectives of the company

The objectives of the company are:

- Providing the beverage sector, the cosmetic industries, Agro-industrial complexes and pharmaceuticals with high quality and suitable glass containers;
- Supplying a variety of tumblers, and glass articles to the domestic market.
- Promoting glass technology in the country.
- Creating employment opportunities; and
- Saving and generating foreign exchanges.

3.5.1.2 Range of products

The company is engaged in two products lines, Bottles and Tumblers. The company produces a wide variety of glass containers in different shapes, sizes, colors and ranging from 50gms to 1000gms in weight. All the products meet internationally required standards. The modern decorating facility has enabled the printing of proprietary labels on glass containers. The quality of label printing fully complies with the requirements of client companies.

Bottle products: Bottle for soft drinks, Beer Bottles, Bottles for Alcoholic & Liquor, Wine Bottles, and Mineral water Bottles.

Glass products: Glass containers like Jam jars & squash bottles for horticultural products, Tumblers of different sizes & designs for the house holdings & commercial purposes, and Ashtrays and give away articles.

3.5.1.3 Organizational setup of the company

The highly qualified, skilled and experienced workers, who are highly committed and with an extraordinary devotion to their tasks are the basic factor for the optimism about the future of the company. The Company believes that the workforce is the most important of all resources. The organizational structure of the company is as presented in ***Appendix 3***.

3.5.1.4 Raw materials for the company

Addis Ababa Bottle and Glass share company exploiting the natural resources of Ethiopia. It is a real manufacturing industry practically using the natural resources of the country. The silica sand, soda Ash, Limestone, Marble, and Cullet are all available in abundance in

Ethiopia. The quality and appropriateness of each of the raw materials and the batch preparation undergo serious check-ups on a continuous basis by qualified technicians in the laboratory, specially organized for this purpose.

3.5.1.5 Production Process

With the installation of the new high-tech forming machine the company is heading towards more productivity and increased flexibility.

At each stage of the production process through analysis are conducted continuously for the attainment of customer satisfaction in the overall activities of the company. The production process flow chart for AABGF Company is shown in appendix 4.

3.5.1.6 Major Problems of Addis Ababa Bottle and Glass Factory

In today's global market Addis Ababa Bottle and Glass Factory faces problems like:

- ✓ Much accumulation of Raw materials, Work-in-progress and finished product inventory that increased the carrying costs.
- ✓ High defect rates (in 1996 E.C. the company has lost about 18% of the melted glasses because of defects and scrap).
- ✓ Longer job change over (1.5-24hrs) because machine set-ups are substantial.
- ✓ The production is not on actual demand rather based on some forecasting techniques.
- ✓ Rise in manufacturing costs and increased selling price.
- ✓ Its production system is a pure push production system.

3.5.2 Data Collection and Analysis of AABGF Company

Addis Ababa Glass & Bottle Factory is owned by the government. Its production capacity is approximately 30-tones/day and the average annual turn over of the company is about 26million ETB. Currently the company runs with 300permanant and 100-150 contract workforces. The plant holds about 81,000 sq. meter extensive lands.

The company's effort for excellence is encouraging. One evidences for this is that its initiatives for ISO-9001 certification. The aim of this data collection in this regard is to analyze the company in view of just-in-time production system. The relevant data's obtained from the company are analyzed in the following manner.

1. Application of JIT manufacturing practices in AABGF

The analysis shows that most respondents, about 66.7%, do not have prior knowledge about JIT. But the majority of the respondent, 75%, belief that the company has tried to implement some aspects of JIT and 58.3% of the respondents said the company has been also trying to initiate this philosophy. As some respondent says, the company is know looking ISO-9001 certification, this forced the company to set-up its internal operation techniques and external operation techniques to a new system. They believe that the JIT philosophy will help them in achieving the objectives of the company. This analysis shows that much training workshops on JIT must be given to AABGF employee to familiarize them with the most innovation systems before the company start implementing JIT program.

a. Level of JIT Production system practices in AABGF

The result shows that most of the JIT components and techniques like production simplification, preventive maintenance, statistical quality control, JIT purchasing, work team quality control and Kanban card information circulation systems are practiced with less emphasis. On the scale of 0-100 they measured, 49.1, 48.3, 48.3, 41.8, 49.1, and 40 respectively. Therefore, the company can implement at least some components and techniques that are applicable for the company and the process as a whole. In general, the level of their practices as perceived by the respondents of the company is ranked as shown in table 3.3.

Table 3. 3 Ranks of aspects of JIT techniques according to their level of practice in AABGF as perceived by the respondent

	Rank order of the attributes	Mean	St. dev
1	Standard Containers	60.0	.83
2	Setup time reduction	60.0	.6
3	Smoothed line production	60.0	.87
4	Continuous improvement	55.0	.73
5	Flexible Workforce	54.5	.9
6	Work in progress (WIP) reduction	52.0	.84
7	Group technology	52.0	.84
8	Production Simplification	49.1	.82
9	Work team quality control	49.1	.9
10	Preventive Maintenance	48.3	.9
11	Statistical process control	48.3	1
12	JIT purchasing	41.8	1
13	Kanban card information circulation system	40.0	1.2

2. Assessment of JIT philosophy in AABGF

a) Waste concentrations in the company

The result of questionnaire survey shows that except the transportation waste, all other types of wastes do exist in AABGF at most. While change over/set-up time takes the greatest portion of waste, motion waste takes the minimum among the waste types considered.

Attributes for wastes	Agg. Mean	St. dev.
Over production	47.2	0.97
Waiting time	47.2	0.72
Lead time	50	0.87
Processing time	47.2	1
Transportation	38.9	1.1
Motion	44.4	.92
Defects	55.6	.98
Inventory	54.2	1.3
Vendor time	50	1.2
Change over/set-up time	57.6	.52

The explanation of each waste type with in focus of the AABGF Company is the following.

***Over production waste*:** Most respondents of AABGF, 58.3% agree that the concentration of overproduction waste is moderate. The definition of overproduction with respect to JIT is making a head of demand both in the process

and at the finished production stage. The evidence also shows that AABGF has this type of wastes in its operation. The reasons sited by the respondent are:

- The production is based on some forecasting techniques not on actual demand.
- Maximum utilization of machines and manpower is emphasized.
- Most of the process i.e., process before furnace and after forming machine/I.S. machine is not synchronized to the same production rate.
- Because the company is using push production system, and
- Machine down time, are some problems mentioned by them.

***Transportation waste*:** The Company uses loaders, conveyors, manpower and trucks for the transportation of materials. Any unnecessary transportation of materials is considered as a waste. The respondents of the company, 58.3% agree that the transportation waste in the company is less. But, the evidence shows that some transportation wastes like:

- Physical movement of finished products.
- Physical movement of raw materials.
- Unnecessary movement of products between the annealing lehr and decoration machines are observed.

Therefore, efforts are required from the company to minimize such type of wastes.

Motion waste: This type of waste includes unnecessary movement of people during the course of their work. 41.7% of the respondent favor that the concentrations of motion waste in the company is high. As some of the respondent

said, this problem includes travel to meetings, access to order from their supervisors, walk to offices to take command, and people are not co-located, and most processes especially the raw material preparation are far apart from the main production are some sited problems for this type of wastes.

Waiting Time waste: the time waste when people are waiting to perform their works or jobs waiting facilities to be processed is called waiting time waste. As the majority of the respondent, 50% agree the concentration of waiting time waste is moderate. The reasons given by the respondents are: long set-up times, delays on some process, and unpredicted machine downtime.

***Inventory wastes*:** perhaps the most significant source of waste is inventory. Most respondents, 41.7% said moderate concentration of inventory waste exists in the company. As most of inventories like work-in-process and finished parts inventory does not add value to a product and it must be eliminated or reduced. The type of inventories existing in the company and the reason why its concentration is high as perceived by the respondents are as given in the following. In AABGF the types of inventory that exists includes: Raw materials, in-process inventories, machines, equipment and tools, chemicals, and finished products (different types and sizes of Glasses & Bottles). As the section head said the high inventory in the company attributed to raw materials, finished products and in-process inventories. The reasons sited for high inventory of finished products are:

- Some times the customers cancel the orders. Fore example, Coca-cola and Ambo.
- Customers minimize the requirement at some point after the orders were set and production is over. An example for this is Ambo mineral waters Factory.

- The usual practice of shipment is random not scheduled, for example, in July 1996, about 7,99,211 bottles were produced for Meta Abo brewery S,Co., but only 7,73,250 bottles were delivered to the company.

On the other hand the reasons for high inventory of raw materials are:

- The process consumes high volume of raw materials.
- Since most of the raw materials are processed in the company, they believe enough materials must be available all the time.
- The delivery of raw materials is not scheduled based on daily requirements.
- The qualities of most materials are analyzed in the company.
- Since special storage spaces are assigned for raw materials, this type of inventory is not considered as wastes.

The in-process inventories are because:

- Much materials are processed at a time on some process
- Especial storage spaces are provided between each process; this situation is mostly seen in material preparation section.
- The material preparation is done batch by batch.
- There is no parallel line production in the company, and etc., are some due mentioned.

In general, as it is obtained from the inventory control section of the company the inventory turn over is about 8-15 days per year.

Defect waste concentration: 50% of the respondent said the defect waste concentration is moderate. But, on scale of 1-100 it measured the highest rank among the types of waste i.e., 55.6. As the information obtained from planning and statistic expert of the company, during the year 1996, about 7739 tons of raw materials are melted but only 6329 tons of glasses and bottles are changed to finished products. The result shows that about 18% of the melted glasses were lost because of defects. The summary of the defect types and its portion is as given below.

Defect type	**Losses**
Trickle----------	430 ton (30% of the total loss)
Reject----------	980 ton (70% of the total loss)
Total loss due to defects-----	1410 ton (18% of the total production)

The problems sited by the respondents for the defective products include:

Assignable causes like: Inaccurate/incomplete raw material quality, inadequate analysis of raw material quality level, inadequate testing, old machines, and less attention given, some times by employees.

Random causes like: power interruption, and machine downtime and Reliability.

Processing time waste: - Addis Ababa Bottle and Glass Factory is a process industry. Some of its characteristics can be summarized as:

- Equipment is large and inflexible in terms of product mix.
- Products are bulky that limits the choice of transportation mode.
- Shutdowns are normally long.
- Equipment set-up and changeover costs can be substantial, and
- Some process must be processed in batches.

50% of the respondents agree that the processing time waste in the company is moderate. The reason given by some respondents are: Absence of parallel line production, inflexibility (for example, to change the color of some products it requires 11 days), excessive job change over for some products up to 24hrs, the machines used for production is old; it is some times impossible or difficult to get the appropriate spare parts, and etc.

Set-up time/ Change over time waste: - as responded by the employee of AABGF this type of waste is the biggest problem. 50% respond moderate concentration and 33.3% respond very high concentration. The production and technical department head of the company has been explained the set up times with regard to their company as follows. The set-up time of the company can be categorized as internal/ job changeover time and external set-up/order set up time. The ordering or vendor set-ups are described under the suppliers of the company. Under this topic only job change over time is described. As the evidence shows that the job change over times of AABGF varies for each product types. It is shorter on changing between some products and longer between some products. In general the set-up time ranges from **1.5hrs-24hrs**.

For other remaining wastes, like lead time and vendor time, we can see from table 3.5 and supplier part, its concentration at the current operation is rated high. But 99% of the raw material is available in the country and most of them are near by, therefore, the company can easily minimize such wastes in the future.

Summary about the waste concentrations in the company

The results obtained to substantiate each waste type are of qualitative analysis. A quantitative analysis is obtained only for the defective product waste from the company. But the analysis shows that the entire waste types do exists in the company. Therefore, the company should work hard in this regard to minimize them gradually. But the commitment of top management and total employee involvement should be maintained along the journey.

b) Aspects of Continuous improvement program

JIT is about pursuing of excellence by minimizing wastes or non-value adding activities in the company. Towards this some attributes for improvement that is necessary for the company is collected and analyzed.

The result shows that the company continuously improve on some techniques like: increase links to customers, increase links to suppliers, increased quality of product and process, increase links of information in between departments, increased preventive maintenance, inventory reduction, lot-size reduction, material handling reduction, increased flexibility of process and personnel, movement distance reduction, and quantity of part number reduction. But fewer efforts have been shown by the company to continuously improve techniques like: transport reduction and paper work reduction. From the result it is possible to see that when the efforts measured on the scale 0-100 most of them measures between 50 and

60. That is 59.72, 56.94, 59.26, 55.56, 43.94, 58.33, 53.03, 47.22, 63.89, 62.5, 51.52, 51.67, 62.5, 68.18, and 63.64 respectively for the attributes shown in appendix 1 under continuous improvement program. Therefore, much efforts is required to device those techniques and continuously working on it.

c) Analysis of Benefits of JIT Implementation for the company

The companies that have been implementing JIT philosophies have been gained many benefits from it. Similarly if JIT will be implemented in AABGF many benefits can be expected. Some of these benefits as perceived by the respondents of the company are collected and ranked as follows.

Table 3. 4 Ranks of the benefits expected to be attained by AABGF as perceived by the respondents

S. NO	Ranks for the Attributes	Agg. Mean	Standard deviation
1	Increase links to customers	74	1
2	Increase links to suppliers	72	1.1
3	Increased quality of product and process	71	0.97
4	Increased profit/reduced cost	71	1.1
5	Increase links to inter departments	69	1
6	Increased flexibility of process and personnel	68	1.1
7	Material handling reduction	68	1
8	Increased preventive maintenance	68	1.1
9	Lot-size reduction	67	0.95
10	Set-up time reduction	64	0.83

11	Inventory reduction	60	1.2
12	Quantity of part number reduction	59	1.3
13	Paper work reduction	56	1.4
14	Decrease in number of suppliers	52	1.3
15	Movement distance reduction	51	1.3
16	Transport cost reduction	51	1.4

3. Justification for Characteristics of JIT in AABGF

The analysis shows that most of the attributes considered justifying the JIT techniques are below requirement. Only parts that are made in the company are those needed by the subsequent process, the company entrusts the work force with functional and decision related responsibilities are below average. The evidence shows that the company should work much to attain the rest results as desired to have the benefits of JIT goals. To see their results on the scale 0-100: a result of 63, 50, 43, 55, and 45 are respectively obtained for the attributes.

4. JIT purchasing /supplier partnership of AABGF

To analysis this part the data about suppliers of AABGF are collected and tabulated.

Table 3. 5 The materials used by AABGF and how they are supplied to the company along with their respective lead-time.

S.no.	Raw material consumed	Suppliers of the RM	Location (place)	Shipment per day	Lead time (hrs)
1	Silica sand	AABGF	Muger Derba	2	6
2	Lime stone	AABGF	,,	2	6
3	Soda Ash	ABJATA	Zeway	1	10
4	Marble	AABGF	Harar Garajewe	1	18
5	Cullet	AABGF	-Rejected process from AABGF -Defected parts -Scratch from customer	-	-
6	Some other chemicals	UK, Italy, south Africa	UK, Italy, South Africa	Shipment/ Month	6 months

The company has both local and oversea suppliers. But it has found that most of the raw materials consumed by the company are available in Ethiopia. The most out standing problems regarding the suppliers as stated by the respondents of the company's are: They are not reliable, their reliability & consistency in trade terms is low, they don't deliver on time, some times the quality of the needed material is not as needed and inferior, delivery time is not the shortest possible, failing to do the exact specification because most of the company's needs, spare parts, are old models.

The other problems regarding oversea suppliers are tied up with the government like: Use of only Ethiopian shipping lines for imported raw materials; Ethiopian Custom processing is the big problem for vendor delay, and high vendor lead time that is about 6 months.

The analysis of the survey questionnaire shows that:

- Most of the respondents 58.3% agree that the company's relationship with supplier is based on mutual trust, cooperation, and long-term commitment.
- 33.3% said the company gives very high attention to price for purchasing decisions.
- 33.3% equally agree that low, and moderate attention is given to delivery time/schedule.
- Most respondents 50% agree that the company gives moderate attention to quality, and 33.3% respond moderate attention is given to mutual trust.

In general the mean value for each purchasing decision is as follows from high to low where 1 = very low, 2= low, 3= moderate, 4= high, and 5 = very high.

Attributes for purchasing decisions	**Mean**	**Standard deviation**
Quality	50.6	0.9
Price	60.16	1.4
Mutual trust and cooperation	50	1.1
Delivery time/schedule	58.3	1

Further analysis of the suppliers' part of Addis Ababa Bottle and Glass Factory shows that:

- Most respondents, 75% agree that the most useful suppliers are oversea (foreign).

- 41.7% respond use of Internet based information system for purchasing process is low.
- The majority of the respondent, 58.3% agree that making mutual trust with local suppliers is highly important.
- Most employees, about 41.7%, highly agree that few near by suppliers are required for the implementation of JIT system in the company.

5. Dignity/respect of individuals in the AABGF

The agreement of the respondent on the scale 0-100 rates 65 for individuals in the company is considered an important asset, 57 for employee experience, creativity and intelligence are all given valuable credit, 58 for operators take responsibility of controlling the equipment, inspecting quality, correcting deviations, maintaining machines, and improving the processes, 55 and 52 for employee involvement in problem solving and empowerment are common in the company and education and training are frequently conducted to enhance the capability of the employee respectively. But most of the respondents disagree about all employees in the company are cooperative, and line works some times are confident enough to make their own managerial decisions, and a mean of 42 is obtained for these attributes.

6. Customer Focus of the Company

✓ Major Customers of the company

Almost all of the customers for the company are local mostly from Beverage sectors and cosmetic industries, but if some times the local customers send their products to abroad, the company will have the opportunity to introduce their packages.

As obtained from the commercial and marketing department of the company the lists of major external local customers of AABGF from different sectors are the following:

Breweries: - Meta Abo brewery S.Co., Dashen Brewery S.Co., Bedel Brewery, Harrar Brewery, and B.G.I. Ethiopia.

Alcohol and liquor: - National Alcohol & Liquor Factory, Balezaf Liquor Industry, Desta Zebib Liquor Industry, and Mola Maru liquor Industry.

Mineral Waters: - Ambo mineral Water Factory and Babile mineral water Factory.

Wineries: - Awash wine S.Co.

Cosmetics: - Zenith Gibs Eshet P.L.C., Berchaco Ethiopia P.L.C., and Pi.Bi.Ti Cosmotics P.L.C.

Agro- Industries: - Upper Awash Agro-industry Enterprise, National pride P.L.C, etc.

Most of the respondents 33.3% agree about the customer focus of the company. For the attributes considered under this part a result of 67, 74 and 63 are obtained. My argument here is that the company should consider internal customers as well. Customers are basically two: external and internal. Also, the result for this issue is satisfactorily the company will attain this goal by implementing a pull production system.

7. Aspects of Quality orientation in AABGF

Total quality control is an integral part of JIT. In JIT system defects are considered a waste. The analysis of data shows that some attributes like defects are screened out immediately after they occur and for the purchased parts, the inspection is completed before delivery were not achieved and they measured 47 and 37 on the scale 0 – 100 respectively. In general the results obtained for each attributes measured 57, 67, 60, 57, and 37 respectively. Even if the company owns a computerized in the line inspection facility, it was not working during the research. There are some quality control indications that was practiced in the company for different materials, like finished products quality control:

1. Visual tests like: Ovality, Color, cracks, folding, bent, wedged body, and blistering.
2. Physical measurements like: Verticality of containers, Uniformity of stress releasing, internal pressure resistance, Thermal shock resistance, Weight of products, Capacity limits of products, Chemical resistance of products, and standard height.

Raw material quality control: For the raw materials available in Ethiopia, the geological survey is first done, and after the quarry is located the raw materials are continuously inspected for **Grain size** and **ratio of each ingredient**. In general the quality practice of the company is that quality is inspected not built in. Quality is mostly the responsibility of the quality control department. Total employee involvement and commitment seems very loose. There fore, the company should work in attaining the objective of zero defects by total employee involvement and ensuring quality at the source.

Chapter - 4

JIT Implementation in Industries in Focus

4.1 Introduction

The Japanese have achieved their current level of manufacturing excellence mostly by doing simple things but doing them very well and slowly improving them all the time [9]. To make Japanese methods work in our Companies, for instance, is not only a matter of applying these techniques: much careful thought must be given to the timing and scope of what is done, and how a new method can advance progress towards the vision of excellence. A comparison of JIT systems and our companies' production system will be presented to help in examining the application of JIT manufacturing strategies in the environment of the two companies.

4.2 Key Factors for the Successful Implementation of JIT

By applying the JIT philosophy, many companies are improving their productivity. However, incorporating JIT requires a heavy commitment of time and imposes a rigorous discipline upon the organization [44]. Shingo, a recognized JIT authority and engineer at the Toyota Motor Company (TMC) stated that it took 20 years for the TMC to implement the JIT system and it took most other companies 10 years to obtain similar results [4].

AMCE and AABGF are the oldest industries in Ethiopia. Their products are popular in the country, but their production systems are tied with the traditional ones like Assembly line

and continuous production in pure push production system respectively. But they find that this type of production system will not be assure them staying in this global competitive market. Obviously they are looking some strategies that will keep them in this competitive edge. It is aimed that implementing JIT production system can alleviate such problems. The companies will no more expending much time on finding the critical elements of the system. It was already in place by the pioneer companies who have been using it. The only effort required by our industries will be the adaptation of the innovative systems. Therefore, this thesis will lay a better roadmap for the implementation of JIT in the companies. As stated by Harrison, manufacturers can gain support from four sources to implement JIT [5]:

1. **Stakeholders and owners of the company-**should maintain good long-term relationship among them.
2. **Labor organization**-all labors should be well informed about the goals of JIT, this is crucial in gaining support from them.
3. **Management support-** support from all levels of management. The ideas of continuous improvement should spread all over the factory, managers and all shop floor labor.
4. **Government support-** government can show their support by extending tax and other financial help. This can enhance the motivation, and also help in financing the implementation of JIT.

Some factors that the industries in focus should strictly consider are tried to substantiate as following. Those practices are the most influential to the successful implementation of JIT, therefore the company should try to minimize if possible avoid the barriers [25, 44].

***TOP MANAGEMENT COMMITMENT*:** To be successful in JIT, the commitment of time and resources required to complete the analysis will require the long-term cooperation and support of senior managements. The JIT principles says that top managements can show their commitment by devoting much time and effort to human relations, expending their time much on the work, and access to every employee at all times. In the industries these important issues are missing, and the practice shows that:

- There is a big gap between top-management and shop floor workers.
- The management style is a tally type.
- Top managements are taking changes through hesitation.

***WORKING CULTURE OF THE COMPANY*:** JIT requires an overall cultural change of an organization, but the trends of the industries discovered, are currently influenced by the culture of traditional manufacturing system.

The overall culture as sited by the respondents and observations reflects the following:

- Keeping high work in process (WIP) to ensure capacity utilization.
- Based on safety stock.
- Fixing the blame rather than the problems.
- Social and emotional issues are suppressed.
- Mistakes are inevitable because employees are afraid to disclose.
- Corrective mentality of defective goods.
- Corrective mentality of equipment maintenance.
- Front line workers are given limited responsibility; because of this the employee involvement for continuous improvement is relatively low.

***TRAINING PROGRAM*:** The training program in JIT environment is a continual process, but most of the training is extensive at the beginning and the others are given on job training. The education and training system in Ethiopia, in general does not reflect the culture and socioeconomic aspect of the country, rather it is based on the other country curriculum. The summaries of training program in our industries are as given below:

- Only a familiarization program.
- The majority of the training is limited to higher-level management.
- It is not considered as a long-run return.
- Training is seen as an investment rather than a continual improvement program.
- The training given is optimal training to meet immediate job need.

***EMPLOYEE RESISTANCE*:** As the literature says it is the people who make JIT work, therefore, a total employee involvement is required to ensure the quality of their product. It seems that employees in the industries are not fully ready for this issue. The main reasons sited by the respondent for the employee resistance in companies are:

- Fear of job security.
- Job security prevailing.
- Segmented problem solving practices (segmented concern).
- Working or acting to be loyal to their supervisors rather than the company.
- The employees are loyal to professionals.
- Narrow skill of most employees.
- Functional workers are somewhat specialized and rigid.
- Decision is usually initiated at the top and flow down, and it is also individual.
- The employees, in general agree with their boss in all aspects but violently.

***QUALITY COMMITMENT*:** As perceived in the literature review, a prerequisite for JIT success is commitment to quality, and commitment to qualities requires changes in policies affecting procurement, production processes, product change, problem troubleshooting, and relationships with suppliers. When we look at the quality perception of the companies it is best fit with the following:

- It costs money to make quality.
- Quality is controlled rather than built-in.
- Inspection is highly emphasized.
- Quality personnel are responsible for quality problems.
- Their quality practice is more of control oriented.
- Most of important quality improvement tools are not commonly used.
- The quality costs are not properly documented, and
- Only charts, formats for reporting defects are used.

***COMMUNICATION*:** In a well JIT practiced environment, the level of communications is very strong with both internal and external organizations. In the recent innovation systems the use of Internet facilities for external organizations, electronic data interchange (EDI) for internal organization, and Kanban information circulation systems for production lines are used. In our industries these information communication technology is at most missing. It has been seen that the use of Internet facilities are limited for higher officials and management, the purchasing process is also based on traditional methods. Therefore, the author recommends at least the use of Internet facilities for purchasing purposes. And for internal communications it is recommended to form small group improvement program to initiate the issues and exploit to the whole organizations.

***VENDORS/SUPPLIERS ASPECT OF THE INDUSTIES*:** The data analysis shows that AMCE has almost fixed oversea suppliers from IVECO, and some local suppliers. The participation of IVECO in the company's product quality improvement seems promising; but IVECO has got a problem of delayed delivery time. It has been shown that from a total of 4month of oversea vendor lead time, about 2month is delivery time, and 2month is custom processing time. With these regard AMCE eagerly look for Ethiopian government to: Improve the processing method of the custom, improve the domestic spare part manufacturer capability, establish component manufacturing factory as an integral part of the assembly plant, and improve the taxi imposed on imported raw materials of the company, etc. On the other hand, AABGF has almost local suppliers. As respondents said 99% of the raw materials used by the company is local. In this regard AABGF has a good opportunity to have a few key suppliers, the only problem sited about the suppliers of AABGF are: Inconsistence in quality, some times inferior quality, and unscheduled delivery time according to the pace of production process.

4.3 JIT Vis-à-vis Two Companies' Manufacturing Strategy

It is paramount to compare JIT manufacturing strategies with the two companies in focus counterpart for the better understanding of the distinction between them. There have been studies that have attempted to identify differences in socio-economic, quality, people, purchasing, production system, and management practices of JIT vis-à-vis traditional manufacturing practices [3, 5, 9, 13, 52]. Comparison between JIT and the companies' production system is explicitly discussed very comprehensively in table 4.1.

Table 4. 1 Comparison of JIT and the companies manufacturing strategies

Attributes/sub-attributes	JIT manufacturing strategies	Our companies manufacturing strategies in focus
1. *Work force and organization*		
Work force		
• Multi functional (sojinka)	Flexible.	Specialized and rigid.
• Attitude	Common values, facilitating cooperation.	Often divergent values, Individualism sometimes hindering cooperation.
• Decision making	▪ Collective decision making ▪ Change by consensus. ▪ Involvement of many people in preparing and making decision. ▪ Decision flow from bottom to top and back. ▪ Slow decision making, fast implementation of the decision. ▪ Group activities are stressed. ▪ Employees disagree with their boss often but politely.	▪ Individual decision-making. ▪ Change by edict. ▪ Involvement of few people in making decision and "selling" the decision to persons with divergent values. ▪ Decision initiated at the top, flowing down. ▪ Fast decision making, slow implementation requiring compromise, often resulting in sub-optimal decisions or no implementation at all. ▪ Difficult to organize. Many cases poorly planned and unorganized ▪ Employees will disagree with their boss rarely but violently.
• Willingness to change	Learn to accept.	Resistance to change. The true leadership is missing
• Loyalty	▪ Loyal to company.	▪ Loyal to profession.

	▪ Holistic concern.	▪ Segmented concern.
• Employment	Life time employment, dedication and job Satisfaction.	Short term employment, Job security prevailing
• Job design	Non-specialized carrier paths.	Specialized carrier paths.
• Training and education	▪ Lifetime training. ▪ Training and development considered long-term investment. ▪ Broad skills.	▪ Optimal training to meet immediate job need. ▪ Training and development undertaken with hesitation. ▪ Narrow skills.
• Motivation	Hard pace.	Easy pace.
• Continuous improvement (Kaizen)	Never rest on success.	Often rest on success.
Organization		
• Organizational values and culture	▪ Human resource management is connected with individual sense of purpose, emotions and social meanings. ▪ Fix the problem not the blame. ▪ Saving face. ▪ Mistakes are treasures the study of which leads to process improvement.	▪ Social and emotional issues are suppressed, and power domination is usual. ▪ Fix the blame not the problem. ▪ Fixing blame. ▪ Mistakes are inevitable people are afraid to disclose.
Enterprise unions	▪ Union fights management.	▪ Union fights the company.
• Industrial relations	Harmonic industrial relations.	Aggressive
• Empowerment	Employee empowerment to take right decisions.	Total control to meet production targets.
• Organizational structure	Flat management.	Tall hierarchy.
• Respect for human system	▪ No status differentials. ▪ Respect to humanity and creativity.	▪ Status symbol pays privilege. ▪ Respect to status.
• Profit sharing	Sharing profit with labours.	Making profit for themselves.

• Manpower planning	Work force is first built and workers are then placed in business hierarchy according to their abilities.	Required number of slots are created and then filled in.
2. *Quality*		
• Quality management	▪ Quality is free. ▪ Quality is built in.	▪ It cost money to make quality. ▪ Quality is controlled.
• Statistical quality Control	▪ Quality at the source is emphasized. ▪ Statistical study of variations to understand causes. ▪ Process control.	▪ Inspection at large. ▪ Scoring, reporting, and evaluating. ▪ Acceptance sampling.
• Total quality control	Workers are on-the-spot troubleshooter.	Quality personnel are responsible for quality problems.
• Visual control	Control charts, Poka-Yoka system.	Only charts to some extent.
3. *Plant and equipment*		
• Group technology (GT)	GT is highly used.	Reluctant to use.
• Automation	Automation is valued because it facilitates consistent quality.	Automation is used with limited area.
• House keeping	5's (Seiri, seiton, seiso, seketsu, and shitsuke) are used.	Comparatively untidy and disorganized work place.
• Displays	Light displays to highlight trouble spot.	Not used.
• Total productive maintenance (TPM)	▪ Prevention mentality. ▪ Preventive maintenance. ▪ Maintenance is regular, machine break down and tool failure must be eliminated.	▪ Corrective mentality. ▪ Break down maintenance. ▪ Maintenance is done only after failure. Machine break down is not serious because of inventory.
4. Production system		
• Priorities	Priorities: limited market.	Accept all orders.
• Manufacturing system	• Make to order. • Kanban (Pull System).	• Made to stock. • Push system style.
• Standardization	Standardized output.	Customized output.

• Capacity utilization	• Capacity moderately utilized. • Run equipment slow but for 24 hours • Just in time production, no WIP.	• Highly utilized. • Run equipment fast as long as it runs. • WIP is needed to assure that machine utilization stays high.
• Set-ups	Low set-up time.	High set-up time.
• Layout	Flexible layout.	Rigid layout.
5. Inventory System		
• Waste reduction	• Inventory is an evil it hides problems that should be allowed to be surfaced. • Every effort must be extended to minimize inventory.	• Inventory is useful (asset). It makes production rolling along. • It protect against forecast error, machine break down, and late deliveries.
• Queues	Once in motion, always in motion. Production should be just-in-time; there should be no queues of work in process.	Queues of work-in-process are needed to be sure that machine utilization stays high.
• Lot sizes	Keep reducing the lot-size. The smallest quantity is desired for both manufactured and purchased parts.	Keep revising the optimum lot size based on some formulas.
6. *Purchasing*		
• Small lot purchasing	Small lots.	Large batches.
• Supplier buyer proximity	Frequent deliveries.	Few deliveries.
• Supplier selection	Supplier selection: long-term contract.	Short-term contract for local suppliers and fixed suppliers from IVECO for AMCE.
• Few committed suppliers	Single source supply.	Multiple source supply for local suppliers of AABGF.
• Complimentary concern	Work together to maximize the economies of co-operation.	Reduce supplier power, widen supply base; reduce buyer

		power, widen customer base.
• Buyer supplier cooperation	Win-win situation.	Playing them off against each other, competitive perspective
• Buyer control over freight	Transportation mode: concern for both inbound /outbound freight.	Outbound shipment
• Supplier evaluation	Supplier evaluation; includes quality, delivery, and price.	Mainly price.
• Zero defects	No rejects acceptable.	Some percentage reworks are permissible.
• Supplier as designer	Loose specification, emphasis on performance.	Rigid specifications innovations are not encouraged.
7. *Product and price*		
• Product design	• Innovations. • Customer oriented product.	• Imitations. • R & D lacking: product design depends upon what is available rather what the customer demands.
• Pricing strategy	Believe in long-term gains, low profit margin; sell high volume at lower price to make high profit.	Strive for short-term gain; sell at high price to make high profit.

In order to implement JIT successfully in the companies those deviations from the actual practice of the system must be evolutionally changed to the significant result. Therefore, this research shows the right track to the company, by strictly observing the JIT characters listed above and correlating to their current practices the management and employees can take corrective measures. The author therefore, strongly recommends the company to consider these situations before starting Implementation.

4.4 Applicability of JIT Techniques in the Industries

Table 4. 2 Applicability of JIT techniques to AMCE and AABGF

S. No.	JIT techniques/ tools	Applicability to	
		AMCE	**AABGF**
1	Pull production system	Partial	Partial
2	Total quality control (TQC)	Full	Full
3	Total employee involvement	Full	Full
4	Multi-skill employee	Full	Full
5	Continuous improvement	Full	Full
6	Cellular manufacturing	Partial	Difficult
7	Parallel line production	Partial	Partial
8	Work standardization	Full	Full
9	House keeping (5s's)	Full	Full
10	Total preventive maintenance	Full	Full
11	Kanban card like production system	Partial	Partial
12	Set-up time reduction	Full	Full
13	JIT purchasing	Partial	Full

From table 4.2 we can see that some JIT techniques are fully applicable to both companies and they can be achieved in the long run, but some techniques are partially applicable and some are completely difficult. This investigation is done based on the nature of the industries and current status, but some techniques that are even difficult at the moment may be achieved gradually in the long run. From the analysis we can also see that only a hybrid (Push-Pull) model can be implemented in both industries.

Chapter- 5

Developing JIT implementation Model for Companies in Focus

5.1 Introduction

Once the company sets its operation on the JIT model, it becomes easy to implement the JIT philosophy. Since, many techniques and components of JIT are introduced gradually it will not force the company to go through the traditional approaches at once and install a new JIT systems. In the implementation phase of JIT production system, the guidelines developed by the American Production and Inventory Control Systems (APICS), and others will be presented.

5.2 JIT Implementation Guidelines Developed By APICS

Implementing a JIT production system consists of completing a sequence of projects, each of which makes changes to one or more of the six subsystems that comprise the production system. Under normal circumstances the sequence of projects shown in Figure5.1 is implemented. Sometimes the order in which the projects are done, and the pace at which they are done, will vary. This depends on factors such as the following [34]:

- How critical is the need for change? When an organization faces a crisis it will, of necessity, make changes faster than when things are going relatively well.
- How healthy is the organization? How much capability does it have? If the organization is not healthy (that is, it has cash flow problems, poor management-union relations, obsolete products, etc.) or has oldest capabilities (that is, it has old

facilities, unskilled workers, poor managers, mediocre suppliers, etc.), then there is a poor foundation on which to make changes. Consequently, the implementation should be done more slowly.

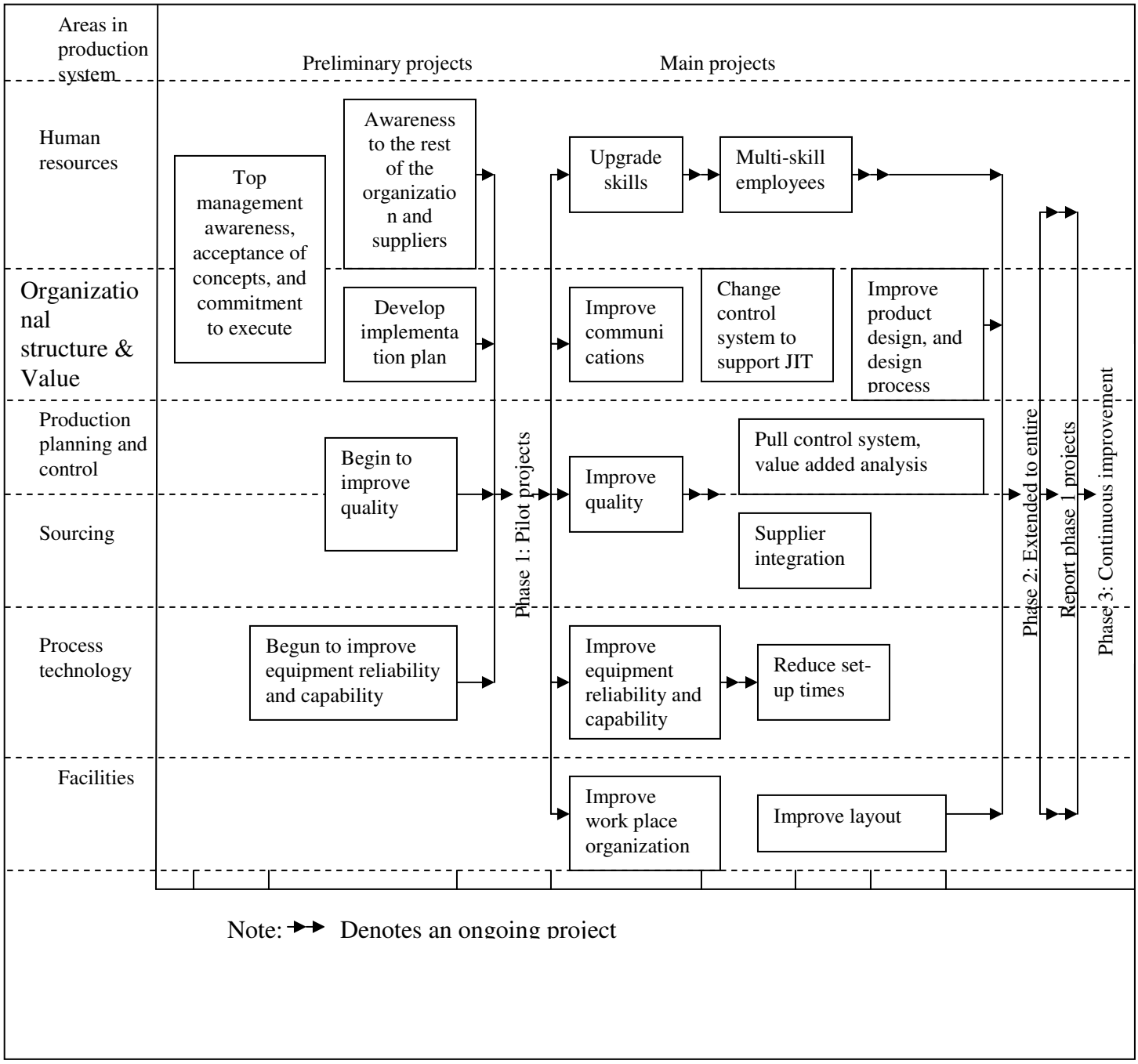


Figure 5. 1 JIT Production System Implementation Projects [34]

- What does each project require? Often extra personnel, additional time, and new expertise are needed for each project. The internal and external resources that are available affect how quickly the implementation can be done.

The sequence of projects is divided into two parts – the preliminary projects and the main projects. The preliminary projects are five simple projects that are designed to get the JIT implementation off to a good start. They have two goals [34]:

- Achieve early, visible successes. This will generate momentum and create a "bandwagon" for employees to jump on; and
- Prepare a foundation for the more difficult projects that will follow.

The main projects are more difficult projects that are designed to change each of the six production subsystems into ones that are appropriate for JIT. These projects take longer and require more resources. The main projects are divided into three phases.

i) During phase1 the projects (usually called "pilot projects") focus on selected products and machines, and only selected employees, departments, and suppliers are affected.

ii) In phase 2 the scope is expanded to include the entire organization. The same projects that were executed in the first phase are undertaken again, but this time all products, machines, employees, and departments are included.

iii) Changes are still made in phase 3, but rather than have separate projects, an organization-wide continuous improvement program is undertaken. Despite the advantages of beginning with pilot projects, there will be instances where an

organization has sufficient capabilities and resources to start in phase 2 and implement JIT throughout the entire organization.

It is important to track the progress of each project, and so at the start of each project, performance measures, such as quality attributes, repair costs, inventory levels, lot sizes, cycle time, conveyor length, set-up time, open and customer orders are selected. The measures are then tracked on display boards, so that everyone can follow each project's progress. Tracking ensures that the improvements made during a project do not go unnoticed. It also helps to build enthusiasm and momentum, and helps to keep each project on course [34].

5.3 JIT Production Paradigm: Toyota's JIT production system

5.3.1 Japan's war against waste

The Japanese automakers could not use new technologies to improve their productivity. Not many new technologies were emerging in the auto assembly process. Further the worldwide customers hold a very low image of Japanese products. Toyota decided to pursue "low cost leadership" strategy. They had to cut out waste. Every production operation was rationalized. Large corporations used paper on both sides even for the business document [49]. The techniques that Toyota Company used to increase profit by reducing waste is shown in figure 5.2 and it is called Toyota production system. In the figure "Toyota production system" Yasuhiro Minden describes how quality, quantity costs and humanity are improved in an integrated lean production system. Toyota's dominance over the automaker's can be also depicted as shown in Appendix 5 [30]. It is the

combination of strategies, mechanisms, tools/methods and environments for associates [30]. Based on this strategies used by the pioneering company and their experiences an implementation model for Ethiopian companies can be devised. But much attention should be given to determine the level of preparation and applicability of the new strategies.

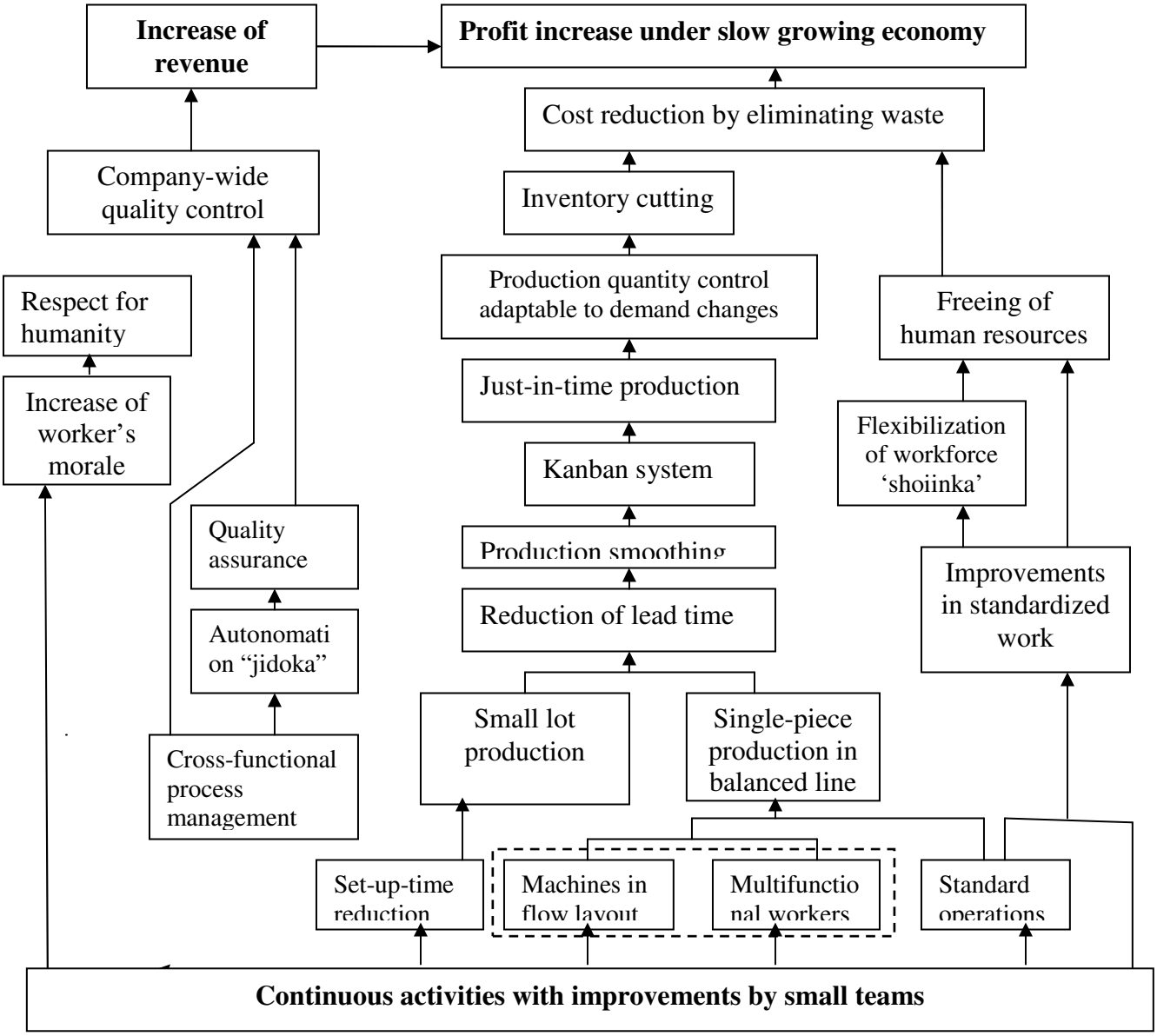


Figure5. 2 ***Framework of Toyota Production System (Source: Lean Enterprise institute Sweden)***

5.4 Ohno's Mental Model for JIT implementation

Not much is written on how to implement JIT. Some firms fall through with trial and error. Others rely on repeated Kaizen events. Another approach emphasizes phases [48]:

1. Stability.
2. Continuous Flow.
3. Standardize Work.
4. Pull System.
5. Level Production, and
6. Continuous Improvement.

These phases are supposed to roll through the plant. For most firms this is unrealistic and likely to fizzle. What guidance they do have is highly prescriptive. "Do the above things (followed by a list) and everything will be go right." The laundry list for JIT includes Cellular manufacturing, total quality, teams, rapid setup (SMED), Kanban, value stream mapping, 5-s, pokayoke, elimination of waste, total productive maintenance, continuous flow, standard work, takt time, level production, kaizen, supplier development, and etc. Examining the matter more strategically raises several questions [48]:

- Do we need the entire list of "Tools and Techniques?"
- If not, which do we employ?
- Which elements come first?
- Do we implement plant-wide or in focused areas?
- How does Kaizen fit into the picture?
- How detailed should the plans be?
- How long will it take?
- How do we know when we are *really JIT*?

Taiichi Ohno and **Shigeo Shingo** developed and implemented JIT at Toyota over a period of 20-30 years. Their approach provides a **mental model** for other implementations.

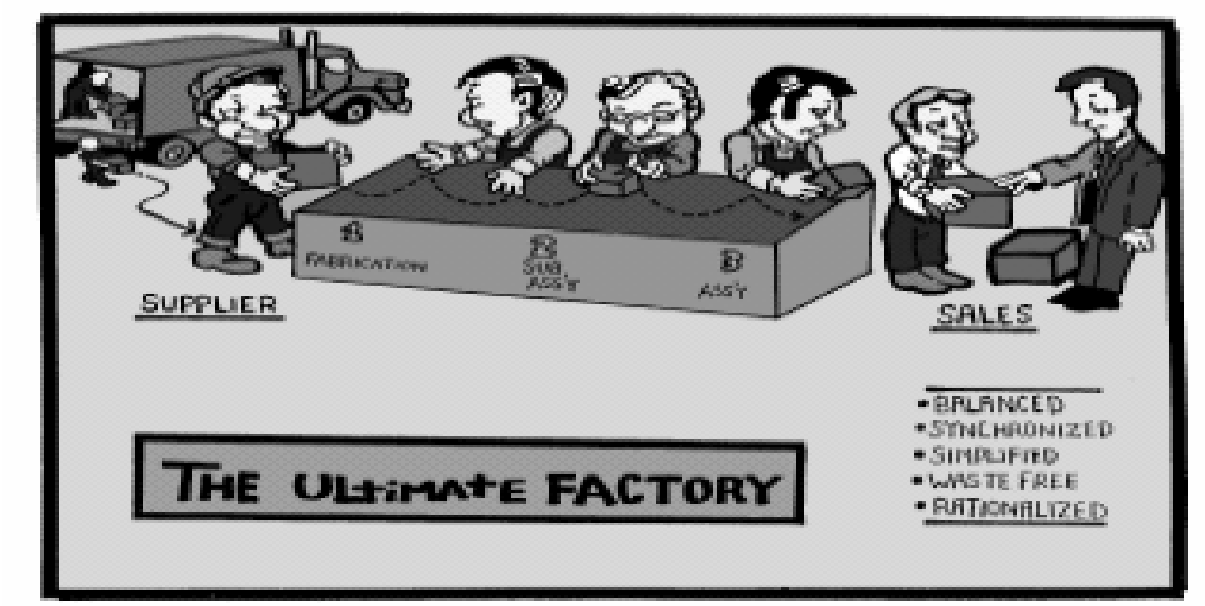


Figure5. 3 Ohno's mental model of JIT implementation (source: www.strategosinc.com)

Ohno first visualized an **ideal production system,** in **terms of workflow**. Ohno's ideal system was inspired by his observations at Ford Motor Company. It had a series of adjacent workstations that were balanced and synchronized with no inventory between stations. It delivered finished product to the customer exactly when needed (Just in Time) and drew materials, Just in Time [48].

According to legend, Ohno asked Shingo and others what prevented the realization of this ultimate, **no-inventory system**. As the reasons Surfaced, Ohno requested his deputies to "eliminate the reasons."

Table 5. 1 Ohno's dispute to eliminate the reasons

Cause	Effects	Remedy
Inflexible Equipment	►Long, expensive setups,Large Batches, and Inappropriate Layouts	►Setup Reduction ►Smaller Scale Equipment
Functional Layouts	►Excessive Handling ►WIP Queues ►Disconnects ►Poor Quality	►Cellular Layouts
Poor Quality	►Angry Customers ►High Scrap & Rework Costs ►Unpredictable Schedules	►Six Sigma & TQM ►Work cells ►Work & Quality Teams
Inappropriate Scheduling	►Complex Systems ►Inaccurate Inventory Records ►Large Queues, and ►Long Lead Times	►Kanban ►Broadcast Schedules ►Work cells

The resulting elements of JIT aim at eliminating (or at least reducing) the reasons for inventory. While the real goal is to **eliminate waste**, Ohno understood that **inventory mirrors waste.** The best way to reduce inventory is to improve processes, facilities, quality, scheduling and setups. To develop a JIT Manufacturing Strategy and implementation plan, they recommend five general steps [48]:

1. Evaluate the Current State.
2. Determine the Future-State Workflow (In Principle).
3. Identify Future State Infrastructure (In Principle).
4. Identify Precedents and Priorities, and
5. Develop the Plans.

The Mental Model is simple; the implications profound**.** It led Toyota to setup reduction, work cells and, eventually, the other tools of JIT Manufacturing. In other situations, it may lead to a somewhat different set of tools. The moral is:

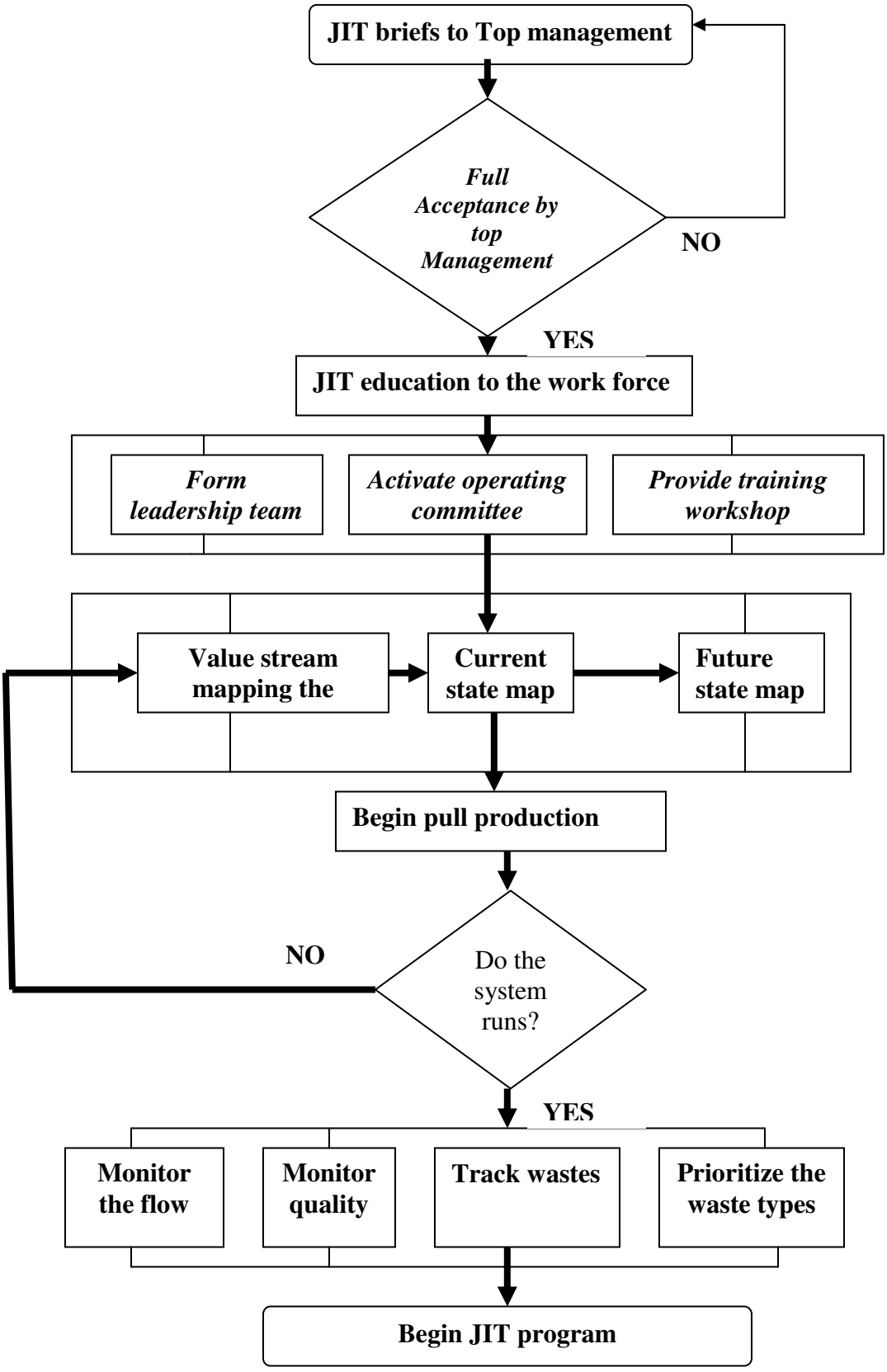
⇒ ***Do not copy specific tools and techniques; they are not universal.***

⇒ ***Copy the thinking and analysis methods; they are universal.***

5.5 Proposed JIT Implementation Model for AMCE and AABGF

After the investigation of JIT concepts from its conception, and the analysis of the companies in depth it is possible to formulate the implementation models for the company. But, the use of other countries experience in using JIT like the general implementation guide lines developed by APICS, Ohno's mental model for JIT implementation, and others should not surpassed. Therefore, the proposed line implementation model shown in figure 5.4 will be best suit for the company to follow. Following is a brief discussion of each step in the implementation model.

***JIT BRIEFS TO TOP MANAGEMENT*:** Top management support is especially important to the success of JIT because its operating principles are so different from traditional operations that it calls for fundamental changes in the way people do and think about their jobs. Therefore, to be successful in JIT, the commitment of time and resources required to complete the analysis will require the long-term cooperation and support of senior management. Hence, the JIT principles must be briefed to the top management and full acceptance by the top management is required and should be maintained through out the implementation phases.


JIT briefs to Top management
Full Acceptance by top Management
NO
YES
JIT education to the work force
Form leadership team
Activate operating committee
Provide training workshop
Value stream mapping the
Current state map
Future state map
Begin pull production
NO
Do the system runs?
YES
Monitor the flow
Monitor quality
Track wastes
Prioritize the waste types
Begin JIT program

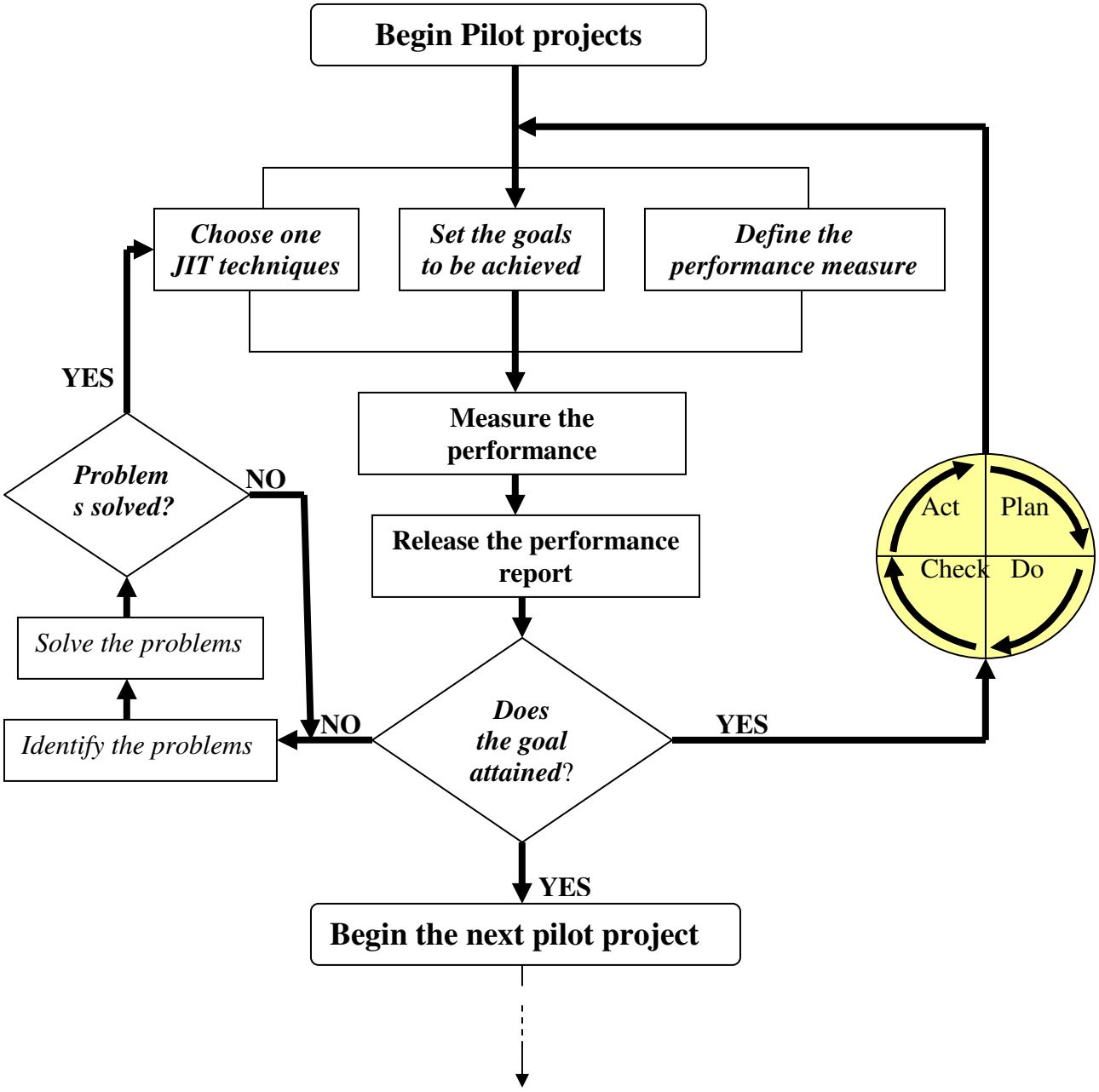


Figure5. 4 proposed model for JIT implementation

***JIT EDUCATION OF THE WORKFORCE*:** The work force is the asset of any company. They are the roads to link between the old and new systems. Therefore, the employees at all levels must be given a training program about the JIT system. After the work force is educated to the desired level it is possible to start JIT implementation by

forming leadership team, activate operating committee and provide special workshop to the leaders and steering committee.

LEADERSHIP TEAM SUPPORT: The management team, at every level of the organization, must be aligned around the purpose and importance of successful implementation of the change initiatives. This group would include the executive team, departmental, and first-line leadership, down to the shop and office floor level. The initiative should be reflected in their operating plans and performance reviews at the individual and team level. The change efforts cannot be seen as something other than their real jobs. This is a key to gaining overall organizational alignment around the strategy.

ACTIVATE OPERATING COMMITTEE: The operating /steering committee would be responsible to provide support in the planning, re-sourcing, implementation, and follow-up accountability for implementation. The steering committee is often identical to the normal line management team. The internal resources and external consultants would provide consulting support to the steering committee. This infrastructure would resolve inter-departmental issues. The steering committee would be responsible for:

- Aligning JIT enterprise efforts to the overall business objectives.
- Determining sequence and timing of rollout, including implementation responsibility and accountability.
- Workshop leader's roles and responsibilities.
- Follow-up plans and executive audits.
- Communication and sharing of best practices.
- Using rewards and recognition to reinforce team accomplishments, and behaviors.

In general the steering committee consists of people from different departments and sections of the company.

***LEADERSHIP EDUCATION*:** The entire management team needs a baseline of understanding which develops a common language and framework for planning JIT implementation and support.

***PROVIDE TRAINING WORKSHOP TO STEERING COMMITTEE*:** Provide a hand - on demonstration of JIT principles to achieve a common base of understanding for all team members. Here it is important to clearly illustrate the differences between the "batch" or "push" system and the JIT "demand pull" concept. It is paramount to include all employees in this workshop. The workshop has helped to instill changes in attitudes as well as mechanics, and has served to stimulate employee identification with the process.

***VALUE STREAM MAPPING THE PROCESS*:** This part is an important part in the implementation steps of JIT. With the description of the production processes of the two companies stated in background, value stream mapping at AMCE & AABGF are developed. It is done by first building the current state mapping, and then the future state mapping. In the future state map it is paramount to determine the takt time of the process. The current state mapping and future state mapping of the two companies are as given in figure 5.5, 5.6, 5.7, and 5.8 respectively. The Current state mapping shows that both companies are currently using a pure push production system; therefore, it requires much effort to change from this traditional production system. For both companies a **hybrid push-pull production system** is applicable. A push production system is used for

purchasing parts in AMCE, and from melting glasses in the furnace to forming machine in AABGF.

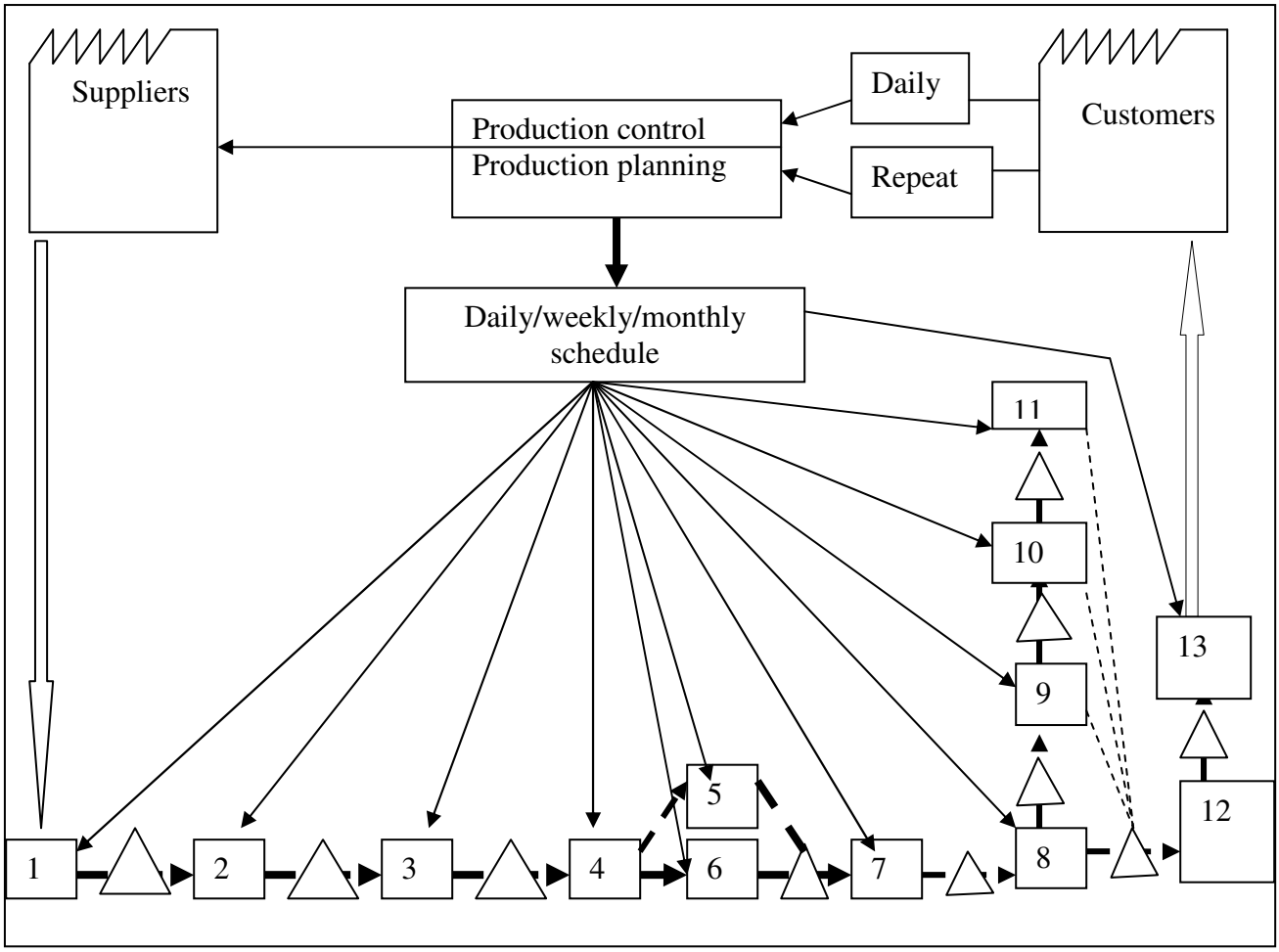


Figure5. 5 Current Value stream mapping of AABGF's Production process

Key:

1=Raw material preparation

2= Raw material batching

3= Raw material weighing

4= Melting the RM in the furnace

5= Glass production

6= Bottle production

7= Annealing

8= Decoration

9= One color decoration

10= Two color decoration

11= Three color decoration

12= Annealing

13= Shipping

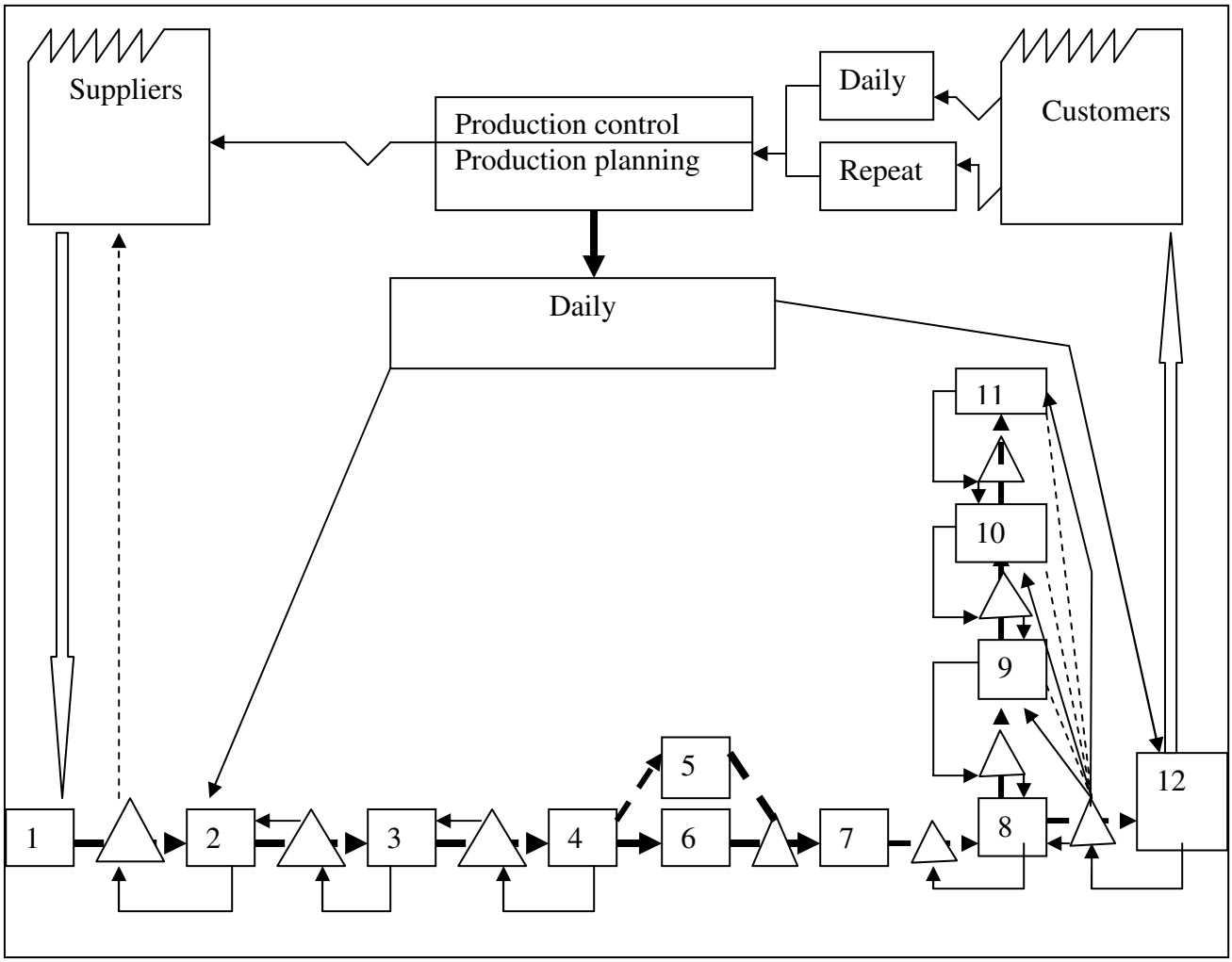


Figure5. 6 Future Value stream mapping of AABGF's Production process

It can be seen from the figure that in the future state mapping only a hybrid (push-pull) system is applicable. A kaizen (improvement program) is done at each process in the value stream. Hence, the wastes that will be attacked by JIT techniques will be easily identified. The takt time for AMCE Company is found to be 4 hrs per assembly of trucks and 0.048min per bottle for AABGF Company. This is based on average value and the company should do for each product families.

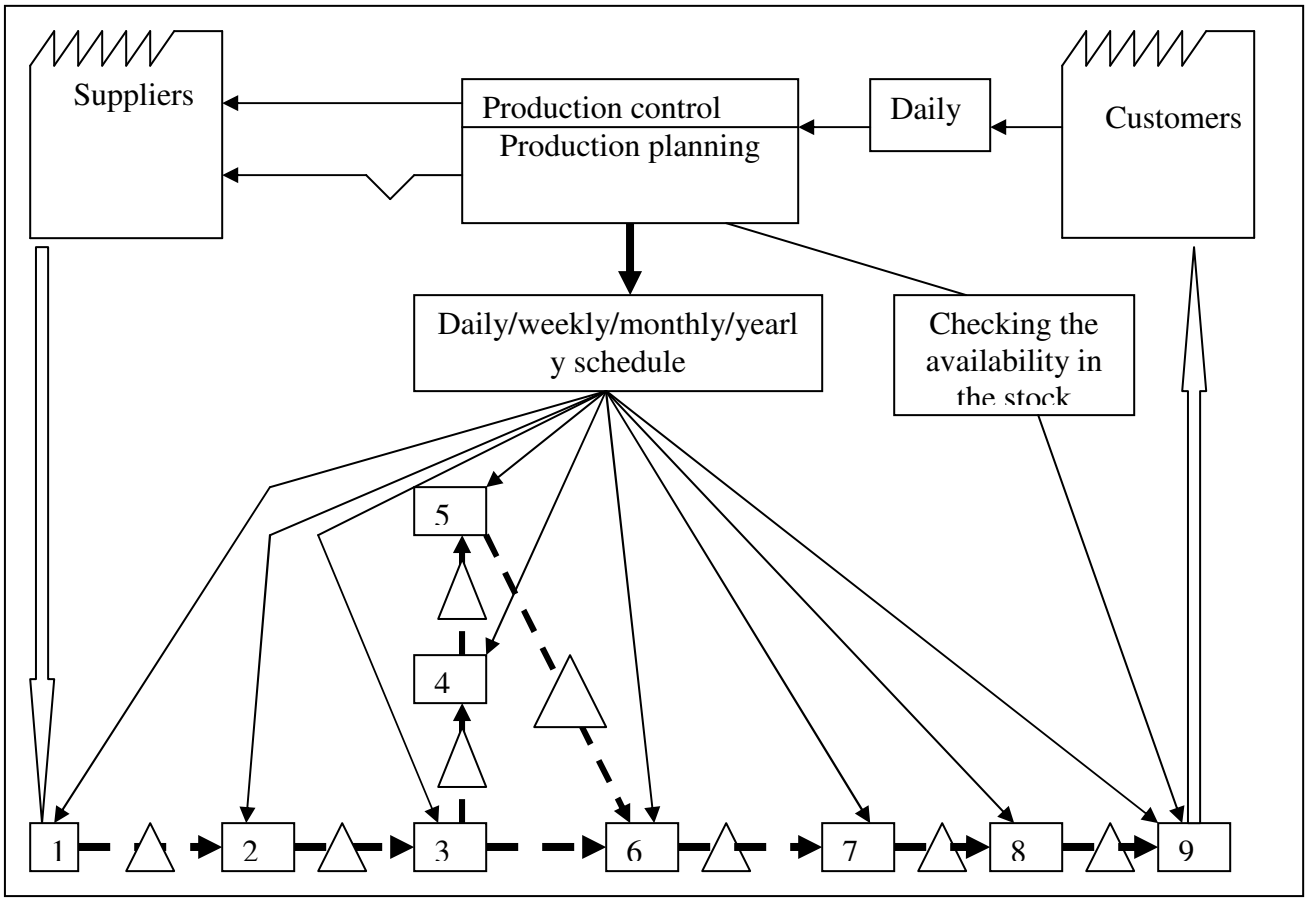


Figure5. 7 Current Value stream mapping of AMCE'S Production process

Key: In the figure the numbers represents

1= Load/unload

2=Moving parts

3= Moving parts and components

4=Mechanical assembly line

5= Body shop

6=Electrical work

7=Refinishing and trimming

8= Final inspection

9= Shipping

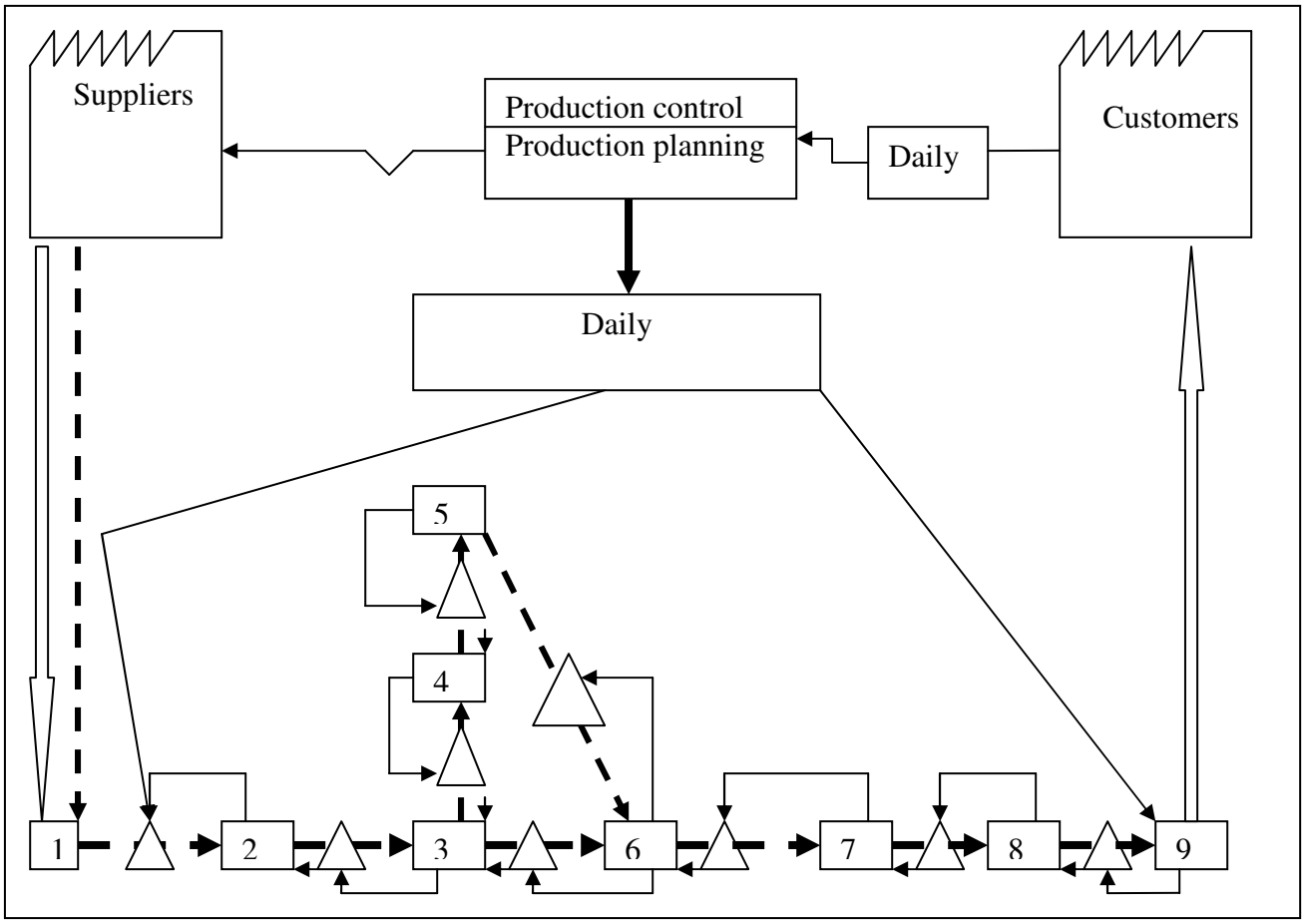


Figure5. 8 Future Value stream mapping for AMCE's production process

BEGIN PULL PRODUCTION SYSTEM: After the future value stream mapping has been built, the next step is to begun pull production system. With the great contrast between JIT and traditional manufacturing practices, in reality there can be no transition period between the two. Set a start-up date, regardless of whether or not you are "ready", and start today. JIT is a process of improvement, and a commitment to the process is more important than trying to work out all the "bugs" before you begun. After running the pull production system it is important to see how the new system works. If some problems are

observed in the new system, reworking the value stream mapping is necessary. If it works well pass to the next steps.

MONITOR FLOW: After the process began re-balance the line as required, monitory performance against targets, split or combine functions as necessary, remove additional queues. Opportunities for improvement abound for managers with open eyes, ears, and minds.

MONITOR QUALITY: Eliminate on-final product inspections, placing the primary responsibility for product quality with each team member. The company should support the workers with "process audits", or spot analysis of workstation procedure. The more the company's can build into these procedures, the easier it become to identify problems and strengthen quality.

TRACK THE WASTE: the main objectives of JIT as seen in the literature review are to achieve: Zero inventories, Zero lead time, Zero defects, Zero set-up time, zero handling, and a lot size of one in the process. At this point it is possible to see the waste types that can exist in the value stream. Track the waste types that exist in the system and prioritize them in their major abundance, then categorize them in the sequence of simple, complex, and difficult to avoid or minimize the wastes. The wastes can be in the form of over production, waiting time, processing, defect, inventory, transportation, and motion. The next step after identifying the waste type is to use the JIT components (techniques) to act against it. Now it is possible to begin JIT implementation program.

BEGIN PILOT PROJECTS: In JIT implementation an attempt is made to implement all the components and/or techniques gradually. To avoid the frustration of the company for loosing their objective each traditional manufacturing process of the company should be maintained at the beginning, but after JIT is started implementing these traditional approaches are gradually minimized to zero. Pilot projecting on the techniques based on the type of wastes to be attacked meets these objectives.

The pilot projects are done in the following steps:

1. Choose one JIT techniques
2. Set the goals/objectives to be attained.
3. Define the performance measure.
4. Measure the performance, and
5. Release the performance report.

If the desired result based on the performance measure is not achieved:

- Identify the problems
- Rectify the causes
- Solve the problems, and
- Work again on the techniques.

If the desired result based on the performance measured for are achieved the company can do either of the following:

1. Continuously improving of the previous works, and/or
2. Beginning the next another pilot project.

***CONTINUOUSLY IMPROVE THE PROCESS*:** JIT is about pursuing of excellence in the manufacturing process and market place, and it is a revolutionary in its definition of minimizing waste [44]. There fore, the company will put a continuous improvement program at this point. The best method/tools to be used for this continuous improvement

Program is the Deming Cycle (PDCA Cycle) which stands for planning - Doing - Checking - Acting.

- The plan step includes identifying a problem, or potential for improvement, and developing a plan for the problem's solution.
- The do step includes a trial run of the planned solution which is evaluated in the check step. Correctly evaluating the trial run depends on an understanding of the variation in the system.
- The check step includes revisions to the plan where they appear to be needed.
- The final action step represents the implementation of the plan.

As explained in the literature survey on page 21. The PDCA cycle involves using a variety of statistical tools such as: Pareto diagrams, Fishbone diagrams, Histograms and control charts and etc. In general, the implementation will be continued until all the JIT techniques will be fully implemented and the company is changed to JIT operating company.

Summary of the Model

The model is developed after thorough analysis of the two companies. The model developed may seem similar for both companies. But, there are many attributes that makes specific model for each essential. For example, the value stream mapping of the two companies are completely different. Besides, on this value stream the pull production system that will be applied are also different. The wastes that will be tracked and the abundance of each waste are different. Based on the waste type identified the pilot project initiated at first is different for the two companies. Therefore, the author assures that the model will suit both companies (AMCE and AABGF) when used along the value stream mapping.

Chapter-6

CONCLUSTIONS, RECOMMENDATIONS, AND FUTURE DIRECTIONS

6.1 INTRODUCTION

In this chapter, the key aspects of this thesis are concluded and recommendations are suggested. The contributions of this research are addressed and future directions are offered for the work.

6.2 CONCLUSIONS

The main goal of this research was to develop a general model to implement Just-In-Time production system with a focus on AMCE and AABGF. As gained from the survey results, the more driving force to implement JIT in the companies are cost reduction and become more competitive, increase customer satisfaction, reduction of machine downtime, and having a better and safer work place by eliminating or reduction of waste and continuous improvement program on the process.

The industries in focus are facing fierce international competition in the face of global markets and very demanding customer. To be effective they must provide better cost, quality, performance, delivery, flexibility, and innovativeness than ever before.

From the literature review, we can conclude that, one of the best ways to do this is to implement JIT production system principles into their operations. As it has been seen so far, JIT principles can be applied to all parts of the organization- from order taking, purchasing, operations, distributions to sales, accounting, and design, etc.

The survey result shows that both industries discovered are in the very infancy stages of JIT implementation. Therefore, before attempting implementing JIT in these companies, the adversarial manager-worker relationship should be developed, and then they have to start with implementing a few JIT techniques. This is easy because, it is just another improvement project and organizations have improvement projects operating all the time like Toyota Motor Company (TMC).

The other part of this work is to investigate the waste concentration in each of the companies. The survey result shows that moderate concentration of some wastes and less abundance of wastes like overproduction of finished products and less defects in AMCE. The reasons sited for the high concentration of Wastes by the respondents of both companies are:-

- High inventories (WIP inventories) that hides problems like: machine breakdowns, reworks, defects, high set-up times, longer cycle times, and many quality problems.
- Absence of using statistical quality control tools.
- Absence of rapid continuous improvement program on the process and product.
- Lack of training.
- Because of using old machines.
- Lack of advanced technology in the country, and

- Lack of research and development in each industry, are sited as the out standing problems.

Other investigation shows that both companies are currently using a pure push production system; therefore, it requires much effort to change from this traditional production system.

From the research it is also possible to conclude that:

- AMCE has almost fixed oversea suppliers from IVECO with average lead time of 4 month, and has lots that last for about 2 weeks in the process.
- AABGF has almost local suppliers, because 99% of the raw materials used by the company are available in the country, and uses lots that last for about a week.
- The condition of using JIT is difficult on suppliers' part for AMCE and on the process between Furnace and molding machine & pressing machine for AABGF.

On the other hand, the tools and techniques of JIT according to their suitability for each company is identified. While some of these techniques and tools are universally applicable to both companies, some of them like kanban card production system, pull productions system are partially applicable. Cellular manufacturing can be attained by AMCE but it is difficult for AABGF to attain this technique because of its nature of manufacturing process.

Finally a general implementation model was developed based on the status of industries and experiences from general guidelines for JIT implementation developed by APICS, and others.

In the model, in order to identify opportunities for implementing JIT, value stream mapping was used as a tool. The industries can use it to identify various types of waste in the value stream of the company and try to take steps to eliminate them. This step makes the implementation model unique to each company.

For both companies a **hybrid push-pull production system** is applicable. A push production system is used for purchasing parts in AMCE, and from melting glasses in the furnace to forming machine in AABGF.

In general, the findings of this research demonstrated potential gains in different areas at AMCE and AABGF. It is worth mentioning that there could also be some limitations and potential barriers in implementing the different JIT tools and techniques addressed in this research. This includes issues like:-

- Union contracts to management changes.
- Resistance to changes in current working culture.
- High machine breakdowns.
- Top management commitment and support through out the implementation phase.
- Training of employee to multi-skill.
- Time commitment.
- Quality commitment by total employee involvement, and
- Communication in the organization, are some due mentioned

6.3 RECOMMENDATIONS

In order to achieve the benefits of the pull (customer-demand) production, AMCE and AABGF should utilize the Just-In-Time production system. The procedures necessary to implement the pull production system are simple yet powerful in maintaining efficiencies with minimum inventory. The basic idea is that the companies are only responding to the company's actual-customer demand for their product families.

The implementation model of JIT developed for the companies are made with the consideration of where the companies are at the moment. Their readiness is rated at their infancy stage to implement JIT. Therefore, the line implementation model should be followed sequentially without shortcutting or jumping any of the steps.

The author recommends that the following should be avoided to overcome the failure of the implementation model:-

- Impatient and lack of preparation of proper foundation on which to make changes.
- Skipping the small, preliminary projects and jumping directly to the large projects such as pull production system.
- Implementing one or two JIT techniques and expecting the benefits associated with implementing a complete JIT production system.
- Under estimating the difficult of changing their production system to JIT.
- Setting insufficient resources aside for ongoing training and development of employees.
- Champions are promoted out of implementation projects before the projects are completed.

- The companies are not prepared to loosen their control over inventories, production planning and control, shop floor activities, etc, enough to let JIT work.
- The company sees JIT only as inventory control techniques.
- Top management is involved but not committed,
- Viewing JIT as simply a project rather than a philosophy of continuous improvement.
- Lack of systematic measurement of progress and accomplishment to identify faltering activities.

In general, to implement JIT the companies should first made priorities like:-

- Respond to customer's requirement.
- Integrate and stream line all processes in their manufacturing system.
- Develop employee participation in meeting the commitments of the company.
- Implant a company-wide commitment to education.
- Eliminate redundant processes.
- Locate and eliminate all sources of inventory.
- Establish goals that require continuous improvement to the production process.
- Use a pull production system.
- Develop controllable production processes.
- Have a company wide defect protection program.
- Set goals on reducing set-up time, and
- Build products to specifications.

After achieving the above general goals, each of the companies should work to achieve the following specific requirements such as:-

- Stabilize and level the master production system with uniform plant loading.
- Reduce or eliminate set-up times.
- Reduce lot sizes and lead times.

- Use total productive maintenance to reduce machine breakdowns.
- Train the work force to multi-skill.
- Develop few nearby suppliers, this may be difficult for AMCE during the first time but in the long run it can be achieved, and
- Use small-lot (single unit) conveyance using kanban card like system.

6.4 RESEARCH CONTRIBUTIONS AND FUTURE DIRECTIONS

The major contribution of this research is the development of a systematic implementation model of JIT production system for automotive manufacturing company of Ethiopia (AMCE) and Addis Ababa Bottle and Glass Factory (AABGF). Previously there was no effort to implement this innovative system in any of the Ethiopian Industries.

The primary idea of this research is to help the two companies to take initiatives such as JIT production system in order to become more cost-effective in today's global market. The model developed for the two companies can be readily extended to other industries.

The value stream mapping in this work was conducted by focusing on the process. So a natural extension of this work is to map for each product families in the value stream. It is also important to investigate how the synchronization of the pull systems for different product families could be best accomplished.

Other extension of this work can be the cost-benefit analysis of the system. Finally, further efforts should be done to transform the production system in to a pure pull production system. In this research I considered a hybrid production system.

APPENDIXES

Appendix 1 : Survey Questionnaire

Personal information

Section/department: _____.

Position: _____.

Duration of stay in your current company: _____.

I. To assess the characteristics of JIT production system

The following are some characteristics of JIT production system. Rate your agreement with respect to your company according to the following scale.

1=strongly disagree,...2=Disagree,…3=Moderately agree,…4= Agree,...5= strongly agree

		1	2	3	4	5
1.	Parts are made in the company only when needed by the subsequent processes.	☐	☐	☐	☐	☐
2.	The company continuously minimizes work that does not add value to the end product, and give high regard for safety.	☐	☐	☐	☐	☐
3.	Each worker can stop the line and issue warning if they experience a problem on the shop floor.	☐	☐	☐	☐	☐
4.	The company entrusts the workforce with functional and decision related responsibilities.	☐	☐	☐	☐	☐
5.	The company believes that every problem offers some new opportunities for improvement.	☐	☐	☐	☐	☐

II. To assess the application of JIT in the company.

1. Do you have any prior knowledge of JIT production system?

☐ *Yes* ☐ *No*

If yes, what is JIT according to you?

_____
_____
_____.

2. Do you think your company is implementing or planning to implement some aspects of JIT?

☐ *Yes* ☐ *No*

3. According to you, what are the essential requirements for JIT implementation?

_____
_____
_____.

4. How do you rate the JIT efforts in your company?

☐ *Nil* ☐ *Under research* ☐ *Ready to accept*

5. In JIT environment the following aspects of JIT are practiced. Therefore, rate them according to the level of their practice in your own company.

4 = High,…….. 3= Medium,……2= Low, ……1= Not at all

	1	2	3	4
○ Flexible workforce.	☐	☐	☐	☐
○ Work in progress reduction.	☐	☐	☐	☐
○ Production simplification.	☐	☐	☐	☐
○ Preventive maintenance.	☐	☐	☐	☐
○ Statistical process control.	☐	☐	☐	☐
○ Set-up time reduction.	☐	☐	☐	☐
○ Continuous improvement.	☐	☐	☐	☐

- JIT purchasing. ☐ ☐ ☐ ☐
- Work team quality control. ☐ ☐ ☐ ☐
- Standard containers. ☐ ☐ ☐ ☐
- Group technology. ☐ ☐ ☐ ☐
- Smoothed line production. ☐ ☐ ☐ ☐
- Parallel line production. ☐ ☐ ☐ ☐
- U-shaped line production. ☐ ☐ ☐ ☐
- Kanban card information circulation system. ☐ ☐ ☐ ☐
- Others:_____
  _____.

III. To assess the JIT philosophy

1. Waste reduction

If JIT production system is implemented in your company; there will be wastes that are eliminated. How do you rate the concentration of these wastes in your own work area?

5 =Very high,….. 4 = High,……. 3= Moderate,…….2= Less, ……1= Not at all

	1	2	3	4	5
▪ Waste from overproduction.	☐	☐	☐	☐	☐
▪ Time spent waiting.	☐	☐	☐	☐	☐
▪ Productions lead lime.	☐	☐	☐	☐	☐
▪ Waste in processing time.	☐	☐	☐	☐	☐
▪ Transportation waste.	☐	☐	☐	☐	☐
▪ Waste of motion.	☐	☐	☐	☐	☐
▪ Waste from product defects.	☐	☐	☐	☐	☐
▪ Inventory waste.	☐	☐	☐	☐	☐

- Vendor time. ☐ ☐ ☐ ☐ ☐
- Change over/ set-up time. ☐ ☐ ☐ ☐ ☐
- Others:_____
  _____.

2. Continuous improvement/one less at a time

JIT philosophy preaches continuous improvement. Do you think that your company is making efforts on the following JIT techniques? Use the earlier scales.

	1	2	3	4	5
○ Inventory reduction.	☐	☐	☐	☐	☐
○ Set-up time reduction.	☐	☐	☐	☐	☐
○ Lot-size reduction.	☐	☐	☐	☐	☐
○ Increased flexibility of process and personnel.	☐	☐	☐	☐	☐
○ Paper work reduction.	☐	☐	☐	☐	☐
○ Material handling reduction.	☐	☐	☐	☐	☐
○ Movement distance reduction.	☐	☐	☐	☐	☐
○ Transport cost reduction.	☐	☐	☐	☐	☐
○ Increased quality of product and process.	☐	☐	☐	☐	☐
○ Increased preventive maintenance.	☐	☐	☐	☐	☐
○ Decrease in number of suppliers.	☐	☐	☐	☐	☐
○ Quantity of part number reduction.	☐	☐	☐	☐	☐
○ Increase links to other departments.	☐	☐	☐	☐	☐
○ Increase links to suppliers.	☐	☐	☐	☐	☐
○ Increase links to customers.	☐	☐	☐	☐	☐

○ Others: _____
_____.

3. To assess the benefits of JIT production system

The following are some of the benefits gained through the implementation of JIT. Rank the benefits of the implementation of JIT to your company if JIT is implemented.

5= Very high, 4= High/much, 3= Medium/moderate, 2= Low/few, 1= No change

	1	2	3	4	5
♦ Inventory reduction.	☐	☐	☐	☐	☐
♦ Set-up time reduction.	☐	☐	☐	☐	☐
♦ Lot-size reduction.	☐	☐	☐	☐	☐
♦ Increased flexibility of process and personnel.	☐	☐	☐	☐	☐
♦ Paper work reduction.	☐	☐	☐	☐	☐
♦ Material handling reduction.	☐	☐	☐	☐	☐
♦ Movement distance reduction.	☐	☐	☐	☐	☐
♦ Transport cost reduction.	☐	☐	☐	☐	☐
♦ Increased quality of product and process.	☐	☐	☐	☐	☐
♦ Increased preventive maintenance.	☐	☐	☐	☐	☐
♦ Decrease in number of suppliers.	☐	☐	☐	☐	☐
♦ Quantity of part number reduction.	☐	☐	☐	☐	☐
♦ Increase links to other departments.	☐	☐	☐	☐	☐
♦ Increase links to suppliers.	☐	☐	☐	☐	☐
♦ Increase links to customers.	☐	☐	☐	☐	☐
♦ Increased profit/ reduced cost.	☐	☐	☐	☐	☐
♦ Others: _____ _____.					

IV. To assess the JIT purchasing part/supplier partnership of the company.

1. The company relationship with suppliers is based on mutual trust, cooperation, and long-term commitment.

☐*Strongly disagree* ☐*Disagree* ☐*Moderately agree* ☐ *Agree* ☐*Strongly agree*

2. In your view how much importance does your company give in making purchasing decisions to the following factors:

	Very low	*Low*	*Moderate*	*High*	*Very high*
▪ Price	☐	☐	☐	☐	☐
▪ Delivery time/schedule	☐	☐	☐	☐	☐
▪ Quality	☐	☐	☐	☐	☐
▪ Mutual trust	☐	☐	☐	☐	☐

3. According to you, which suppliers are more useful to the company?

☐*Local* ☐*Overseas (global)*

4. Uses of internet based information systems in purchasing process of the company are:

Very low☐ *Low*☐ *Moderate*☐ *High*☐ *Very high*☐

5. If local suppliers agree to make mutual trust with the company, how do you rate the importance?

☐*High* ☐*Medium* ☐*Low* ☐*No difference*

6. According to you, what are the most outstanding problems regarding the suppliers?

_____

_____

_____.

7. If JIT production system is to be implemented in the company's operation, it is necessary to make a close relationship with a few suppliers of the company.

☐*Highly agree* ☐*Agree* ☐Moderately *agree* ☐*Disagree* ☐*Strongly disagree*

V. To assess the dignity/respect of individuals in the company

Rate your level of agreement on the following scale.

5= Highly agree, 4= Agree, 3= Moderately agree, 2= Disagree, 1= Strongly disagree

		1	2	3	4	5
1.	Each individual in the company is considered an important asset.	☐	☐	☐	☐	☐
2.	Education and training are frequently conducted to enhance the capability of the employees.	☐	☐	☐	☐	☐
3.	Employee involvement in problem solving and empowerment are common in the company.	☐	☐	☐	☐	☐
4.	Employees experience, creativity, and intelligence are all given valuable credit.	☐	☐	☐	☐	☐
5.	All employees in the company are cooperative.	☐	☐	☐	☐	☐
6.	Operators take responsibility of controlling the equipment, inspecting quality, correcting deviations, maintaining machines, and improving the processes.	☐	☐	☐	☐	☐
7.	Line workers sometimes are confident enough to make their own managerial decisions.	☐	☐	☐	☐	☐

VI. To assess customer focus of the company

Rate your level of agreement by the scales used earlier.

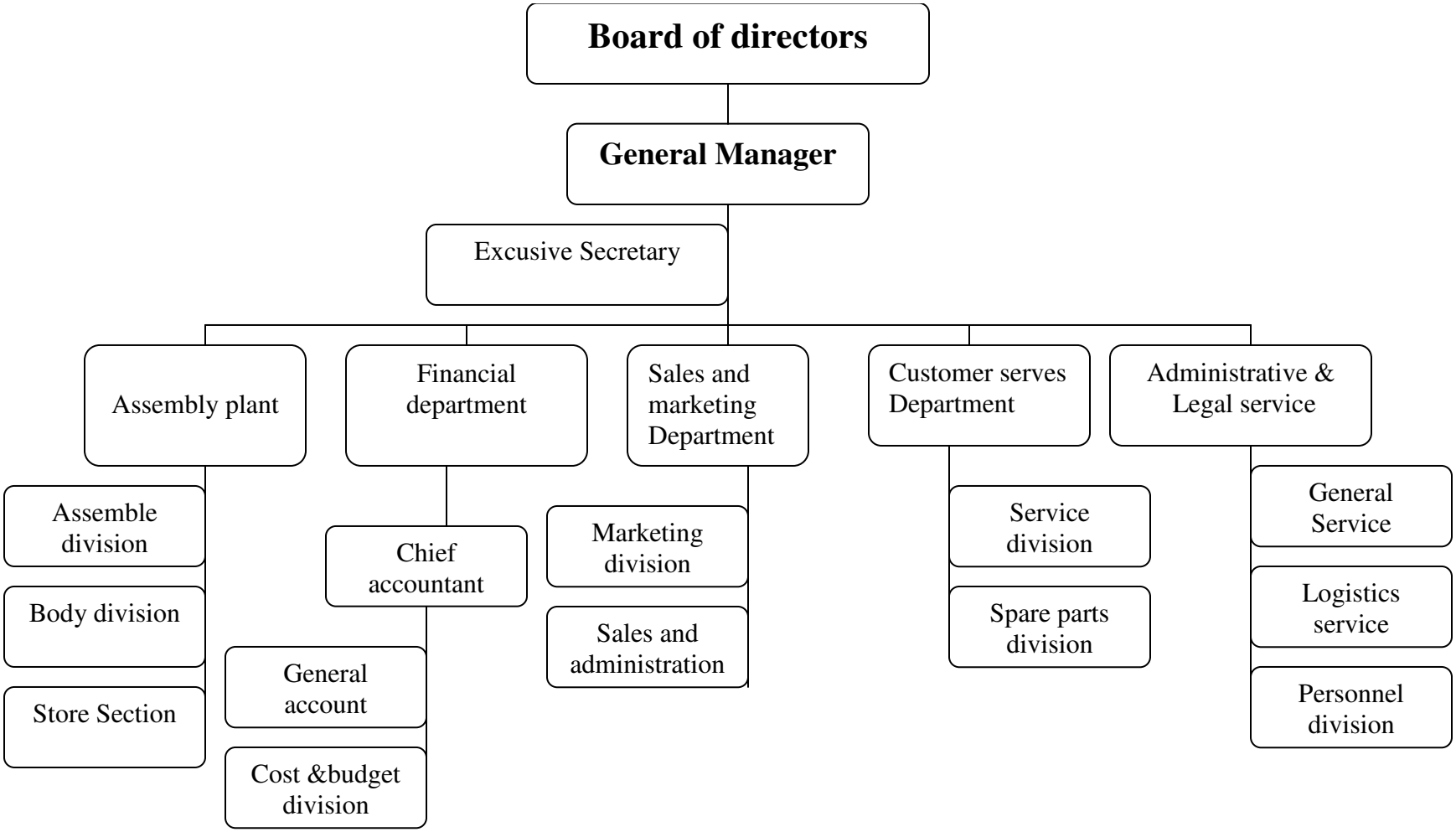
1.	The values that customers give are the only real values.	☐	☐	☐	☐	☐
2.	All products are customer driven.	☐	☐	☐	☐	☐
3.	All systems such as product design, material procurement, fabrication, assembly, and distribution to after service focus the customer.	☐	☐	☐	☐	☐

VII. To assess the practice of quality control aspect in the company.

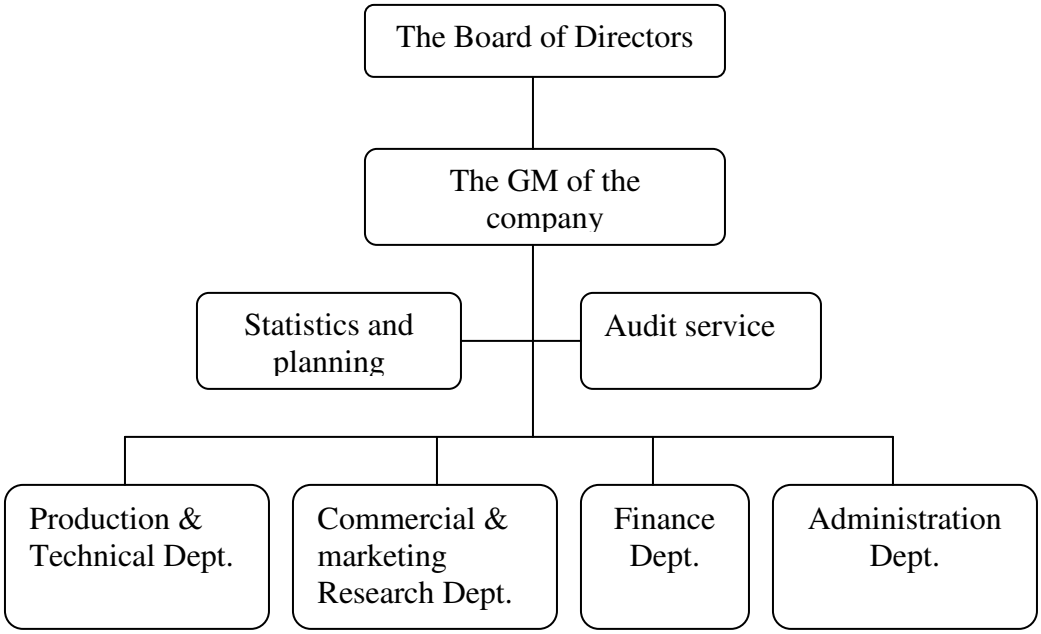
Defects may occur at the design stage, at any workstation in the production line, or at the supplier plants. Rate your level of agreement by the scales used earlier.

1. Defects are investigated at the source. ☐ ☐ ☐ ☐ ☐
2. Quality does not come from inspection. ☐ ☐ ☐ ☐ ☐
3. Quality comes from good design. ☐ ☐ ☐ ☐ ☐
4. The operators them selves at each step of the line before the parts are passed to the following process execute inspection. ☐ ☐ ☐ ☐ ☐
5. Defects are screened out immediately after they occur. ☐ ☐ ☐ ☐ ☐
6. For purchased parts, the inspection is completed before delivery. ☐ ☐ ☐ ☐ ☐

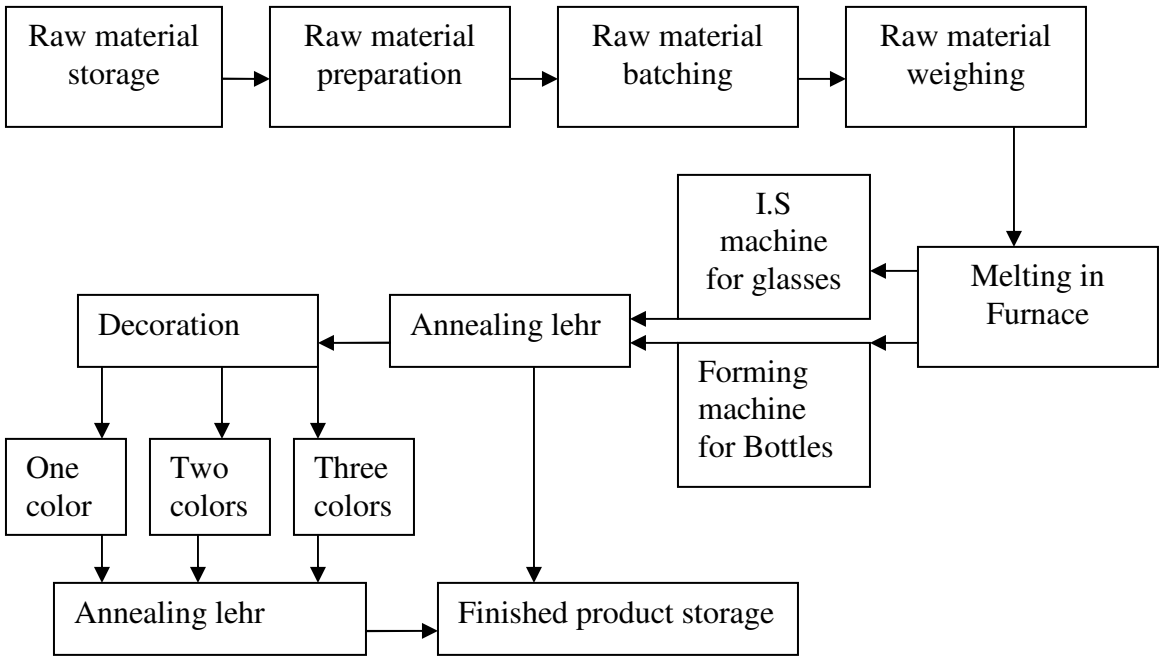
Appendix 2 : The Organizational Chart of AMCE



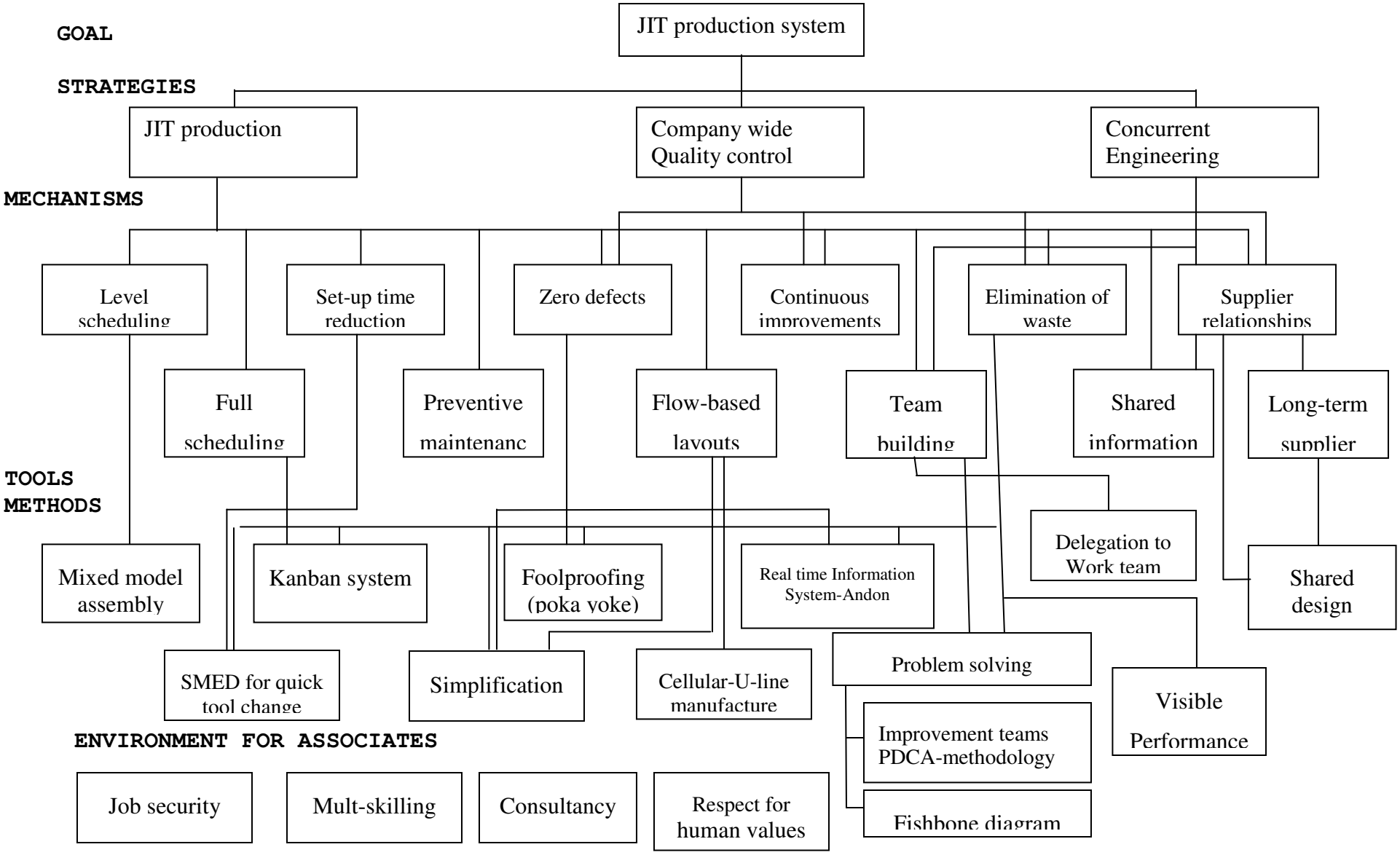
Appendix 3: The Organizational Chart of AABGF



Appendix 4: production process flow chart for AABGF's Company



Appendix 5: The new industrial revolution used by Toyota (Source: Cranfield Lean Enterprise Institute Sweden)



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