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Efficiency Improvement through Lean Manufacturing Approach In Lifan Motors in Ethiopia

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled**"Efficiency Improvement through Lean manufacturing Approach in Lifan Motors in Ethiopia"**is original work of my own, has not been presented for a degree of any other University and all the resources of materials used for the thesis have been duly acknowledged.

Elias Alemayehu ____________________

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

Dr. Mengist H. (PhD)

(Thesis Advisor) Date

Acknowledgment

This thesis is dedicated to my parents who taught me how to build bridges upon strong foundations, to cross boundaries safely with faith, hope, and love, to smile and look forward to yet another sunny day. If I owe my being to my parents, I do owe my good life to my teachers and advisors.

There are number of people to whom I would like to express my personal gratitude. First of all I would like to thank my advisor Dr. Mengist H. for his guidance, inspiration, useful suggestions and valuable feedback concerning the technical aspects of the thesis. Without His enthusiasm and patience this work would not have been possible.

I am grateful to Ato Semere (Human resource manager), Ato Alemayehu (Production Manager) and Ato Tessema (final line team leader) for their time for interview and discussions.

My deep gratitude is expressed to my brothers whose love and support have made years of study enjoyable and unforgettable experience. My special thanks go to Ato Leta Lencha and Segni Belachew for their constructive discussions on research issues and great help in many other matters in daily life.

Elias Alemayehu

Abstract

Now days, lean are increasingly used by automotive industry to increase their efficiency for reducing costs and lead time. The study is limited to assessing the challenge at manufacturing place and improving the efficiency through lean manufacturing principles, tools and techniques in Lifan motor in Ethiopia specifically on selected vehicle 530,. Vehicle 530 was selected for this research because currently it has been assembled more in quantity than the rest of the model. Both qualitative and quantitative research methods were used in carrying out this research. By using those data the current value stream map was developed with the help of E-draw max7software and analyzed through lean manufacturing tool, techniques and principles. After analyzing the result of the current flow process the most vital wastes were identified. In order to eliminate those wastes across the whole value chin, the future state map were developed and some improvement area was suggested.

Results for the study, after the investigation and the analysis of the application of Lean techniques and principles in Lifan motors in Ethiopia, shows that the total production waiting time were reduced by 28%. The proposed solution improves the performance of the Lifan motors in Ethiopia to be able to compete in the market and contribute to countries development. Moreover the thesis's contribute to an empirical study to the area of research under taken on lean manufacturing.

Key word: Lifan Motors, Value stream mapping, Automotive, Lean manufacturing

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List of abbreviations

LME:	Lifan Motors in Ethiopia
LP:	Lean Production
VSM:	Value Stream Mapping
JIT:	Just In Time
NVAA:	Non Value Added Activity
VAA:	Value Added Activity
CT:	Cycle Time
C/O:	Change Over
WIP:	Work In Process
MIP:	Material In process

CHAPTER ONE: BACKGROUND AND JUSTIFICATION

1.1. Introduction

Lean manufacturing or lean production uses less of everything, compared to mass production. [1] The primary objective of Lean manufacturing is to increase in productivity by elimination of waste had major influence on manufacturing during the last decades[2]. Lean manufacturing maximizes the value of the product through minimization of waste and continuous improvement. Lean principles defines the value of the product/service as perceived by the customer and then making the flow in-line with the customer pull and striving for perfection through continuous improvement to eliminate waste by sorting out Value Added activity(VA) and Non- Value Added activity(NVA) [3].

Since the birth of Toyota Production System, many of the tools and techniques of lean manufacturing such as just-in-time (JIT), cellular manufacturing, total productive maintenance, single-minute exchange of dies and production smoothing have been extensively used to minimize waste. All these effort is objectively to keep cost down and stay ahead in the race. [4] According to lean management there are eight categories that non-value added waste can fall into including: overproduction, waiting, unnecessary transport, over processing, excess inventory, unnecessary movement, defects and unused employee creativity [5]. Elimination of these wastes is achieved through the successful implementation of lean elements [3].

The major elements considered by [3] for the implementation of the lean manufacturing system are *Value stream Mapping (VSM)*which defines value stream as “Each and every activity including Value-Added activity (VA) and Non-Value-Added activity (NVA) required to convert the raw material into finished product through the mapping of process and information flows essential to every product.

Value stream includes all the specific activities (both value-added and non-value-added) needed to bring a particular product by implementing three important management skills of any business that are problem solving, information management and physical transformation. Lean manufacturing applied tools and approaches such as Just-In-Time (JIT), Total Productive Maintenance (TPM), Cellular Manufacturing and 5S. Moreover, lean accounting, as a coordinated approach [6] along with lean thinking provides administrators with reliable, accurate and timely information for decision-making.

Hence implementation and control, of the lean system as new approach becomes for strategic management approach

The purpose of this study is to assess the challenge at manufacturing place and improve the efficiency through lean manufacturing approaches in Lifan Motors in Ethiopia which helps the company to become lean by eliminating wastes and improve productivity.

1.2. Problem statement

LIFAN MOTORS in Ethiopia YANGFAN MOTORS PLC is a subsidiary branch of LIFAN Motors (China) engaged in assembling and distributing LIFAN vehicles in Ethiopia. The Company is located at the Eastern Industrial Zone at the place called Dukam. The company strives gradually to become a functional area of integrated industry, commerce, residence and entertainment. The total infrastructure investment is USD 450 million; the first phase costs USD 270 million and the rest, USD 180 million is slated for the second phase.

The organizational chart presented in **Appendix B,** shows the departments in which the company is divided and the main activities undertaken in each department.

Depending on the model of the vehicle and material usage, the assembling process can vary. Lifan motors in Ethiopia has mainly five sections/departments in which a progressive route is followed in order to produce the final product. These are: panting, interior/trim line, chassis line, finishing, and Quality checking station depicted in Figure 1.

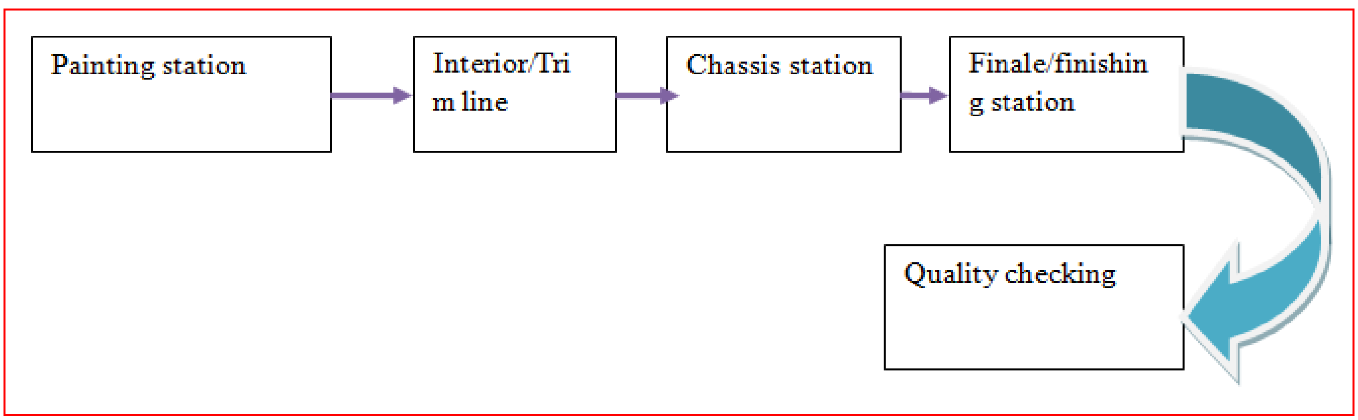


Figure1: Vehicle assembling process in Lifan Motors in Ethiopia

Currently, Lifan Motors in Ethiopia is working in one shift per day and it has a designed production capacity of 5000 vehicle annually. According to Factory Entry-Stock management report from out of 977 received vehicles to be assembled 954 them are finished, the rest 23 are not yet finished from 954 vehicles 904 are transferred to delivery center the rest 50 vehicles are still not yet transferred to delivery center.

Comparing the targeted value with the actual production and 2016/2017 report only 18.08 % was fulfilled. Long time of raw material shipment, inspection time, and processing time leads to long order delivery time and high throughput time of production. This results producing below standard that make the company unable to compete and maintain its position in the market [6].

From the above information, it is clear that the company is performing below production capacity with low performance which makes it unable to compete and maintain its position in the market.

The thesis therefore, will focus on assessing the challenges in the current manufacturing place and improve the efficiency using lean manufacturing tools techniques and principles and solve the manufacturing system problem like that of long shipment time of raw material and semi processed materials, inspection time and processing time which leads to long delivery date.

Basic research question

The following basic research question are developed and shown below:

- What are the most vital wastes found in Lifan Motors in Ethiopia?
- Which lean tools and techniques are appropriate to eliminate the wastes?
- What is employee's perception in order to have smooth communication?
- What should be done to be able to improve productivity?

1.3. Objectives

1.3.1. General Objective

The general objective of this thesis is to assess the challenges at manufacturing place and improve the efficiency through lean manufacturing approach in Lifan motor in Ethiopia.

1.3.2. Specific objective

- To identify the most vital wastes
- To integrate the appropriate lean tools techniques with that of identified problem
- To investigate employee perception in order to have smooth communication
- To propose possible solution to improve productivity

1.4. Significance of the study

This study helps the institutes and the researcher in the way that the detailed Road Map, which gives a unified theory and practical for Lean Manufacturing System. It also helps the company to be sustained in competitive business environment.

1.4.1. Beneficiaries

The company: helps as to understanding market, inter-firm relationship and critical constraints that limit the targeted producer/ enterprise growth and competitiveness

The researcher: the study gives deep learning journey in lean manufacturing and its principles.
The institutions: the study will become a valuable reference for othes researcher that leads to deeper research on lean manufacturing in automotive industry

1.5. Scope of the study

The study mainly focuses on assessing the challenge at manufacturing place and improving the efficiency through lean manufacturing principles, tools and techniques in Lifan motor in Ethiopia specifically on selected vehicles, L530 this because they are currently assembled more in quantity than the rest.

1.6. Thesis outline

This thesis contains a total of five chapters. The contents of the chapters are as follows:

Chapter 1 –Background and Justification: This chapter gives introductory view to the reader about the thesis and these includes Statement of the problem, objectives, significance of the study and scope and limitation of the study

Chapter 2 –Literature review: This chapter reviews in detail the literature available in the area oflean manufacturing tools, principles and techniques.

Chapter 3 –Research design and methodology: This chapter describes different aspects of the methods used and situations that the researcher must consider during each phase of the study. Different ways of carrying out the study and different ways of collecting information will be discussed.

Chapter 4 – Result and discussion: Data analysis and presentation based on collected data's and analyzing the processing time with the help lean manufacturing tool and techniques discussed in this chapter.

Chapter 5 –Conclusions and Recommendations: This chapter presents the conclusions drawn from the study and gives recommendations

CHAPTER TWO: LITERATURE REVIEW

The purpose of this literature review is to gain insight into lean manufacturing and how it can be applied within a manufacturing environment. With global competition, it is important for manufacturers to remain competitive in their respective markets and to understand the principles of lean manufacturing and the steps to implement them to ensure that they are on the leading edge of manufacturing. This literary review describes these key principles.

2.1. History of lean manufacturing system

The term lean manufacturing was first used to describe the implementation of what is now considered to be part of lean manufacturing such as a Kanban or just-in-time (JIT). It began as a description of procedures used by the Toyota Motor Corporation from 1950 through the 1980s now lean means much more. The Toyota production system started as part of a strategy to survive developed by TaiichiOhno, presently vice president of the Toyota, in an effort to conserve capital, eliminate waste, reduce inventory, and reduce production times and operating expenses while increasing quality and production flexibility at the same time. The Toyota production system was proved to be successful and implemented throughout the entire company.
Toyota opened its first major operation in the United States in 1984 through a joint venture with General Motors in Fremont, CA. Since then, Toyota has made continuous progress adapting its production system to a diverse workforce and a geographically spread supplier base. The reputation of the company has grown across the world. While most companies have suffered with enormous losses in business cycle decline, Toyota has not lost money since 1960. The major contributor to their success has been Toyota production system.

The Toyota production system has been created on the practice and evolution of one very useful technique that reduces cost and time while challenges every activity in the value stream (Ohno, 1988). It is applying a methodology known as the “Five whys by asking why an activity is performed and then asking why after each response, it is frequently possible to get to the origin of the problem. Understanding the root cause assists in successful redesign.

The lean philosophy (lean thinking, lean manufacturing or Toyota Production System) were developed by the Japanese in the mid 50’s, and is nowadays worldwide used by companies [7].

Thus Lean manufacturing with its origin from the Toyota manufacturing system has received attention from practitioners and researchers since its introduction. [8].

The founder of Toyota Motors, "Kiichiro Toyoda" was highly influenced by Henry Ford theory on the mass production strategy. Toyoda could not adapt mass production strategy from Ford Company due to economic situation in Japan after the World War II, where the demand for mass produced vehicle was low. This situation led to the development of Toyota Production System (TPS), which emphasized on process to build several models of both cars and trucks in small volume with low investment, as well as minimizing the cost with Just-in-Time (JIT) and even shortening the lead time. This theory helped Toyota to minimize cost, maintain the quality and provide several models to satisfy different customer requirements [9].

Toyota Seen as the leading practitioner and the main originator of the lean approach, the Toyota Motor Company has progressively synchronized all its processes simultaneously to give high-quality, fast throughput and exceptional productivity. It has done this by developing a set of practices that has largely shaped what we now call lean or just-in-time but which Toyota calls the Toyota Production System (TPS) [10].

The lean transition is, an organizational culture transition to manage lean, specifically during the initial phases, is more about managing the change process than managing lean tools and techniques. Lean production is a socio-technical system which is viewed as a philosophy that takes care of both technical and cultural aspects. Efficiency of manufacturing has been an objective in development of Toyota Production System (TPS) [11].

2.2. Lean manufacturing

Lean manufacturing is one that meets high throughput or service demands with very little inventory [12].And also, Lean manufacturing is a system with a systematic approach to eliminate waste (non-value added) in its form and enabling continuous improvement to satisfy the customers[8]. Moreover, Lean is a production practice that aims to minimize waste along entire value streams and create more value for customers [13].

Lean is most well-known as a manufacturing system, but many argue that to be successful it has to be applied much more broadly as a complete business system. The measures are provided in a visually simple way, rendering the information useful for all employees. Since lean relies on worker involvement, the workers must be able to clearly see and understand the information they use to make and evaluate process improvements[14]. Not only these but also Lean manufacturing focuses on efficiency, aiming to produce products and services at the lowest cost and as fast as possible. [15].

Manufacturing (LM) has been widely applied in the management of manufacturing processes. To Ohno (1988), LM aimed for the elimination of activities and procedures that do not add value to the final product. Therefore, Chowdary and George (2012). enhanced the operational improvement in a company due to the implementation of LM practices. Reductions of waiting time, cycle time and inventory were among the improvements to manufacturing processes.

2.4. Element of lean manufacturing

Apart from the production area, there are 4 important elements that must be coordinate and improve so that the whole system works perfectly: the design and product engineering, supply chain, demand and customer.

The design area is based on the work of teams formed by members of different departments, guided by experienced leaders, where communication has an important weight and all members have to be according to all the decisions made, so that the conflicts are due at the beginning of the project and not after.

A company needs to have good coordination in its supply chain to be able to have all the material on time with good quality and low prices. Lean organizes the suppliers into functional levels. Each level has some responsibilities. For example, first-tier suppliers are an integral part of the design and development of a new product. These in turn should be sought Second tier suppliers that supply the necessary parts.

For Lean, the most important thing is the client; it's worth nothing to manufacture in the way more efficient a product that the customer does not want. This is why the Companies must adapt to the changing demands of customers. Toyota integrated the sales centers and customers in the factory processes, creating long-term relationships to the sales centers he linked them with the production system, so that they are the ones who determine the quantity produce, and customers were involved in the process of design and development of the product.

2.3. The basic 5 lean principles

In the book *The Machine that Changed the World*, the authors suggested five lean principles and that this literally meant life or death for a company, (at least in automotive industry). The principles were renewed in the book *Lean Thinking*, and focused more on how to add value in any manufacturing company or service not just to reduce waste. The five principles are:

1. **Specify value from the point of view of the customer.** This means that the customer buys results, not products, and that any company needs to identify and begin product design and manufacture by focusing on what their customers need and want. It is as simple as the old expression "give the customer what they want" and not what is convenient for the manufactures.

2. **Value Stream**. Value Stream techniques focus on one object or product in the company not the viewpoint or the department of process step. The principle is to focus on the whole supply chain, from customers' orders, to the planning department, orders of raw material from different suppliers and then the value adding steps for the product, emphasizing economics of time rather than economics of scale. Value is added to a product while someone is working on the piece, non-value adding steps are when the product is waiting in batches or stocks, which is waste.

3. **Flow**. This principle tries to describe that it is important to make the product move through one value adding step to the next one and keep the product in constant one piece flow. Companies should avoid batches and queues, or at least continuously reduce them and never delay a value adding step by a non-value adding step.

4. **Pull**. Pull means meeting consumer's rates of demand with production but not over producing. Most organizations will have to push to a certain point and response to a final costumer from that point. The idea with Lean is to push this point as long upstream in the product making process as possible, wait for a demand and then make the product fast and with high quality. So if the delivered products have any defect, only a small batch of products will have been affected.

5. **Perfection**. The last principle seems more possible after the other four principles. Perfections does not only mean quality, it also means producing exactly what the customer wants, exactly when they want it, to a fair price and with minimum waste.

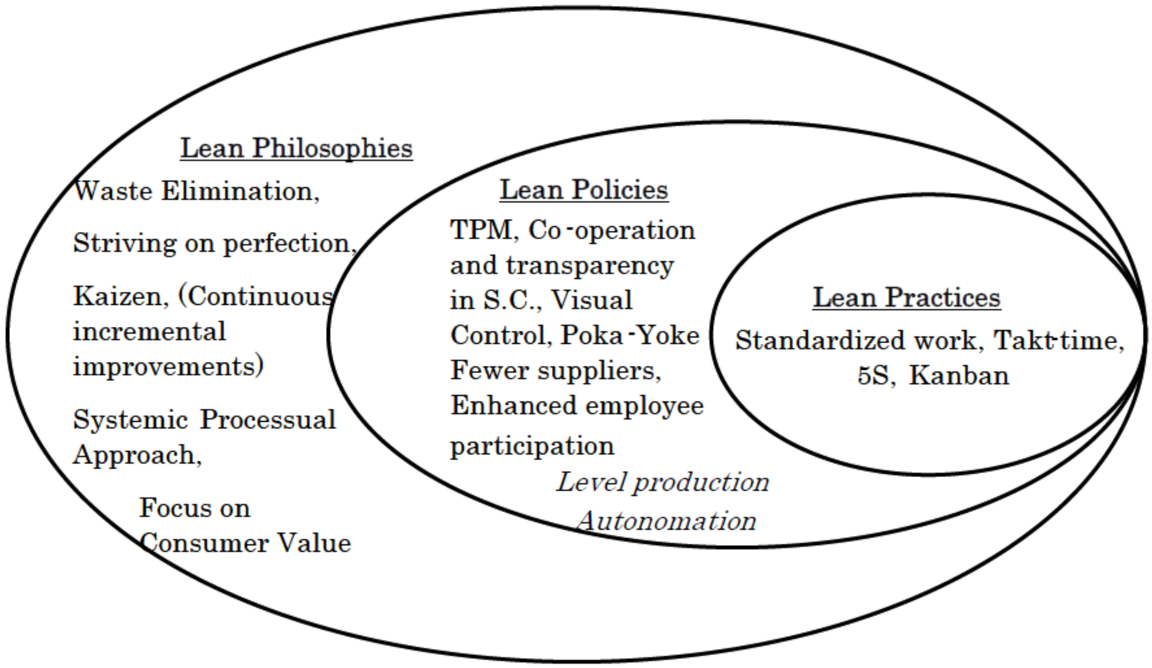


Figure 2: Lean philosophy, policy and practice (Source:-KeivanZokaei and David Simons, "Performance Improvements through Implementation of Lean)

Successful lean implementation involves amalgamation of various elements from different levels in Figure 2 For example; Just-in-Time inventory management policy and creation of smooth flow go hand in hand while both depend on the introduction of Takt-time in practice. Furthermore, companies which implement single piece flow need to promote the workers' participation policy and pursue continuous improvement philosophy to sustain the flow production system within the organization [16].

2.5. Types of Wastes

Lean manufacturing is focused on continuous eliminating non-value added activities and maximizing value added activities through reducing costs and increase the quality of an organization processes. Normally, non-value added activities add costs to the process without enhancing the value. Non-value added activities can called as waste in lean manufacturing. Non-value added activities or waste refer to any activity that does not add value to the process and to activities that a customer would be unwilling to pay for [17].

The Japanese word muda is worth remembering because it has an uglier sound than waste. Muda is any activity that absorbs resources without creating any additional value. The telephone operator did not create value, nor did the bank teller, or the checkout clerk at a supermarket. All could be, and have been, partially replaced by machines that provide "do-it-yourself" ability for the customer. Waste also is found in poor utilization of space. Space is money, and it is paid for every month. If extra space is acquired when the existing warehouses are not completely full, the waste is obvious [18]. Waste can be categorized into seven areas: waste due to overproduction, unnecessary waiting, unnecessary transportation, over processing, excess inventory, unnecessary movement, and defects [17]. According to [18]there is additional waste which is Unused employee creativity represents a waste of human resources. And each waste are described briefly as shown below:-

1. **Overproduction**. This is the most egregious of all the wastes since it not only is a waste itself but aggravates the other six wastes. For example, the overproduced volume must be transported, stored, inspected, and probably has some defective material as well. Overproduction is not only the production of product you cannot sell, it is also making the product too early [19].
2. **Waiting**. This is simply workers not working for whatever reason. It could be short term waiting, such as what occurs in an unbalanced or longer waits, such as for stock outs or machinery failure.
3. **Transportation**. This is the waste of moving parts around. It occurs between processing steps, between processing lines, and happens when product is shipped to the customer.
4. **Over processing**. This is the waste of processing a product beyond what the customer wants. Engineers who make specifications that are beyond the needs of the customer often create this waste in the design stage. Choosing poor processing equipment or inefficient processing equipment increase this waste also [19]. This waste refers to machines and processes that are not quality-capable. A capable process requires correct methods, training and required standard that does not result with making defects. Over-processing also occurs in situations where overly complex solutions are found for simple procedures such as using a large inflexible machine instead of several small flexible ones [20].
5. **Movement**. This is the unnecessary movement of people such as operators and mechanics walking around, looking for tools or materials. All too often, this is frequently overlooked as a waste. After all, the people are active; they are moving; they look busy. The criterion is not whether they are moving, it is: Are they adding value or not? I can't think of any example of

people movement that is value added. Work design and workstation design is a key factor here.

6. **Inventory**. This is the classic waste. All inventories are waste unless the inventory translates directly into sales. It makes no difference whether the inventory is raw materials, WIP, or finished goods. It is waste if it does not directly protect sales.
7. **Making defective parts**. This waste is usually called scrap. But the phrase Ohno uses, “making defective parts” is classic Ohno. Most people use the term “scrap,” so they view the defective part as waste. Ohno moves far beyond this. He not only categorizes the part as scrap, but the effort and materials to make it. Ohno was a natural process thinker. In this case, he not only lamented the loss of a production unit but the fact that people spent valuable time, effort, and energy to make the unit—all of which was lost, not just the production unit. [19]
8. Unused employee creativity represents a waste of human resources[18]. It also mean that Refers to more people involved in a job than necessary, not involving the associates in process improvement, not leveraging the potential individual to the fullest, not using the creative brainpower of employees, not giving the right assignment/work, uneven work distribution/load balancing, and losing time, ideas, skills, improvements, and learning opportunities by not engaging or listening to your employees [20].

2.6. Tools and Techniques of Lean Manufacturing

Most of the industries are facing a major challenge in identification of the relevant optimized lean tools. In today’s industrial environment the price reduction and productivity improvement are the major concern. To deal with this problem, the industry needs some quality policies focused on quality of the products. There are varieties of quality policies come before them and the industry experts are in a state to choose the right tools that are more effective for them. [21].

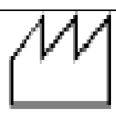
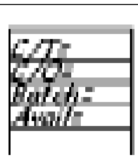
Unfortunately there are so many tools that are useful successful implementation of lean manufacturing system but it is impossible to use all tools at once. Depending on the situation in which the case company need in accordance with different constraint like social, environmental and even commitment to manager it can be selected and used. So that some of the tools are described as shown below:

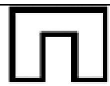
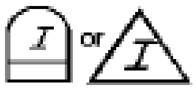
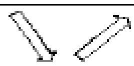
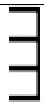
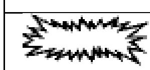
Value Stream mapping : Among the several tools of Lean Manufacturing, VSM (Value Stream Mapping) can be highlighted since it provides a holistic view of manufacturing processes and has been one of the most used in the universe of applications of lean thinking in industrial and service companies.

A value stream is the set of processes, including value-added and non-value-added activities, required to transform raw materials into finished goods that the customers value. Value streams bring a specific good or service through three critical management tasks: problem solving (figuring out what needs to be changed), information management (improving information flow), and physical transformation (implementing changes).

VSM describes the information and process flow, which allows for identification of sources of waste, and thus it proposes future scenarios for improvement. Perhaps VSM also used by an engineer's to order a production system to identify waste in all stages of the manufacturing process, and thus they reduced the process lead-time. this has been also utilized VSM to reduce high inventory levels and activities that do not add value, to the process, and as a result, they increased the productivity of a process in the automotive industry. applied VSM in a medical clinic to reduce the waiting times of patients, which demonstrated that VSM can be applied in different segments. VSM can be used to identify points of waste or opportunities for improvement in processes of all applications.

Table 1: List of value stream mapping Symbols

Symbol	Exhaustive Meaning of Symbol
 Customer/Supplier	It represents the Supplier when in the upper left, the usual starting point for material flow. The customer is represented when placed in the upper right, the usual end point for material flow.
 Dedicated Process	It is process, operation, machine or department, through which material flows. Typically, to avoid unwieldy mapping of every single processing step, it represents one department with a continuous, internal fixed flow path.
	It goes under other icons that have significant information/data required for analyzing and observing the system. Typical information in a Data Box underneath MANUFACTURING PROCESS icons: · C/T (Cycle Time in seconds,· C/O (Changeover Time)

Data Box	- Uptime- percentage time that the machine is available for processing·
 Work cell	This symbol indicates that multiple processes are integrated in a manufacturing work cell. Such cells usually process a limited family of similar products or a single product. Product moves from process step to process step in small batches or single pieces.
 Inventory	These icons show inventory between two processes. While mapping the current state, the amount of inventory can be approximated by a quick count, and that amount is noted beneath the triangle. If there is more than one inventory accumulation, use an icon for each. This icon also represents storage for raw materials and finished goods.
 Shipment	This icon represents movement of raw materials from suppliers to the Receiving dock/ s of the factory. Or, the movement of finished goods from the Shipping dock/s of the factory to the customers.
 Push arrow	This icon represents the “pushing” of material from one process to the next process. Push means that a process produces something regardless of the immediate needs of the downstream process.
 Supermarket	This is an inventory "supermarket" (kanbanstockpoint). Like a supermarket, a small inventory is available and one or more downstream customers come to the supermarket to pick out what they need. The upstream work center then replenishes stocks as required. When continuous flow is impractical, and the upstream process must operate in batch mode, a supermarket reduces overproduction and limits total inventory
	Supermarkets connect to downstream processes with this "Pull" icon that indicates physical removal.
	These icons are used to highlight improvement needs and plan kaizen workshops at specific processes that are critical to achieving the Future State Map of the value stream

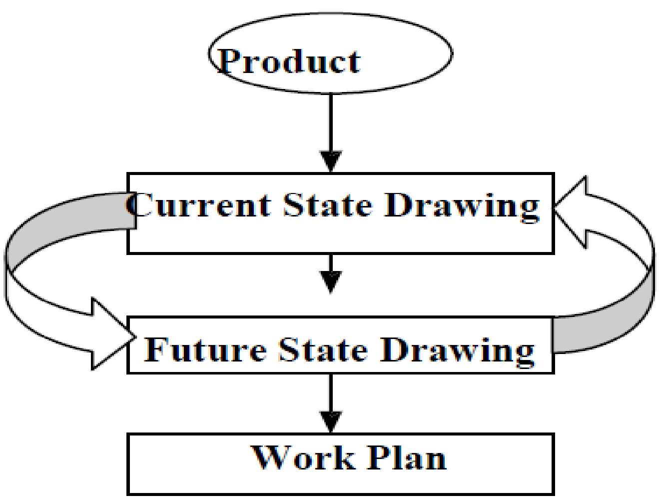


Figure 3: Value Stream Map Step

Kanban: Kanban system is just one of the tools and techniques used in lean manufacturing besides other techniques like Quality Circle, 5S Housekeeping, and continuous improvement and many others.Kanban system is one of the tools under lean manufacturing system that can achieve minimum inventory at any one time. Kanban system provides many advantages in managing operations and business in the organization. Using Kanban system is a strategic operational decision to be used in the production lines. It helps to improve the company's productivity and at the same time minimize waste in production. The Kanban system requires production only when the demand of products is available. Manufacturing companies especially in Japan have implemented Kanban system successfully as this system originates from this country [22].

2.7. The benefits of being 'lean'

The benefits seen within non-process industries, such as the automotive industry, are well documented:

- Decreased lead times for customers;
- Reduced inventories for manufacturers;
- Improved knowledge management

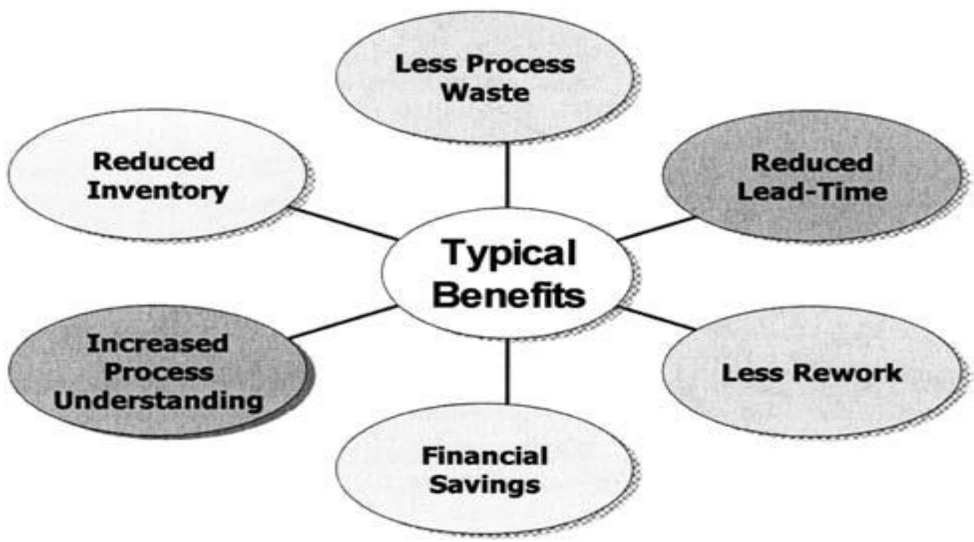
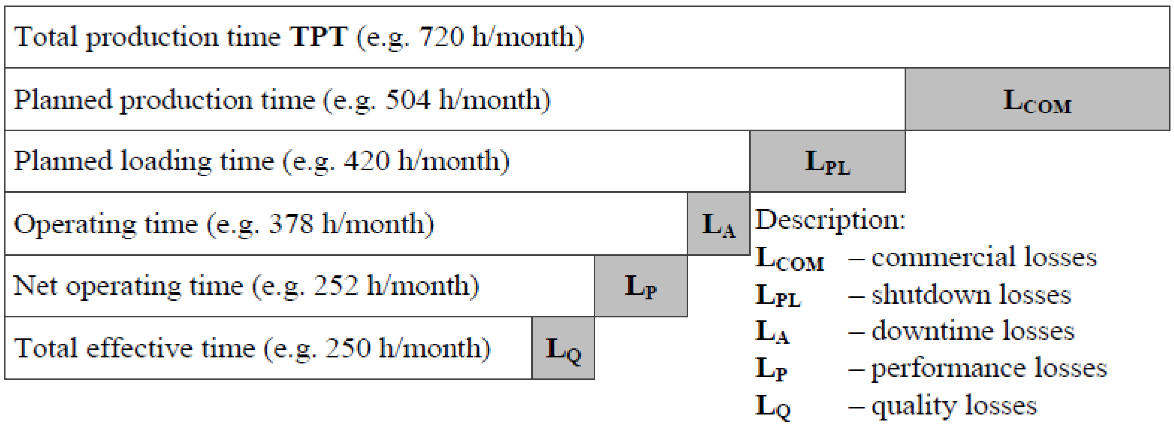


Figure 4: What Lean Thinking has to Offer the Process Industries (T. Melton, 2005, The Benefits of Lean Manufacturing)

2.8. Performance Measurement For Automotive Industry

2.8.1. Key performance indicators (KPI's)

A key performance indicator **(**KPI) is a measure reflecting how an organization is doing in a specific aspect of its performance. A KPI is one representation of a critical success factor **(**CSF**)**- a key activity needed to achieve a given strategic objective. Organizations that measure performance identify the handful of critical success factors that comprise every strategic objective. [23] And also it is a group of factors which indicate the effectiveness of exploited equipment in manufacturing environment. Hence the Basic factor in this field is OEE de. OEE as a concept of TPM assumes achieving zero defects and zero breakdowns of equipment over specified period of time when equipment is planned to produce components [24].



Three types of KPIs

According to Joao Alegre, 2010 in his master thesis paper put Key performance indicators come in three types:

1. **Process KPIs** measure the efficiency or productivity of a business process. Examples include "Product-repair cycle time," "Days to deliver an order," "Number of rings before a customer phone call is answered," "Number of employees graduating from training programs," and "Weeks required to fill vacant positions."
2. **Input KPIs** measure assets and resources invested in or used to generate business results. Examples include "Dollars spent on research and development," "Funding for employee training," "New hires' knowledge and skills," and "Quality of raw materials."
3. **Output KPIs** measure the financial and nonfinancial results of business activities. Examples include "Revenues," "Number of new customers acquired," and "Percentage increase in full-time employees." Three particularly common output KPIs that are used by managers include:
   - Return on investment (ROI): Return on investment represents the benefits generated from the use of assets in a company, unit, or group—or on a project. ROI is helpful to top net income (revenues less expenses less any liabilities, such as taxes) by total assets. ROI measures how effectively managers have used resources, and can be figured as follows:

$$ROI = Net\ Income/Total\ Assets$$

- Economic value added (EVA)™: EVA, popularized in the 1990s by U.S. management consultancy Stern Stewart & Co., is defined as the value of a business activity that is left over after you subtract from it the cost of executing that activity and the cost of the physical and financial capital deployed to generate the profits. In the field of corporate finance, EVA is a way to determine the value created, above the required return, for a company's shareholders. It's therefore useful to senior management, boards, and shareholders and other investors. EVA is calculated as follows:

  EVA = Net operating profit after taxes minus (net operating assets multiplied by the weighted average cost of capital)

All three types of KPIs-process, input, and output-generate valuable performance information. A mix of the three types ensures a comprehensive picture of your unit's or organization's performance.

Table 2: Survey of selected different literature and their works related to lean manufacturing

Authors	Title	Methods	Tools and techniques	Finding
Amelia Natasya Abdul Wahab, M. M. (2013)	A Conceptual Model of Lean Manufacturing Dimensions	literature survey, books and report analysis		The result of this research has shown that there are seven main dimensions that contribute to leanness measurement in manufacturing.
Anita Susilawati, J. T. (2015)	Fuzzy logic based method to measure degree of lean activity in manufacturing industry.	Questionnaire, Interview	VSM, Fuzzy number based scoring method	The survey result of lean practices measurement in Indonesian manufacturing industry showed significant variations of degree of lean manufacturing implemented in all impact areas.
Juthamas Choomlucksana , M. O. (2015)	Improving the productivity of sheet metal stamping subassembly area using the application of lean manufacturing principles	Observation, Interview	VSM, Poka-Yoke, and 5s	The significant results indicate that the processing time of a polishing stage, after applying lean manufacturing principle, was reduced from 6,582 seconds to 2,468 seconds or by 62.5%. Also non-value added activities were reduced from 1,086 activities to 261 activities, or by 66.53%. Furthermore, overtime cost was reduced by 1,764 Dollar per year.
Naveen Kumar, S. K. (2013).	Implementing Lean Manufacturing System: ISM Approach	Interpretive Structural Modeling, Questionnaire, literature review and experts' opinions		The result shows that No variable has been identified as linkage variable and autonomous variable. From the model developed, 'Relative cost benefits' has been identified as top level dependent variable and top management commitment as bottom level most independent variable.
Nor Azian Abdul Rahmana, S. M. (2013).	Lean Manufacturing Case Study with Kanban System Implementation.	A qualitative research design, observation and structured interview techniques	Kanban,	The Kanban system implemented in this manufacturing company was found to be adequate due to the many benefits such as the operational costs, wastes, scraps and losses were minimized, over production stocks were controlled with flexible work stations.
Rosemary R. Fullertona, F. (2014).	Lean manufacturing and firm performance: The incremental contribution of lean management	Questionnaire, survey questions are either categorical or interval semantic differential		The results show that 119 of the 244 plants have some form of lean accounting in place, and all 119 of those plants indicated that they have formally implemented lean manufacturing, presents descriptive statistics for

	accounting practices	scales		the test model variables for the full sample, the plants indicating they had adopted lean accounting, and the plants that had not adopted lean accounting.
Simons, K. Z. (2006).	Performance Improvements through Implementation of Lean Practices: A Study of the U.K. Red Meat Industry	FVCA method, A casestudy research method	Takt-Time, Standardized Work Practices,	The result leads to an estimate 2 to 3% cost savings for each actor in the chain at their selling price in implementing lean practices.
Thorhallsdottir, T. V. (2016).	Implementation of lean management in an airline cabin, a world first execution?			
IdrisZehrudin, 2004	Aspects of lean and agile manufacturing systems and their appropriateness in Ethiopia	Literature survey and internet surf, Industry survey and questionnaire, Peer discussion, interview and personal observation	VSM, Cellular Manufacturing	It is found that ***Lean Manufacturing*** is a response to competitive pressures with limited resources. It is a *collection of technical* and *operational systems* focused on productivity in relatively stable demand environment. Cases on the implementation of Lean techniques indicate that industries can enhance competitiveness by adapting Lean.
Alemayehu Tesfaye, 2014	Manufacturing wastes measurement for productivity improvement in Ethiopia plastic industry	Interview, observation, literature survey		The result waste of production activities with the horizon of planned production contributed a total of 7,811, 363.86 Et.Birr which was greater than the industries actual net profit and a huge capacity inbuilt in different machineries and factories that can be used as a competitive advantage was wasted without adding anything to the industry and also the country at large.

Research Gap

- Most of the researcher that has been conducted in lean manufacturing use only one or two lean tools to analysis the data and also few researches has been done in automotive industries.
- There for this thesis tries to fill the gap in the way that by studying in Lifan motors (automotive industries) and by incorporating more than two lean tools to enhance the efficiency of the company

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

The following methods are employed in order to gather relevant information for this paper. And this includes data collection, data organization and data analysis was used.

3.1.Methodology

Primary source

- **Interview:** the interviews were conducted with asking different person for assistance from shop floor workers, production supervisors, department head and other concerned individuals.
- **Questionnaire:** The prepared questioner containing ten basic questions were distributed to all employees of the factory to get their views on lean manufacturing principles. 61% of the questioner was responded and analyzed based on their response**.**
- **Physical observation:** All sections of production departments in the company were visited during actual operation time, in order to observe the existing conditions.

Secondary source

Different literatures which are relevant with the topic under investigation are used; these include lean manufacturing related books, web-pages, related research papers, and articles/journals.

3.2.Data analysis

After primary and secondary data are collected, the data are analyzed using SPSS, Excel spreadsheet, and Lean tool and principles.

After collecting data and other relevant information using available scientific methods, the value stream mapping was modeled using E-draw software.

3.3.Research design

- Selection of product
- Collection of relevant data
- Create current state value stream map
- Identifcation of nature of waste in the process
- Analysis of the current state value stream map
- Create Future state value stream map
- Suggestion for improvement

CHAPTER FOUR: RESULT AND DISCUSSION

4.1. Part one: Assessment

In Lifan motors there are 52 employees which are directly engaged in assembling process in manufacturing plant, there are also 30 supporting staff which facilitate the production system.

In this study both qualitative and quantitative type research, in order to do so questionnaire and interview was conducted. Based on the response of the respondent and personal and expert opinion were also incorporated.

Ten questions are prepared and distributed to 82 employees (respondent) in order to see their perception on lean manufacturing as well as to assess the challenges in current market. Since the target population low the whole population is considered. From the distributed 82 questionnaires 50 of them are retuned and which account 61 %, so that it is possible to continue the research.

1. Challenges of the company (Employee perception)

i. Main challenges that company are facing in the current market

As the result in table 3 shows lack of the production system flexibility and increased demand for product or service variety are the main challenges that company are facing currently this account 32% and 24 % respectively

Table: 3. Challenge that the company faces in the current Market

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	increased demand for product/ service variety	12	24.0	24.0	24.0
	limited organizational capacity	7	14.0	14.0	38.0
	global or local computation or both	8	16.0	16.0	54.0
	Lack of production system flexibility	16	32.0	32.0	86.0
	market fluctuation	7	14.0	14.0	100.0
	Total	50	100.0	100.0	

The other challenges are global or local competition or both and this account 16%. From the response of the respondent the forth challenges that the company faces in the current market are limited organizational capacity and market fluctuation account 14% each.

It can be concluded from these findings that lack of production system flexibly the major challenge for the hosting company. The increasing demand for product variety is also another challenge that Lifan motors in Ethiopia are experiencing.

ii. Changes that the company experienced in the last three years

In order to overcome the challenges and become more productive the company has been employing different strategies. According to the data obtained from the respondents (employees) , modifying the department (26 percent) and introducing new product or service (22 percent) are among the major decision that company has been taking to improve productivity. Additional, reducing production volume is the other changes that have been seen in the last three years.

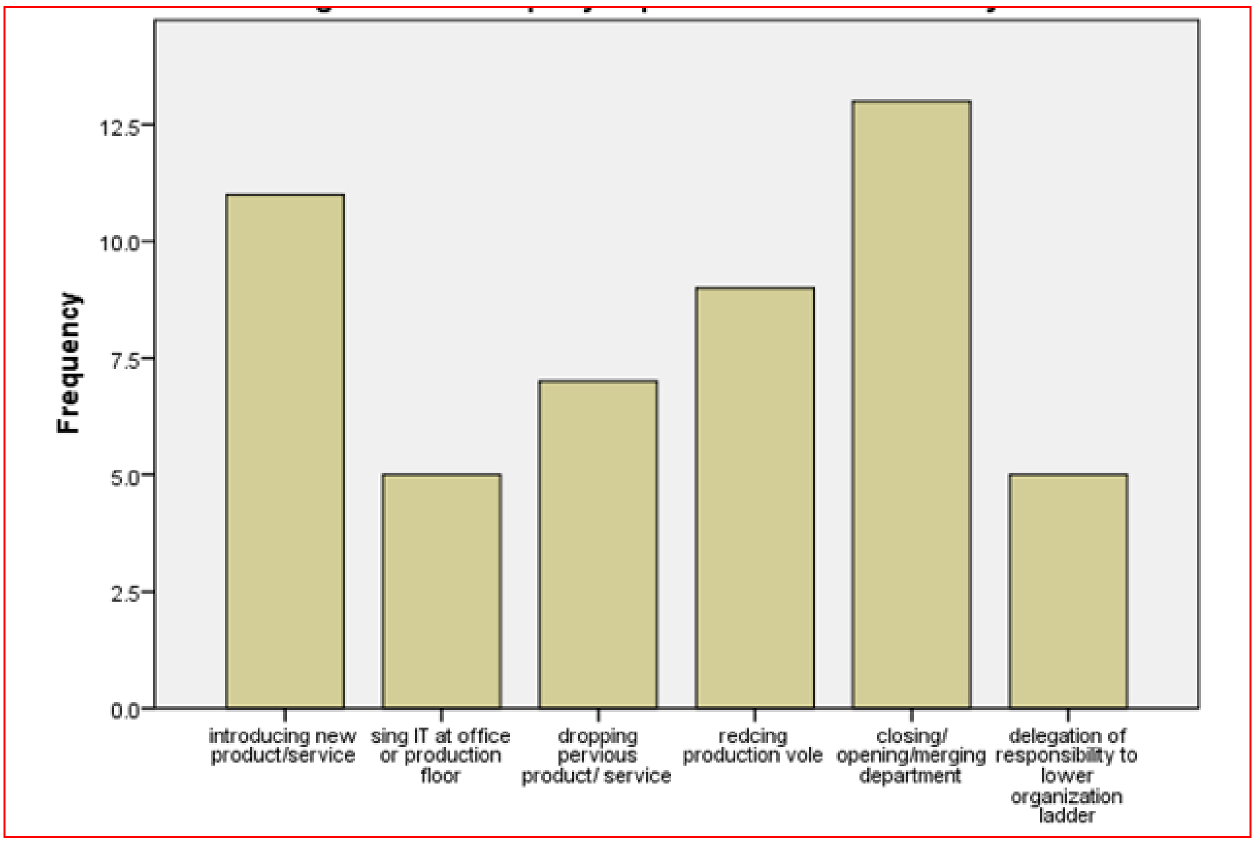


Figure: 5 changes that the company experienced in the last three year

From the information given in the above fig 5dropping of previous product, accessibility of IT in the shop floor and delegation of responsibility to lower level or organizational ladder is the changes that the company seen in recent year respectively.

iii. Main Problem of the company with regard to market responsiveness

In addition to the challenges that has been seen in table 3above, the company has been facing challenges from market responsiveness aspect due to different factors. For instance, inefficient use of resources (labor and machines) which accounts about 32 percent and unpredictable demand (twenty percent) are the among the main problems that company is facing. Beside these factors, the role of worker inflexibly (18 percent) is the other main problem that the company faces in the current market.

Table: 4. Rank the main problems of the company with regarded to m market responsiveness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	rigidity of production/ service system	7	14.0	14.0	14.0
	inflexibility of worker	9	18.0	18.0	32.0
	employee morale and culture	5	10.0	10.0	42.0
	inefficient use of resources (labor, machines)	16	32.0	32.0	74.0
	unpredictable demand	10	20.0	20.0	94.0
	others	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

The rigidity of production system employee morale and culture pointed out 14% and 10 % respectively. The last problem according to employee response account 6% which is others like that of lack of foreign currency in Ethiopia which delays the imported material from China.

Generally from the above table 4 it is clear that insufficient uses of resources is the leading problem that the company faces currently at most. This is not the only one but also other main problem also existed like that of unpredictable demand for the product is the next major problem,

Association between customer behavior and company's challenges

As indicated Table 5 below their cross tabulation between the companies challenges and customer behavior supports result obtained in table 3 (Main challenges). The chi-square values for this cross tabulation is founded to be 34.5 with significant p value (p=0.005). This result provides strong evidence to reject to reject the null hypothesis which claims there is no association between customer behavior and companies challenges.

Table 5 Association between customer behavior and company challenges

rank the challenge that the company faces in the current market * Which change in customer behavior did the company experience in recent years Cross tabulation

			Which change in customer behavior did the company experience in recent years					Total
			Product/ service quality consciousness	Need for reduced price	Need for more products/ services variety	Request for shorter delivery time	5	
rank the challenge that the company faces in the current market	increased demand for product/ service variety	Count	0	3	3	4	2	12
		Expected Count	4.1	1.7	2.9	2.9	.5	12.0
	limited organizational capacity	Count	0	2	5	0	0	7
		Expected Count	2.4	1.0	1.7	1.7	.3	7.0
	global or local computation or both	Count	3	0	2	3	0	8
		Expected Count	2.7	1.1	1.9	1.9	.3	8.0
	Lack of production system flexibility	Count	9	2	2	3	0	16
		Expected Count	5.4	2.2	3.8	3.8	.6	16.0
	market fluctuation	Count	5	0	0	2	0	7
		Expected Count	2.4	1.0	1.7	1.7	.3	7.0
Total		Count	17	7	12	12	2	50
		Expected Count	17.0	7.0	12.0	12.0	2.0	50.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	34.359[a]	16	.005
Likelihood Ratio	41.888	16	.000
Linear-by-Linear Association	10.335	1	.001
N of Valid Cases	50		

a. 24 cells (96.0%) have expected count less than 5. The minimum expected count is .28.

Level of Quality

According to the employee perception regarding the level of quality is described in figure below. And it shows that argue that the level of quality that the company provide for their end user is faire which account 36% of the total respondent,

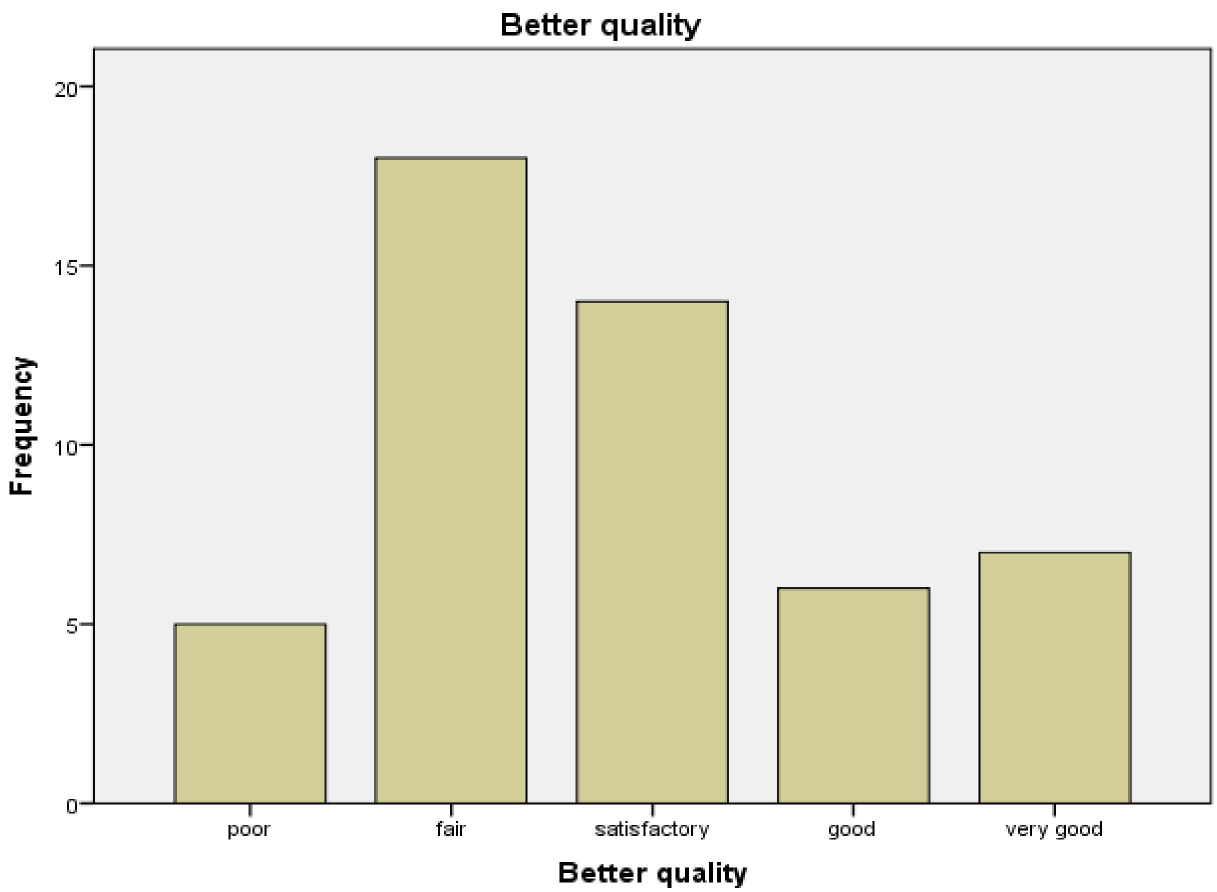


Figure: the level of quality in LME

Next to that 28% of the respond at the level of quality is satisfactory. The level of quality is about 14% is very good, about 12% is good and also there is level of quality which shows poor level of quality which is about 10% respectively .

Rank the productivity according to the factor given

According to the employee perception regarding the level of productivity is described in Table below. And it shows that argue that the productivity level that the company provide for their end user is faire which account 36% of the total respondent,

Table 6: Productivity level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	poor	11	22.0	23.4	23.4
	fair	18	36.0	38.3	61.7
	satisfactory	4	8.0	8.5	70.2
	good	9	18.0	19.1	89.4
	very good	5	10.0	10.6	100.0
	Total	47	94.0	100.0	
Missing	System	3	6.0		
Total		50	100.0		

Next to that 22% of the respond at the productivity levelarepoor. The productivity level about 18% is good, about 10% is very good.

Generally from the above information we can conclude that most of the respondent argued that the productivity level of LME currently is fair and 22% o f the respondent did not argued with currently the stated company has poor level of productivity.

4.2. Part two: Application

LIFAN MOTORS in Ethiopia YANGFAN MOTORS PLC is a subsidiary branch of LIFAN Motors (China) engaged in assembling and distributing LIFAN vehicles in Ethiopia. The Company is located at the Eastern Industrial Zone at the place called Dukum. The company strives gradually to become a functional area of integrated industry, commerce, residence and entertainment.

Depending on the model of the car and material usage, the assembling process can vary. The LFME has mainly five sections/departments in which a progressive route is followed in order to produce the final product. This can been shown in the fig: below.

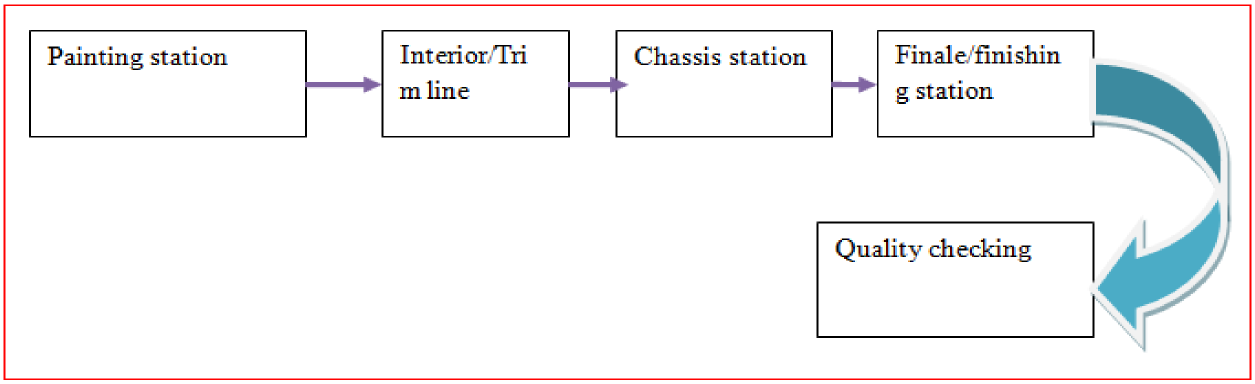


Figure: 4.2 material flowswithin assembly plant

Panting station: this station the first station in Lifan motors in Ethiopia (LME), hence empty structure is imported from China, during shipment if there is any scratch in the body part then on this station re painting process is takes place.

Interior/ trim line station: Painted body are transported to this stations. The process of assembly are doors are removed from the painted body before it goes down the trim line, and are transported by an overhead conveyor to door assembly line at the end of the final assembly line. In one plant, it is almost parallel to the final inspection line. The process allows easier access to the interior assembly of the car. Moreover, the door trim, glass and hard ware can be installed on a separate door assembly line ensuring better fit and finish. With doors remaining attached to the car body, the chance of damages all along the assembly line when it is opened and closed several times at different stations for inside assembly operations, is very high. Further, the door trim assembly is more difficult in the hanging position.

Chassis line station: The car bodies from trim line are picked up by overhead conveyor of chassis line that may be power and free type. Mostly, the parts are fitted from the bottom side. Some of these manual processes require uncomfortable postures, because of the inconvenient position of the car bodies.

Near the beginning of the chassis line, the fuel tank is assembled. As the tank generally comes complete with the fuel gauge unit and pump etc., the operator is required to connect only the breather pipe and some other minor components.

Final line station: Bodies on tyros come down on double slat conveyor of Final Assembly. In final assembly, all the remaining fitments are carried out. With equipment dependent on sophistication level, the different consumables are injected in the car to the desired quantity measure. Items are Engine oil, Transmission oil, Gasoline/diesel, Window washer liquid, Radiator liquid, Brake oil. Near the end of the line, the doors are mounted. The door assembly line is generally located near the door mounting stations.

Inspection station: this the final station in which different parameter is tested when after the vehicle comes out of the Final assembly line, it is driven on its own power to Vehicle Testing area. Inspection equipment include: Wheel alignment tester, turning radius tester, Headlight tester, Side slip tester, Drum tester, Brake tester, by using such equipment inspection is done.
Finally after checking the quality of each parameter then rod test is checked this is done outside the assembly plant within the compound of Eastern industry zone.

4.2.1 Product Selection for Study and its process

Customers give their demands on monthly basis. The demand is then broken week basis and finally on daily basis by the planning department. As there are more than one customer so to select the product for this study the preference is given to the product which contributes more in volume over the other customers. Which is 40% of total annual customer demand is LF530. So product LF530 is selected for this study (Appendix C). The company works 6 days per week and operates one eight hour shift every day.

The process of this product begins when they receive the body parts from China in a batch of 40 within 9 containers.

4.2.2 Map of the current situation

Values streammapis made up of the process map, the corresponding time line and information flow. The process map comprises the steps and the information associated with the steps of the process. The time line is built from the process map and calculates the data entry. The information flow further explains the interaction and activity between the value chains.

The boxes represent each operation and data is placed as the number of workers, cycle time (T / O), and inventory before each process, or raw material in the process (MP) from the reception area of the painted empty body structure to the sales area. Cycle times are average times of each process. The triangles before each process represent the inventories.

The timeline of the lower part of the figure 6 is formed by two Elements: Production wait time, which is the sum of the lead times of the inventories. Inventory times are obtained by dividing the total of inventory among the daily demand of customers. The total waiting time of production obtained is 106 days; the time of activities that add value, which is obtained by adding the cycle times of each process. The time of resulting added value is 36.619 days, which represents 34.54% of the expected total productions.

Table 6:Process description and the corresponding cycle time

Process description/ station	Cycle time per unit (minute)	Cycle time per batch (minute)	% of cycle time	Uptime %	Change over time per batch (minute)
Painting	180	180	35.64	100	0
Interior line	50	2000	9.9	91	180
Chassis line	55	2200	10.89	96	90
Final line	35	1400	6.9	98.5	20
Inspection	240	9600	47.52	100	0
Total	505	15380	100		290

The information in table 6, revel that there is high waiting time at the inspection and painting station respectively.

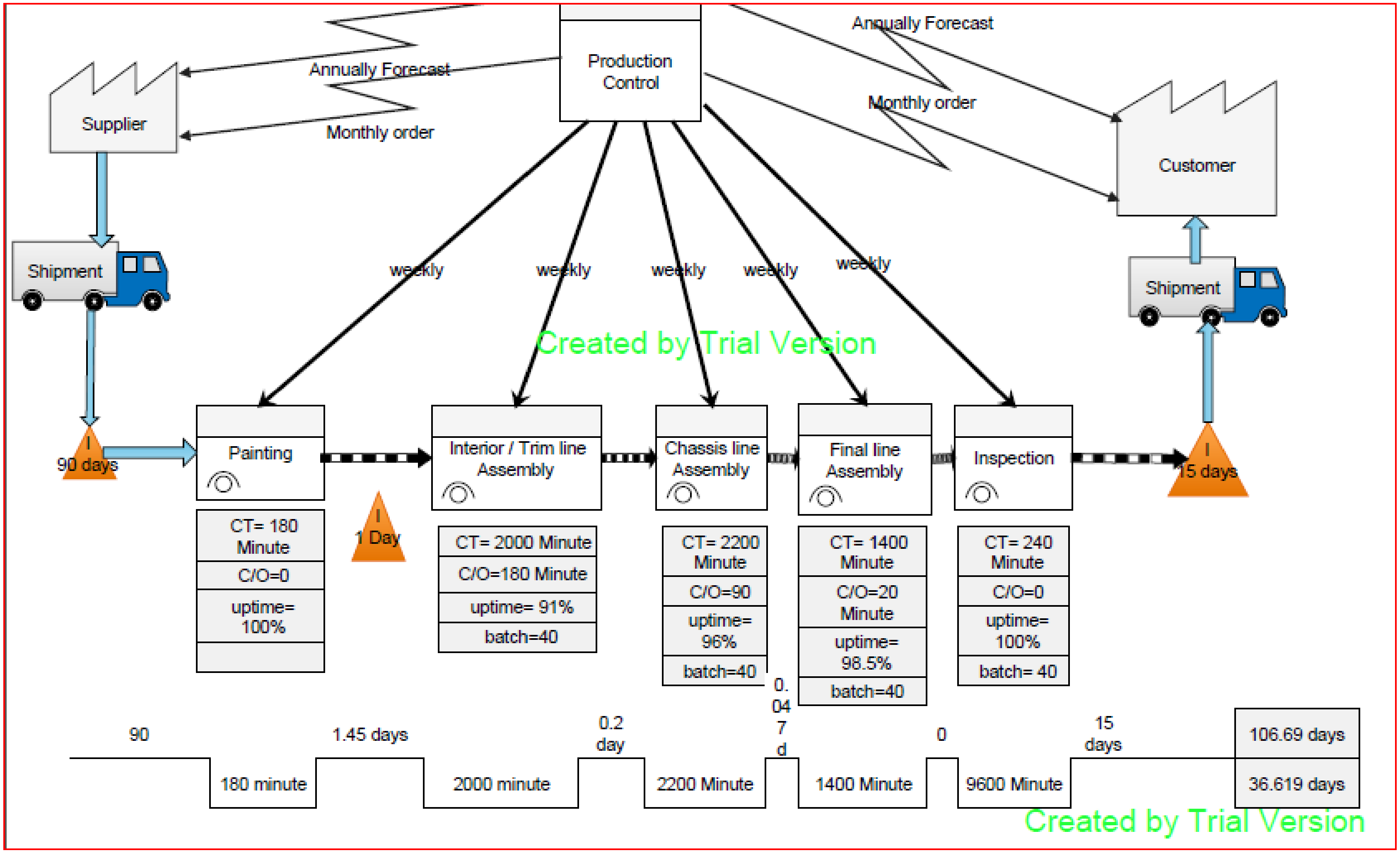


Figure: 6 Current Value stream map

As the current process flow clearly shows, there are many manufacturing wastes and problems that can be avoided. Hence, analyzing the existing practices, and thinking the minimization of these wastes leads to the future value stream. The future value stream map developed that can show the possible methods and practices that enhance the overall performance of the factory and locate areas of further investigation. The future VSM indicates the situations in which the overall value stream should be based on the proposed VSM.

4.2.3 Mapping of the future situation

With the map of the current situation the problems and waste go appearing. Figure: 6 shows the large inventories, the long waiting time against value-added time, as well as a lot of information parallel planning In order to reduce or eliminate these problems, they must be answer a series of questions that allow us to understand the current flow and achieve Create a continuous flow between all the processes. In the table: 7 below the number of question that used to improve the existing value stream map.

Table: 7 Design question for value stream map

Level	Questions
Basic	1. What is the takt time? 2. Will finished goods be built to replenish a supermarket, or will they be built and directly shipped to customers? 3. Where can continuous flow processing be utilized? 4. Is there a need for a supermarket pull system within the value stream? 5. What single point in the production line will be used to schedule production?
Heijunka (*Leveling Production*)	6. How will the production be leveled at the pacemaker process? 7. What increment of work will be consistently released from the pacemaker process?
Kaizen (*Improvement*)	8. What process improvement will be needed?

Source [25]

Some of these questions that are suitable for our case are discussed as follows:

- **What is the Takt time?**

The takt time is calculated by dividing the working hours available between the demands of the product. In the LME 151,200 works seconds a week (6 days of 8 working hours with 1 shift). Of this subtract the non-productive hours, which in particular will be 1 hour per shift, due to meals and breaks. The available time is divided between the demands of the LF530, which is 48 vehicles a week, to get a 3150-second takt time. This takt time also calculated automatically by using excel integrated systems 2win application Appendix

This means thatto meet the demand of the customer during the available work time, the LME must produce a one vehicle of LF530 every 3150 seconds.

- **Is it going to produce for a finished product supermarket from where will the customer request their orders or be sent directly to the dispatch area?**

Produce to send directly to the sales area means that only will be produced the necessary units to send to the customer. Currently LME assembles all vehicles and sends them to a warehouse and show room where they expect to be sold. This production system is known as a push system push system, and the product can remain for a long time waiting to be sold. It is proposed that the production be sent to a warehouse type supermarket, which is no more than a place set aside at the end of the production to store products that are ready to be sold, and produce according to kanban system. When the warehouse inventory is below a certain amount, it will notify the assembling process tells must produce more vehicle of LF530.

- **Where is a pull system necessary to control production**?

Pull system is necessary when some processes have long ripening times or are unprofitable link them to other processes in a continuous flow, as well as when Some of the suppliers are far from the company or have other reasons to motivate important orders. Hence one of the suppliers the LME is located in china. In addition to the proposed supermarket system, 2 zones of additional storage are proposed in order to enhance the productivity one at the beginning of the process, for the body part of the vehicle, and another after the final assembly process. The first warehouse will serve as an indicator to responsible for requesting body parts or other necessary raw materials, so as not to be unsupplied or receive unnecessary matter. The second supermarket is proposed before the final line just after chassis line assembly. This chassis line pushes the product towards the final process, creating inventory in process. So the finial process gives a signal to the chassis line when need more products.

- **What point of the production chain will be used to program production (called the regulatory process)?**

After using transportation (conveyor) systems, it is necessary to plan the production of a single process in the whole chain, called the regulatory process. All the processes upstream of the regulatory process will work under a hauling system and the flow in the downstream processes will be continuous. The regulatory process is in the Chassis line, since it is the last stage and it establishes the bases for the final Assembly. After thisthe process will work under a FIFO system (first in, first out).

- **What process improvements will be necessary in the value chain for that flows as specified by the design of the future state map**

Some changes and actions to carry out the future plan are: -

- ✓ Reduce the total production waiting time by eliminating or reducing the inventory of material in process.
- ✓ Use of visual aids and 5 s in all areas of the process would help in great measure to avoid errors by confusion and time by identifying some home work
- ✓ Standardization of processes.
- ✓ Use a shopping system based on kanban System
- ✓ Create long-term relationships with suppliers and encourage them to that work under a Lean system too.
- ✓ Reduce the amount of information between the managers and each department.
- ✓ Place the materials and tools near the process that is going to use.

The future state map is shown in Figure: 7 where the proposed improvements and the potential areas for improvement the total production waiting time are 76.54 days. This means that the value-added time is now 47.84% of the total production waiting time, when before it was only 34.54% in the current status map. Which means that there is fewer inventories in process and the overproduction Evaluation of the Lean Manufacturing application when comparing current data with what is estimated to be obtained with the improvements proposals we can analyze how effective it is to apply the techniques of this methodology in a process as peculiar as that assembling. In the map of the current state, the data that attracts the most attention is the time of maturation or lead time, which is 106 days, when really the time in Value added is 36.54 days.

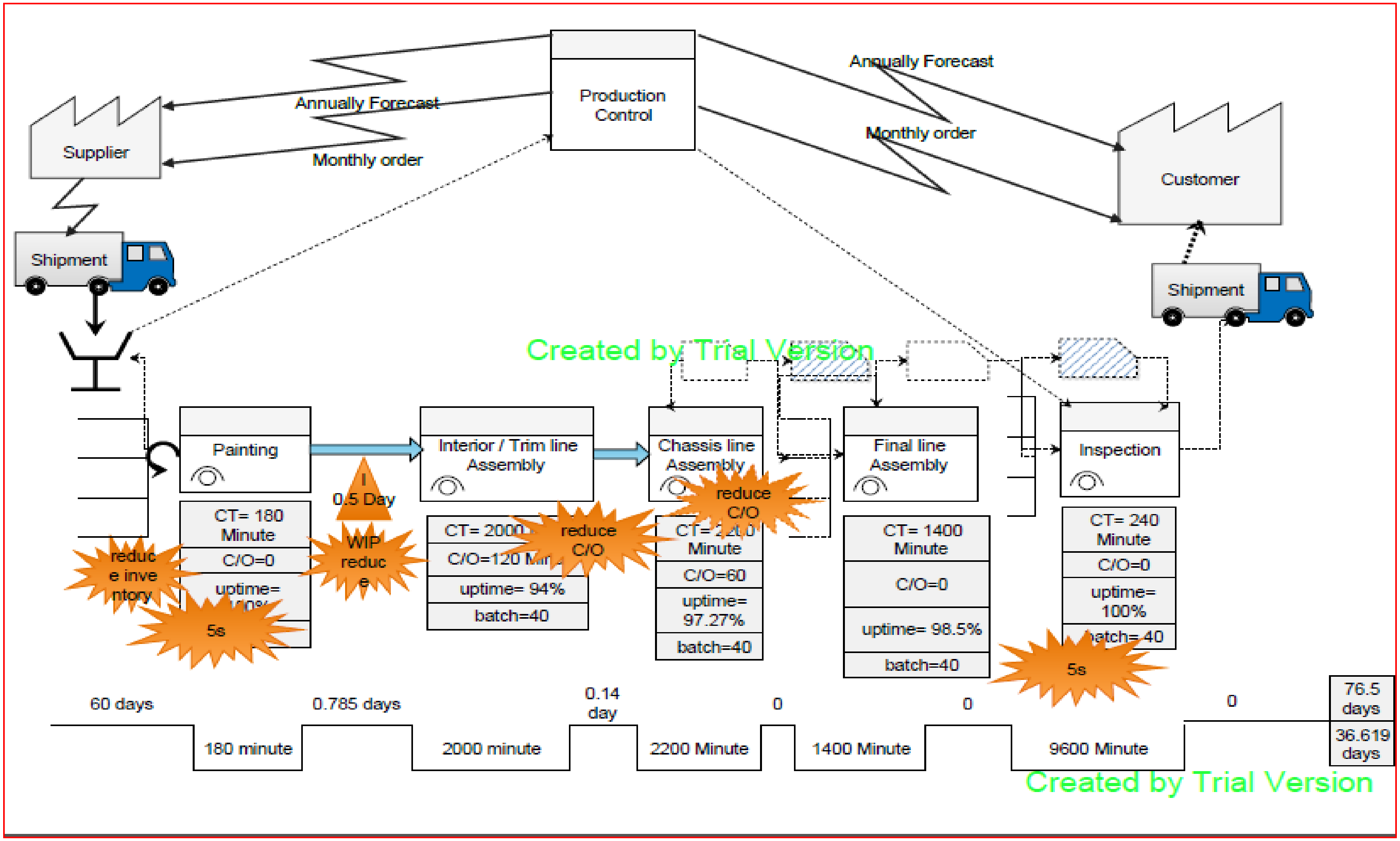


Figure: 7Future Value Stream Map

It is proposed to achieve a continuous flow through the implementation of systems kanban and supermarkets, reaching low volumes of inventory and estimating a lead time of 76.54 days. In addition, with the system of purchases of raw material, the company saves money and space used in storing those materials.

With regard to the information system, the need for Lifan motors in Ethiopia to plan each process, since the whole system would be moved by the continuous flow. Only the regulatory process should be planned, which turned out to be the finishing area

The expected results for the study, after the investigation in the same and the analysis of the results of the application of Lean techniques and principles in processes for the elaboration Lifan motors in Ethiopia, give as results:

- Reduce the total production waiting time by 28%.
- Eliminates losses and deterioration of material in process.
- Reduce the amount of information between processes.
- Allows better use of physical space and machinery in the warehouse
- Achieves a better distribution of work in operators.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusions

In general, companies that have implemented Lean Manufacturing as their work philosophy have experienced significant reductions in time of delivery, cost, rework, inventory, preparation time, material in process, and number of defects, while increasing their productivity, flexibility, improve quality, better utilization of staff, and achieve better use of space and machinery.

The overall content of the literature survey, the case study and the industry survey have led to the following conclusions:

1. It is found that Lean Manufacturing is a response to competitive pressures with limited resources. It is a collection of technical and operational systems focused on productivity in relatively stable demand environment.
2. LPS focuses on minimizing manufacturing wastes, continuously improving methods, utilizing flexible production system and equipment organized to produce wide variety of defect-free goods.
3. Cases on the implementation of Lean techniques indicate that LME can enhance competitiveness by adapting Lean. The survey revealed that the indicated company is experiencing forces that lead to more responsiveness. Moreover, it is found most of the respondents believe that the Lean Production is more appealing in current market Situation.

5.2 Recommendations

A manufacturing company strives to better its internal processes and improve production efficiency to enhance customer satisfaction. An important measure of manufacturing performance is manufacturing efficiency. Minimizing manufacturing lead time and throughput time and queue length can improve manufacturing efficiency.

Based on the result the assessment and analysis of the VSM the following recommendations are forwarded to improve the efficiency of Lifan motors in Ethiopia.

- A manufacturing company should reduce throughput time by minimizing the time consumed by inspecting, moving and queuing activities. As a result of minimizing such activities, the manufacturing lead time is also reduced and delivery performance is improved.
- The Lean production system and its principle should be observed whenever performance improvement is intended.
- Industrial associations, managers and investment promotion bodies, need to focus on the implementation of lean
- It is recommended that Lifan motors pay due attention to the Value Stream and take action to gain the benefits from lean system. Moreover, Lifan motors need to further study other divisions and units using Lean thinking.
- The industrial Engineers and other related professionals need to support the company by providing consultancy services as to the efficient method of production.

If the recommended solution in this paper is fully applied, the researcher believes that manufacturing performance can be improved and the benefit of the result will be enjoyed.

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Appendix: A

Questionnaires

Addis Ababa institution of technology

School of Mechanical and Industrial Engineering

20010 E.C. Graduates

Questionnaires to assess the challenges of Lifan Motors in Ethiopia in the current business environment

This questionnaire is prepared to assess the market forces that require companies to be more responsive to changing business environment. Your honest response is valuable to draw valid conclusion.

After reading the following brief notes on **LEAN MANUFACTURING**, comment on the appropriateness of the production approaches in Ethiopian context.

LEAN MANUFACTURING

Lean manufacturing is one that meets high throughput or service demands with very little inventory. And also, Lean manufacturing is a system with a systematic approach to eliminate waste (non-value added) in its form and enabling continuous improvement to satisfy the customers.Moreover,Lean is a production practice that aims to minimize waste along entire value streams and create more value for customers.

Unlike a limited goal for an acceptable number of defects, high level of inventories, and narrow range of standardized products, lean aims on **perfection**: continually declining costs, zero inventories, and endless product variety. Lean manufacturing based on the following basic five principles:-

1. **Specify value from the point of view of the customer.**This means that the customer buys results, not products, and that any company needs to identify and begin product design and manufacture by focusing on what their customers need and want.

2. Value stream. Value Stream techniques focus on one object or product in the company not the viewpoint or the department of process step.

3. Flow. This principle tries to describe that it is important to make the product move through one value adding step to the next one and keep the product in constant one piece flow.

4. Pull. Pull means meeting consumer's rates of demand with production but not over producing.

5. Perfection. The last principle seems more possible after the other four principles.

1. Have you ever heard of the two new production systems?
   Yes _____ No._______

2. Give additional relevant comments on this system (if any).
   ____
   ____
   ____
   ____
   ____

3. **Rank the challenges** that the company faces in the current market.

- ➢ Increased demand for product/service ☐
- ➢ variety Limited organizational capacity ☐
- ➢ Global or local competition or both ☐
- ➢ Lack of production system flexibility ☐
- ➢ Market fluctuation ☐

4. **Mark changes** that the company has experienced in the last three years.

- ✓ Introducing new product / service ☐
- ✓ Using IT at office or production floor ☐
- ✓ Dropping previous products / services ☐
- ✓ Reducing production volume ☐
- ✓ Closing / opening / merging departments ☐
- ✓ Delegation of responsibility to lower organizational ladder ☐

5. What are the **main problems** of the company with regard to market responsiveness?

- ❖ Rigidity of production /service system ☐
- ❖ Inflexibility of workers ☐
- ❖ Employee morale and culture ☐

- ❖ Inefficient use of resources ☐
- ❖ Unpredictable demand ☐

Others (if any)

- ❖ ________________________________
- ❖ ________________________________
- ❖ ________________________________
- ❖ ________________________________

6. Which **change in customer behavior** did the company experience in recent years?

- Product/ service quality consciousness ☐
- Need for reduced price ☐
- Need for more products/ services variety ☐
- Request for shorter delivery time ☐

7. Does the company subcontract or outsource a demand to other companies in order to gain temporary market opportunity?

Yes _____ No._______

8. Is the exiting organizational structure effective enough to meet today's organization requirements?

Yes _____ No._________

9. What is/are the main strength of the company with respect to competitiveness?

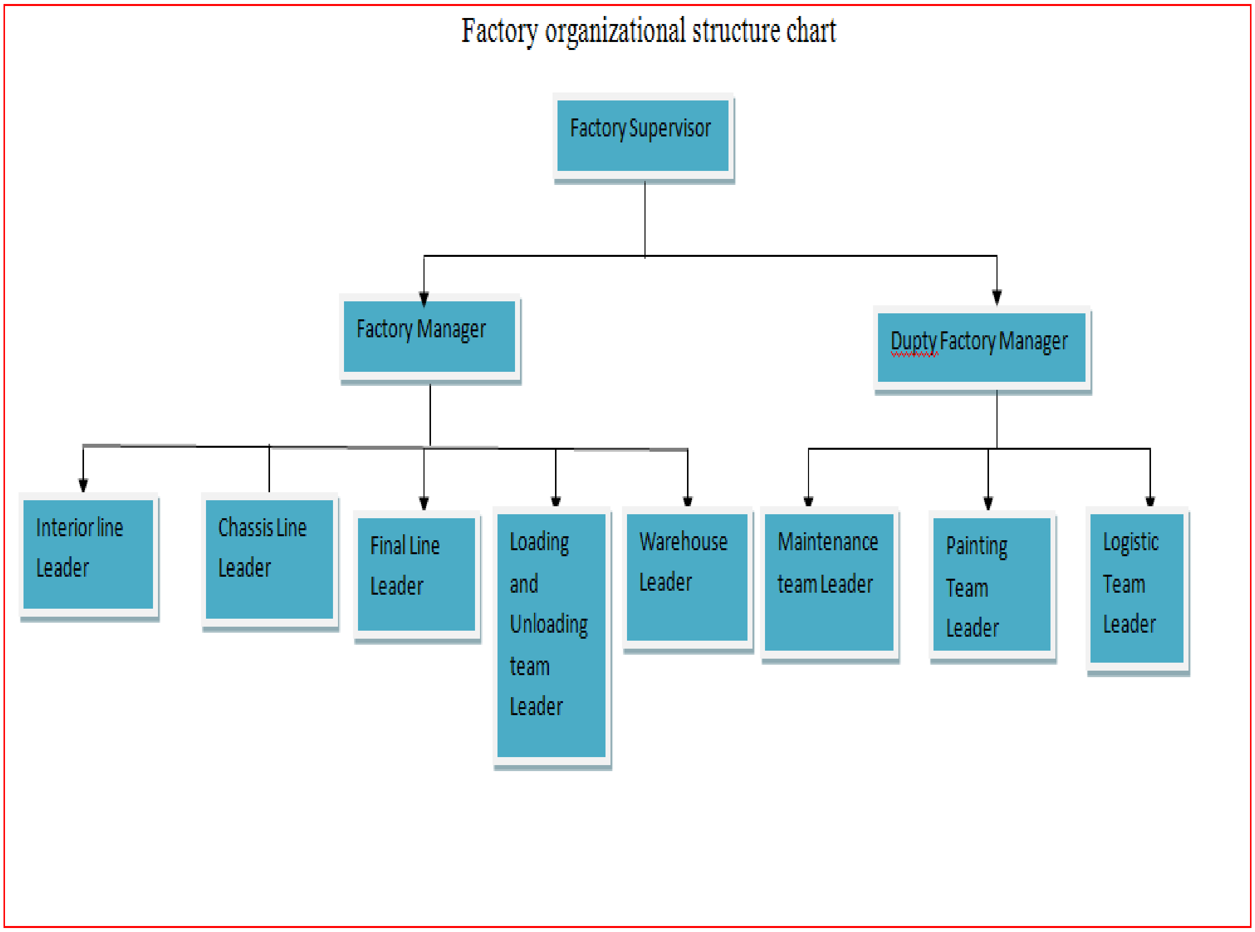
____
____
____
____
____
____

10. For the following questionnaire, **rate** the factors according to the scores given.

SCORE	1	2	3	4	5
RATING	**Poor**	**Fair**	**Satisfactory**	**Good**	**Very Good**

	Factors	**Scores**				
A	How responsive is the existing production system of the company with regard to:					
	➢ Better quality	1	2	3	4	5
	➢ Deliverytime	1	2	3	4	5
	➢ Inventory reduction	1	2	3	4	5
	➢ Space and equipment utilization	1	2	3	4	5
	➢ productivity	1	2	3	4	5
B	To what level the company minimizes non-value adding activities?	1	2	3	4	5
C	To what level supplier and customer are involved in relevant activities of the company?	1	2	3	4	5

Appendix B


Factory organizational structure chart
Factory Supervisor
Factory Manager
Dupty Factory Manager
Interior line Leader
Chassis Line Leader
Final Line Leader
Loading and Unloading team Leader
Warehouse Leader
Maintenance team Leader
Painting Team Leader
Logistic Team Leader

Appendix: C

Factory Entry-Stock management report

No	Model	SDK received	Finished goods quantity	Transferred to delivery center quantity	Ending balance of SDK	Ending balance of finished goods	Percentage %
1	LF320	12	12	12	-	-	1.327
2	LF520	90	90	90	-	-	9.99
3	LF520I	14	14	14	-	-	1.5
4	LF530	380	380	362	-	18	40
5	LF620	34	34	34	-	-	3.76
6	L7	63	63	57	-	6	6.3
7	Suv	147	127	127	20	-	14
8	Mini-van	68	68	62	-	6	6.85
9	Mini-cargo	88	88	86	-	2	9.5
10	Mini-truck	16	16	16	-	-	1.77
11	X50	65	62	44	3	18	4.86
	TOTAL	**977**	**954**	**904**	**23**	**50**	**100%**

Appendix: D

Takt time calculation

Metric	Value	UOM	Links
Work Time Available			
Work Days/week	6	Days/week	
Shifts/day	1	Shifts/day	
Hours/shift	8	Hours/shift	
Overtime	0	Mins/shift	
Meals	30	Mins/shift	
Break minutes/shift	30	Mins/shift	
Change Overs	0	Mins/shift	
Planned Downtime	0	Mins/shift	
Unavailable Time	0	Mins/shift	
Work Time Available	420	Mins/day	
Demand			
Demand per Week	48	Units	
Demand per Shift	8	Units	
Takt Time			
Takt Time	**3150**	**Seconds**	
Takt Time	**52.5**	**Minutes**	
Takt Time	**0.875**	**Hours**	