

A STUDY ON MATERIALS AND EQUIPMENT HANDLING AT SRI LAKSHME BALAJI INDUSTRIES

Submitted in partial fulfillment of the requirements for the award of

Master of Business Administration

by

Atshaya S
Register No.39410028



SCHOOL OF BUSINESS ADMINISTRATION

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
Jeppiaar Nagar, RAJIV GANDHI SALAI, CHENNAI - 600 11**

April - 2021



SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with “A” grade by NAAC | 12B Status by UGC | Approved by AICTE
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119
www.sathyabama.ac.in**

SCHOOL OF BUSINESS ADMINISTRATION

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ATSHAYA S 39410028** who have done the Project work entitled “**A STUDY ON MATERIALS AND EQUIPMENT HANDLING AT SRI LAKSHME BALAJI INDUSTRIES**” under my supervision from January 2021 to March 2021.

Dr. DHIVYA SATHISH
Internal Guide

Mr. K. ARJUN
External Guide

Dr. BHUVANESWARI G.
Dean – School of Business Administration

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I **ATSHAYA S 39410028** hereby declare that the Project Report entitled “**A Study on Materials and Equipment Handling at Sri Lakshme Balaji Industries**” done by me under the guidance of **Dr. Dhivya sathish** and **Mr. K. Arjun** at **Sri Lakshme Balaji Industries** is submitted in partial fulfillment of the requirements for the award of Master of Business Administration degree.

DATE:

PLACE:

ATSHAYA S

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to Dr. **Dr. BHUVANESWARI G.**, Dean, School of Business Administration and **Dr. PALANI A.**, Head, School of Business Administration for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. DHIVYA SATHISH** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the School of Business Administration who were helpful in many ways for the completion of the project.

ATSHAYA S

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	i
	LIST OF TABLES	ii
	LIST OF CHARTS	iii
1	INTRODUCTION	
	1.1 Introduction	1
	1.2 Industry Profile	6
	1.3 Company Profile	7
	1.4 Need for the study	9
	1.5 Significance and Scope of the Study	9
	1.6 Objectives of the Study	10
	1.7 Limitations of the Study	10
2	REVIEW OF LITERATURE	
	2.1 Review of Literature	11
3	RESEARCH METHODOLOGY	
	3.1 Research Design	18
	3.2 Sampling Technique	19
	3.3 Sources of Data	19
	3.4 Structure of Questionnaire	19
	3.5 Sample Size	20
	3.6 Period of Study	20
	3.7 Analytical Tools	20
4	DATA ANALYSIS AND INTERPRETATION	
	4.1 Methodology to Improve Productivity	21
	4.2 Track of Material Flow	22
	4.3 Material Flow and storage	24
	4.4 Material Handling Equipment	29
	4.5 Comparison of OEE and TEEP	48
5	FINDINGS, SUGGESTIONS AND CONCLUSION	
	5.1 Findings	69
	5.2 Suggestions	70
	5.3 Conclusion	72
	REFERENCES	73
	BIBLIOGRAPHY	75
	APPENDIX- I QUESTIONNAIRE	
	APPENDIX- II ARTICLE	

ABSTRACT

The purpose of this study is to help us find the gaps in Materials and Equipment handling at Sri Lakshme Balaji Industries and enhance it to optimize the production process. The study could provide us information on the existing materials and equipment handling processes adopted at the organization and enables us to suggest ways of optimizing it. The study also expands to explore ways to avoid workplace accidents since the employees are predominantly engaging with handling materials and equipment. The comfort of the employees is influenced by their experience, their adaptability to new equipment, timely training provided, usage of protective equipment and the comfort of reaching for the controls. A structured Questionnaire is distributed to the employees to analyze these factors. Minor changes are made in the organization using Kaizen technique and the productivity metrics such as Overall Equipment Effectiveness and Total effective equipment performance are quantified before and after making the changes in materials and equipment handling. It was found that, implementing Kaizen showed significant improvement in the productivity metrics.

LIST OF TABLES

TABLE NO	PARTICULARS	PAGE NO
4.4.3.1	Age wise classification of respondents	35
4.4.3.2	Types of Equipment required	36
4.4.3.3	Frequency of accident occurrence	37
4.4.3.4	Severity of accidents	38
4.4.3.5	Satisfaction of equipment handling	39
4.4.3.6	Inclination to adapt to new technology	40
4.4.3.7	Protective equipment required	41
4.4.3.8	Frequency of training provided	42
4.4.3.9	Labelling of Dangerous goods	43
4.4.3.10	Overall rating of equipment handling	44
4.4.4.1	Observed and Expected frequencies	45
4.4.4.2	One-Sample Chi-Square Test Summary	45
4.4.5.1	Severity and Dissatisfaction Correlation Analysis	46
4.4.5.2	Controls and Comfort Correlation Analysis	47
4.5.3.1	Glue Dispensing M/C- Existing Vs Improved Data	60
4.5.3.2	Heat Sealing M/C- Existing Vs Improved Data	62
4.5.3.3	LCD bracket Twisting M/C- Existing Vs Improved Data	64
4.5.3.4	Riveting M/C- Existing Vs Improved Data	66
4.5.3.5	Comparison of OEE	68
4.5.3.6	Comparison of TEEP	68

LIST OF CHARTS

CHART NO	PARTICULARS	PAGE NO
4.4.1	Material Flow of Glue dispensing machine	28
4.4.2	Material Flow of LCD bracket twisting machine	28
4.4.3	Material Flow of Riveting Machine	29
4.4.2.1	Piston Transfer Conveyor	32
4.4.2.2	Inner Tube Conveyor	32
4.4.2.3	Webbing Sling	34
4.4.3.1	Age wise classification of respondents	35
4.4.3.2	Types of Equipment required	36
4.4.3.3	Frequency of accident occurrence	37
4.4.3.4	Severity of accidents	38
4.4.3.5	Satisfaction of equipment handling	39
4.4.3.6	Inclination to adapt to new technology	40
4.4.3.7	Protective equipment required	41
4.4.3.8	Frequency of training provided	42
4.4.3.9	Labelling of Dangerous goods	43
4.4.3.10	Overall rating of equipment handling	44
4.4.6.1	Respondents of age above 40	48
5.2.1	Modifications in equipment handling	71

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Material handling equipment (MHE) is mechanical equipment used for the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal. The different types of handling equipment can be classified into four major categories: transport equipment, positioning equipment, unit load formation equipment, and storage equipment.

1.1.1 Types of Materials Handling Equipment:

Type 1: Storage and Handling Equipment

This is the simplest type, something so basic you might not even think of it as equipment. These are shelves and racks where you store your material in between receiving it and shipping it. They are often designed to utilize vertical space so the warehouse can hold more items. Bins, drawers, stacking frames, flow racks, cantilever racks, and mezzanines are also included in this category.

Type 2: Bulk Material Handling Equipment

This is, “the storing, transportation and control of materials in loose bulk form.” If there’s a lot of material all together, you’re probably using bulk material handling equipment. An example would be a silo, a large cylinder that can hold stuff like grain.

Other examples include:

- Stackers and reclaimers: Large machines that are used to dump things into piles or to pick them back up again. They can be hard to visualize, so here’s an animation of one working.

- Hoppers: Picture a large metal funnel. It stores material and can release an exact quantity out the bottom.
- Grain elevators: Buildings used to store grain. They include a series of buckets on a track that automatically transport grain to the top of the building where it can be funneled into different silos.
- Bucket elevators: Similar to a grain elevator, this device features buckets that transport large amounts of material.
- Conveyor Belts: Moving belts that transport material. They can be combined into more complicated conveyor systems which are considered engineered systems. If you want a conveyor system for your business, contact DCS.
- Dump Trucks: Also, a type of industrial material transport vehicle.
- Screw Conveyor: A screw-shaped device inside a tube that turns to move material.
- Rotary car dumper: A device that turns a rail car to dump out its contents.

Type 3: Industrial Trucks

These are vehicles or equipment that move materials. Sometimes workers run them, and sometimes they are automatic. Automated Guided Vehicles (AGVs) fall under both engineered systems and industrial trucks.

Other examples are:

- Hand trucks: These are also called dollies. They are simple, L-shaped devices that let you carry material at a tilt.
- Side-loaders: These are used to load materials in narrow aisles where other trucks may be too wide.
- Pallet trucks: Hand-operated or electric devices that slide into pallets to move them.
- Walkie stackers: Thomas Network explains that these “transport and lift pallets like a forklift, though they don’t include a place for the operator to ride in. They come in both powered or manual versions.”

- Order pickers: These vehicles lift a worker off the ground so they can grab high packages.
- Platform trucks: Like a dolly but with a wider platform.
- Forklifts: Operational vehicle used to lift and transport heavy items.

Type 4: Engineered Systems

This type of material handling equipment involves more complicated systems with multiple components, usually automated.

Examples would be AGVs, conveyor belt or robotic delivery systems (complicated systems that come in different shapes and sizes), or Automated Storage and Retrieval System (AS/RS), which are automated systems often incorporating AGVs which make warehouses more efficient—basically anything that moves materials around the warehouse so workers don't have to.

This category of equipment is the most complicated and expensive, often incorporating elements from the other categories into wider more expansive systems. These systems require a lot of time and research before making an investment.

1.1.2 Material Handling

Material handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. As a process, material handling incorporates a wide range of manual, semi-automated and automated equipment and systems that support logistics and make the supply chain work. Their application helps with:

- Forecasting
- Resource allocation
- Production planning
- Flow and process management

- Inventory management and control
- Customer delivery
- After-sales support and service

A company's material handling system and processes are put in place to improve customer service, reduce inventory, shorten delivery time, and lower overall handling costs in manufacturing, distribution and transportation.

1.1.3 OEE: Overall Equipment Effectiveness

Overall equipment effectiveness is a maintenance KPI that measures an asset's level of productivity. OEE is a combination of three factors that tell you how efficient an asset is during the manufacturing process: asset availability, asset performance, and production quality. Each one can tell you something different about how an asset operates.

1. Availability – How often does the asset function when needed?
2. Performance – How much does the asset produce?
3. Quality – How many high-quality items does the asset produce?

When an asset operates with an OEE of 100%, it means that every item it produces is without defect (quality), it is producing as fast as possible (performance), and it experiences no unplanned downtime (availability).

Overall equipment effectiveness is a tool for evaluating the efficiency of assets during the manufacturing process. It can also be used to investigate the people, processes and tools that impact how assets operate. When combined with the insight from other maintenance metrics, OEE provides a great foundation for identifying areas of an operation that can be improved and a quantifiable way to measure progress.

1.1.4 TEEP: Total Effective Equipment Performance

TEEP (Total Effective Equipment Performance) is a performance metric that is used to measure the real capacity of manufacturing operations – indicating how big of a scope is waiting to be unlocked. This metric provides manufacturers insight into how much

potential their factory has based on their current equipment. TEEP takes into consideration Equipment Losses (OEE measurement) and Schedule Losses (Utilization measurement).

TEEP – similarly to OEE – is used by manufacturers to understand how to improve their factory's processes and enhance decision making in the business. And in order to understand your businesses' scalability, all these factors must be taken into view. The main difference between the two metrics is the maximum time available for production. Since TEEP takes into account all-time, the maximum time available for production is 24/7, 365 days a year.

TEEP also goes one step beyond OEE, by emphasizing the impact of scheduled downtime, and in doing so, unveiling the true untapped potential of a factory's production. Measuring TEEP is essential so you can correctly forecast and schedule production. By understanding your factory's losses, you can begin to work on those issues in order to improve reliability.

Note how the OEE gives you an idea of the maximum production capacity, whereas the TEEP is a good indicator of the scalability of your business. If you have a high OEE but a low TEEP, it's time to consider extending shifts, creating a new shift (for example, at night) or start operating on weekends.

$$\begin{array}{ccccccc} \text{⌚} & \times & \text{⚙️} & \times & \text{🏆} & = & \text{OEE} \\ \text{⌚} & \times & \text{⚙️} & \times & \text{🏆} & \times & \text{📅} = \text{TEEP} \end{array}$$

1.2 INDUSTRY PROFILE

Recent developments in factory optimization have forced the need to adapt machinery and other processes to make manufacturing more effective. Industrial Automation sector is opening up many opportunities for technology companies that are innovative and can cater to automotive or agricultural companies. Further, factors like innovations in IT, emerging middle class and augmented disposable income help the industry grow in India. Demand is further expected to increase in the coming years as companies need more Automation to remain competitive. Moreover, Industrial Automation is becoming an important part of companies producing in India that apply the latest technologies.

Besides, India is moving towards Industry 4.0. Hence, the Industrial Internet of Things (IIoT) will emerge as a game-changer for the manufacturing Industry. Known for its large number of engineering graduates and professionals, India provides a great pool of skilled labor for the Industrial Automation sector. This industry has a great present and future prospect. Companies interested in entering India will find good business opportunities in this sector.

- The Industrial Automation Industry in India is still evolving. This is due to increasing Foreign Direct Investments (FDI) and sustained growth of the manufacturing sector.
- Factory Automation becomes more and more important for competitiveness of companies.
- India emerges as a preferred sourcing destination for Industrial Automation.
- India's growing manufacturing sector scales up industrial automation equipment demand

Market Stats

- The global Industrial Automation Market size was valued at USD 157.04 Billion in 2018. It is expected to reach USD 296.70 Billion by 2026.
- The Indian Industrial Automation Market size was valued at USD 5 Billion in 2018. It is further expected to grow at a CAGR of 12% by 2023.

1.3 COMPANY PROFILE

Sri Lakshme Balaji Industries was established in May 2001 to deliver world class Automation solutions customized to Indian/International markets. They enjoy the challenge of reshaping industrial challenges and converting them into more productive and unique high-performance systems. They leverage on their in-depth knowledge and proven design & implementation experiences to meet the complex automation systems needs of multinational customers in industries such as healthcare, Automobiles, electrical / electronic and consumer products. They deliver custom solutions and provide consulting grounded in reality.

1.3.1 SLB Industries Products:

Glue dispensing machine:

This machine has been designed for dispensing adhesive for automotive Head lamp / Tail lamp. The machine basically is a 5 axis CNC machine, which traces the profile of the contours of Automotive head lamp body. The head lamp body and the lens are fixed with hot melt adhesive. This machine performs the task of tracing the profile of the lamp, whereas the melting & pumping of the hot melt adhesive is done by Nordson applicator. In simple terms the machine performs the task of a robot.

Heat sealing machine:

This machine has been designed for sealing / riveting two plastic parts together. The parts sealed are the Plastic body of Automotive Instrument cluster body and the mask rings. The rivet like projections in the mask rings are fused in assembly. The machine is totally controlled by a PLC and the only the loading & unloading of parts is handled by the operator.

Thermal riveting machine:

This machine has been designed for thermal riveting of assembly containing plastic

and metal parts. This machine is used for riveting of the lock mechanism of RCCB (Residual Current Circuit Breaker). The lock mechanism contains various plastic & metal parts. The machine has a 4-station index table and the loading / unloading is done at one station and the riveting is done at the opposite station. The assembly is placed in the fixture and the operator needs to press a start button and the machine automatically indexes and performs the riveting operation. The machine is controlled by a PLC. The riveting time and temperature can be set by the operator through an HMI.

Lcd bracket twisting machine:

This machine is used in the assembly process of Electronic instrument cluster of Automotive. The LCD display panel and related components are assembled manually and the metal cover bracket is placed in position. The machine further performs the task of keeping the assembly intact under specified pressure and twists the 4 tabs of the metal bracket in a specified pattern. The machine is common for 2 different models and the user can select the model to be produced through a selector switch. The machine automatically changes the tooling to suit the selected model. During operation the machine also checks whether the loaded component is the same as the selected model.

Piston nut torquing machine:

This machine is used for tightening a nut to the specified torque in the assembly of valves of the shock absorber. The nuts are loaded in a hopper in bulk. The piston valve assembly components are placed in the piston rod and the piston rod is placed in the work holding fixture. The machine clamps the piston rod and picks up a nut and places & tightens to the specified torque. The nuts are fed by a vibratory feeder. The nut driver control has the facility to set the required torque, acceleration, etc. The machine can be used for various model with quick change parts.

Riveting machine:

This machine is used for riveting the Outer Handle assembly of Automotive Door

handle. The machine is common for LH or RH or front or rear door. No setting change is required for the change of the above handle types. Poke Yoke has been provided to check whether all the necessary components are assembled or not, before riveting is performed. The spin riveting technology has been used for riveting.

1.3.2 Mission:

SLB Industries make the world more productive by improving the efficiency and reliability of the machinery that keeps industry in motion.

1.3.3 Vision:

To provide world class customized Automation solutions and consultancy services to our clients, build Automation solutions which overcomes the industrial challenges which our clients face and help them to maximize their productivity and performance and to become the trusted Automation solution partner to our clients.

1.4 NEED FOR THE STUDY

- To identify the existing equipment handling process and make work easier to improve productivity in the organization.
- To identify the importance of material handling, flow of materials and end product storage and how to enhance it.
- To identify the OEE and TEEP and find the effective way to increase the productivity in terms of OEE and TEEP.

1.5 SCOPE AND SIGNIFICANCE OF THE STUDY

- Understand and make effective material and equipment handling process.
- Efficient usage of metal sheets for making LCD bracket, automobile door handles, shock absorbers, head/tail lamp, huge plastic/metal components.

- Mainly focused on the enhancing productivity aspects by analyzing material storage, overall equipment effectiveness and total effective equipment performance.

1.6 OBJECTIVES OF THE STUDY

Primary Objective:

To study the Materials and Equipment handling at Sri Lakshme Balaji industries.

Secondary objective:

- To find out the overall equipment handling system.
- To know about various problems faced in material storage & flow.
- To compare Overall Equipment Effectiveness (OEE) and Total Effective Equipment Performance (TEEP) before and after making improvement, as a metric for productivity.

1.7 LIMITATIONS OF THE STUDY

Even though the project has been done in production department alone, it suffers from the following limitations.

- In depth and detailed study of all machine's unit in each of the large manufacturing units was not possible.
- For technical analysis one month data only taken.
- Time duration for the project completion is limited. Within the given time it is very difficult to study the production process going on and doing the analysis.

CHAPTER 2

REVIEW OF LITERATURE

2.1 REVIEW OF LITERATURE

Angappa Gunasekaran (2015) The primary focus of total quality management (TQM) is customer satisfaction. Continuous improvement and worker empowerment are primary vehicles for achieving customer satisfaction. Effective TQM hinges also on management performance in planning, organizing, influencing and controlling activities in all functional areas (such as marketing, purchasing, design and engineering, production, distribution, finance and accounting, human resources, etc.).

Ardavan Asef-Vaziri (2005) A sizeable proportion of manufacturing expenses can be attributed to facility layout and material handling. Facility layout decisions involve designing the arrangement of elements in manufacturing systems. Among the most critical material handling decisions in this area are the arrangement and design of material flow patterns.

Ateekh Ur Rehman (2019) In a present competitive market, manufacturing industries are compelled to follow a systematic approach to understand and improve manufacturing plant performance. A variety of management tools and philosophies are adopted by different industries to identify areas of opportunity for minimization of waste and maximization of production productivity. Lean manufacturing is a philosophy of waste minimization, productivity enhancement and continuous improvement.

Ayman Bahjat Abdallah (2018) The relationship between LM and innovation is debated in the existing literature, but the debate is characterized by a lack of empirical evidence. This is one of the first studies that empirically investigates the relationships between IO, LM and innovation performance. It identifies some new insights to direct

future research, particularly regarding different innovation types as well as in service organizations.

capability. The modern manufacturing world is characterized by much different conditions. We present a conceptual overview of a production planning system that maintains the hierarchical structure but is networked across interdependent components and integrates real-time status and sensor information to guide planning and control in a dynamic fashion. Information indicating deviations from expected status initiates the replanning activity. Beginning with linear programming for aggregate planning, duality theory is used to measure the validity of existing plans. Distributed models are integrated to continuously monitor and update model parameters. Several examples are provided to illustrate how the dynamic data-driven planning and control framework can significantly improve manufacturing performance.

Fatine CHOUIRAF (2018) The integration of lean manufacturing in the organization of craft enterprises would contribute to this improvement. Lean is a Japanese approach to production management, based on the elimination of wastes "mudas". Lean and craft production share some objectives, namely production in small series, unitary production and the pull business model.

improvement concepts that have been applied to eliminate waste and non-value-added activities that occur in many companies. This paper explores a real work case study of the manufacturing sheet metal stamping process to demonstrate how lean manufacturing can help improve work efficiency. This study was conducted within 10 Integration is the fundamental goal of the CIM paradigm.

James C. Green (2014) Material handling is defined, simply, as moving material. This is the popular perception that many holds, but in fact material handling includes much more than simply moving material. For a significant number of manufacturers, material handling can account for more than one-half of the total cost of manufacturing. The flow, movement, and storage of materials in the manufacturing processes of firms often require a great deal of resources, both employees and equipment. Material handling is also regarded as being a non-value-added function that is still necessary for the

successful completion of the manufacturing process and can have a marked effect on the ability of a firm to meet managerial goals (Myers and Stephens 2000). The cost generated by material handling systems can be reduced if steps can be taken to improve these systems. Productivity and the incidence rate of injuries, specifically lost time injuries, can also be improved by positive changes to material handling systems.

Jaroslava Kadarova (2015) Implementing of Lean Management removes eight types of wastes; Transport, Inventory, Motion, Waiting, Over-processing, Overproduction, Defects, and Talent. It typically improves Quality performance, Fewer machine and Process Breakdowns, Lower levels of Inventory, Less Space Required, Higher efficiencies, Greater Customer Satisfaction, Improved employee morale and involvement, Higher Profits and more.

John T. Mentzer (2001) This globalization of supply has forced companies to look for more effective ways to coordinate the flow of materials into and out of the company. Key to such coordination is an orientation toward closer relationships with suppliers. Further, companies in particular and supply chains in general compete more today on the basis of time and quality. Getting a defect-free product to the customer faster and more reliably than the competition is no longer seen as a competitive advantage, but simply a requirement to be in the market.

Juthamas Choomlucksana (2015) Companies frequently find techniques and tools to enhance productivity and quality for success in the long-term in order to maximize competitive advantage. To date, lean manufacturing principle is one of the successful

K.C. Ng (2014) Overall equipment effectiveness (OEE) is the key measurable for successful implementation of Total Productive Maintenance (TPM). Total productive maintenance is a key strategy for productivity improvement in manufacturing. The concept was introduced by Nagajima and the main motivation of TPM implementation in the manufacturing industry is to eliminate the six production big losses. It also describes the most common causes for efficiency loss. OEE is a critical metric and

focuses on maximizing equipment effectiveness by reducing equipment downtime. OEE is also the measures and focus on reducing the total production operation cost and hence achieved higher capital productivity.

Man Mohan Siddh (2014) Concept of Lean manufacturing and Six Sigma are striking concept of manufacturing which appeared on demand of customer saving cost and time. Applying Six Sigma and Lean manufacturing tool needs Team. For Six Sigma we have Six Sigma project teams and for Lean manufacturing we have Kaizen teams. Both of the team requires a specialist under which work has to be done, such as master belts or Lean consulting specialist. Lean manufacturing and Six Sigma both applying changes in organization such as behaviour change and system change in organization and the change is must as to improve & to be effective. Most dominating and important similarity is both tools show us possibilities to achieve our required goals. Such as important in Cost, Quality and time. Therefore, the similarities of both tools may be successful in producing tools that both customer and company's demand.

Maozhu Jin (2008) Many production planning and control systems in use today were designed under a paradigm of a static, deterministic world with hierarchical control systems and regular periodic updates. These systems were conceived in a time of lower competition, more stable markets, and limited information and communication months, started from July 2013 till April 2014. Lean and other improvement tools and techniques such as visual control, Poka-Yoke, and 5s were applied to help companies identify areas of opportunity for waste reduction and improve the efficiency of production processes. Studies of the company processes showed that the deburring and polishing processes tend to create the most non-value-added activities and should be addressed as quickly as possible. The improvement results have shown a positive impact on the company productivity improvements. 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.

Nabeel Mandahawi (2012) This article presents a process improvement study applied at a local paper manufacturing company based on customized Lean Six Sigma methodologies. More specifically, the DMAIC (Define, Measure, Analyse, Improve, and Control) project management methodology and various lean tools are utilized to streamline processes and enhance productivity. Two performance measures namely production rate and Overall Equipment Effectiveness (OEE) are employed to evaluate the performance of the cutting and the printing machines before and after the DMAIC cycle. Obtained results indicate that the production rate increment for printing machines by 5% and for the cutting machines by 10%. Moreover, the OEE for the printing and cutting machines has increased by 21.6% and 48.45% respectively.

Paul Brunet (2000) Kaizen has become part of the Japanese manufacturing system and has contributed enormously to the manufacturing success, evolving over a period of forty years. Kaizen cannot deal with all problems and even in Japan, one size does not fit all but a flexible implementation does open up the dimension of collaboration between the workforce, the management and the technical departments. This review of kaizen in Japan will put Kaizen in context before the presentations of some real ideas on Kaizen in the UK. It is intended to make the audience aware of some fundamental concepts of Kaizen so they can think for themselves how this new dimension of collaboration could be applied in their own company. It will also present some of the liabilities and demands which have accompanied Kaizen in Japan which should not be ignored.

Péter Bikfalvi (2004) The need to become or remain globally competitive stimulates firms in engineering and manufacturing industries to integrate the requirements of quality, costs, profit producing capability and fast delivery-to-order into a comprehensive and effective enterprise strategy. In this process more and more widespread applications of Information and Communication Technology (ICT) tools and of the Computer Integrated Manufacturing (CIM) paradigm play an important role.

S. Nallusamy (2016) The word lean means that it is to generate more value for consumers with minimum resources. This has become the modern trend for management of products and services. Continuous improvement with or without capital infusion necessitates competitive manufacturing. Capacity addition is an important metric of a manufacturing facility to meet the ever-increasing customer demand. Lean Manufacturing (LM) is a technique to reduce the cost of product and to enhance the productivity by removing Non-value added (NVA) activities. In Toyota's production system, LM can be defined as a systematic approach to identify and eliminate NVA activities during continuous enhancement by manufacturing the goods at the tow of the customer in detection of precision. Lean techniques help the manufactures to decrease the lead time, to increase the consumer fulfillment and to diminish the waste. Value Stream Mapping (VSM) is a main tool to identify the opportunities for various lean techniques.

T. M. Shahada (2012) Lean and Six Sigma are two widely used business improvement processes that are adopted by companies to make improvements to their cost, quality and customer satisfaction. According to Lean and Six Sigma concepts have some similarities, as both are seeking improvement by minimizing waste and resources, while improving customer satisfaction and financial results. These two concepts when used alone both fail when a complete process improvement is considered, the Lean concept when used alone fails to bring the process under statistical control, and the Six Sigma concept fails to drastically improve process speed or reduce invested capital by itself.

Tushar K. Acharya (2011) Growth of Nations economy owes their success to their wealth creating sectors, of which manufacturing is a key sector. Looking at manufacturing industry the average investment is three times high then non-process (service) industry, while net value added per capital employed is almost half of non-process sector. Looking at current situation firms operating in market has to compete with the firm operating in same market. Firms develop strategies to increase their competitiveness. In order to gain competitive advantage, firms try to reduce their costs, as well as try to differentiate their service or products from their competitors. With the

publication of Book *“The Machine That Changed the World”* lean manufacturing practices have found acceptance in many industries. Lean manufacturing is one of the initiatives that many major businesses in the United States have been trying to adopt in order to remain competitive in an increasingly global market. The focus of the approach is on cost reduction by eliminating nonvalue added activities. The objective of this paper is to use a case-study approach to demonstrate how lean manufacturing tools when used properly, can help to eliminate waste, maintain better inventory, obtain better operational and financial control.

Vincent S. Palmer (2001) Kaizen, pronounced Ky Zen, is a Japanese philosophy that means continuous, incremental improvement. “Kai” translates as Change and “zen” translates as good or for the better. When applied to the work place, it means continual improvement that involves managers and works alike. At BAE SYSTEMS, we have adopted the Kaizen philosophy to help us to achieve our goal to become as “Lean” as possible. To become Lean is to eliminate waste (the Japanese term is Muda) from all areas of your business. There are seven types of Muda: waste from over producing, waste of time, waste from transporting, waste from over processing, waste from inventory, waste from motion, and waste from producing defects and rework.

CHAPTER 3

RESEARCH METHODOLOGY

Business research is a systematic enquiry that provides information to guide business decisions and aimed to solve managerial problems. Business research is of recent origin and is largely supported by business organizations that hope to achieve competitive advantages.

Research methodology is a way to systematically solve the research problems. It may be understood as a science of studying how research is done scientifically. It includes the overall design, the sampling procedure, data collection method and analysis procedure.

3.1 RESEARCH DESIGN

The research design stands for advance planning of the method to be adopted for collection of the relevant data and the techniques to be used in analysis, keeping the view the objectives of the research and availability of time.

In general, research design is the conceptual structure withing which research is conducted: it constitutes the blue print for the collection, measurement and analysis of data.

Descriptive research design is used for the purpose of this study. It includes, collection of Primary and Secondary data from the organization, its subsequent analysis and conclusive Interpretation. The study aims to establish a Cause-and-Effect relationship. It aims to study the influence of various factors on productivity. Value Stream Mapping (VSM) can be used to assess the gaps in the existing practices so that enhancements can be made to the Supply Chain.

3.2 SAMPLING TECHNIQUE

Sampling is the process of selecting the sufficient number of elements from the population (the items selected technically are called Sampling).

Random sampling technique was adopted to fit the study.

Random Sampling is a way of selecting a sample of observation from a population in order to make inferences about the population. For example, exit polls from voters that aim to predict the likely results of election.

3.3 SOURCES OF DATA

3.3.1 Primary Data

Data which is collected for the first time is called Primary Data. Well-structured Questionnaire has been prepared for collection of Primary Data. Most of the questions are multiple choices. The structured Questionnaire method was undertaken. Proper care was taken to frame the Questionnaire in such a manner, it should be easily understood in view of educational level of the employees.

3.3.2 Secondary Data

The Data is collected through physical observation of equipment, devices, material and people. The Data on the Machine specifications and its run-time are collected from the operator's log record.

3.4 STRUCTURE OF QUESTIONNAIRE

The structure of questionnaire consists of two parts.

Part A consists of profile of respondents and Part B consists of questions related to objectives.

3.5 SAMPLE SIZE

Sample Size means the number of sampling units selected from the population for investigation. It helps to achieve the objective of research. The sample size taken for the study is 112 and the population consists of 150 employees.

3.6 PERIOD OF STUDY

The study period is from December 2020- February 2021.

3.7 TOOLS AND METHODOLOGIES USED

Statistical Tools

- Percentage Analysis
- Correlation Analysis
- Chi-Square Analysis

Software Tools

- ERP System: Enterprise Resource planning
- Microsoft Excel
- SPSS: Statistical Package for the Social Sciences

Methodology for process Improvement

- Lean Management: Kaizen Technique

Kaizen is a Lean manufacturing tool that improves quality, productivity, safety, and workplace culture. Kaizen focuses on applying small, daily changes that result in major improvements over time. Kaizen first surfaced during the effort to rebuild Japan after World War II. At the time, several U.S. business consultants collaborated with Japanese companies to improve manufacturing.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

4.1 METHODOLOGY TO IMPROVE PRODUCTIVITY

Identify the work flow associated with manufacturing the product. This includes the people, processes and technology required for production as well as the resources, communication and procedures needed throughout the company. Value stream mapping helps business professionals assess, monitor and identify process improvement projects. Then project managers can prioritize and plan to implement new processes to fix the known problems. By reducing the product defect rates and eliminating processes that don't add value to the end product, we can improve the manufacturing productivity.

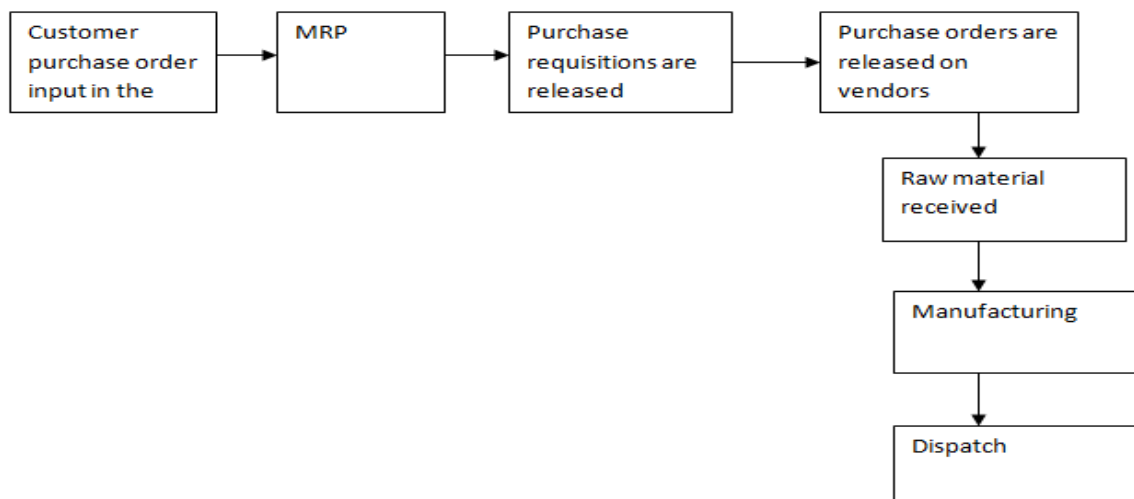
Tracking reports to analyze the financial and customer satisfaction data. Sharing the same comprehensive data with all project managers will develop manufacturing process, improvement plans, assign resources to complete the tasks, manage the budgets and determine if the projects met their goals. Establish criteria for standardizing project processes to ensure that all project managers systematically evaluate performance consistently and interpret changes appropriately. For example, if customer satisfaction falls below 50 percent for any product, trigger distribution of a survey to customers to solicit input on any problems that might be fixed by changing manufacturing processes to make them more productive.

Monitor information generated from process improvement projects and implement the improvement plans throughout all the manufacturing operations. We have to analyze the costs and benefits. Ensure all employees have access to the information and appropriate training on how to implement the procedures to improve the manufacturing productivity.

4.2 TRACK OF MATERIAL FLOW

SLB Industries maintains an ERP system to track the flow of the material and pass the information about design, spec and any special information to other departments. They follow "Make to Order" strategy, i.e., goods are manufactured when purchase order is received from customer.

Following is a broad flow chart of supply chain inside SLB Industries:



ERP System Once the sales department gets the customer purchase order, they verify if prices, payment terms, specification of the product are as per the prior agreement with the customer. Once the above details are analysed the data are entered in ERP system, which further becomes an input to production planning department as what is to be made and in what quantity. Based on this input, production planning department does the raw material planning.

Entering customer purchase order in ERP is a very critical process; since any wrong input at this stage will lead to erroneous information to production planning department, as a result huge raw material planning will happen in the department.

At the same time, due to wrong input in this process, right material will not be procured; hence, manufacturing will not be able to produce the finished product as a result dispatches will not happen which will further worsen the relationship with customer. To avoid this, universal automation systems have a well experienced employees to analyse the specification of the product and enter in the ERP.

MRP: Material Requirement Planning is done based on the Customer Purchase Order entered by sales department in ERP system. In this process, Bill of Material of the products for which planning is to be done is exploded to identify which raw material is required.

Net quantity of raw material to be procured is calculated after considering raw material (stock in hand + raw material quantity on order).

Release of Purchase Requisitions: Based on calculation during MRP, purchase requisitions are released by production planning department containing the details of part number, quantity to be procured and the dates at which a particular raw material is required in factory.

Release of Purchase Orders on Vendors: Based on the purchase requisitions released, procurement department sends RFQ (Request for Quotation) to the relevant vendors. The responses of RFQ are compiled and purchase orders are placed on vendors.

Raw Material Received in Factory: Though this process seems to be mundane, but it's an important process. It is at this point that the raw material is inspected for quality and observed whether it is meeting the desired specifications. If this process is not followed strictly, then inferior quality raw material will get in factory which will hamper the quality of finished product. Hence universal automation systems have a dedicated employee for inspecting the quality of the raw materials and provide acceptance. Also, they are responsible to provide storage for the raw material so that they can be accessed easily.

Manufacturing: Important thing is to manufacture the product as per the specifications but also important is to manufacture the product at the time when it is required. Hence, manufacturing needs a close coordination with production planning department to make sure that the product manufacturing date meets the date as per production plan. They also include a team of quality control members to inspect the produced products with the requirement.

Dispatch: After the goods are manufactured, they are inspected, packed and dispatched.

4.3 MATERIAL FLOW AND STORAGE

Material flow (MF) is the description of the transportation of raw materials, pre-fabricates, parts, components, integrated objects. The term applies mainly to advance modeling of Supply chain management.

Material Flow Management (MFM) is a method of efficiently managing materials. Material flow management is the goal oriented, efficient use of materials, material streams and energy. The goals are given by ecological and economical areas and by observing social aspects.

Material Flow Analysis (MFA) (or substance flow analysis; SFA) is a method of analyzing the flows of a material in a well-defined system. MFA is an important tool of industrial ecology, and is used to produce better understanding of the flow of materials through an industry and connected ecosystems, to calculate indicators, and to develop strategies for improving the material flow systems. Material Flow Analysis is the basis for a material flow management.

Material Flow Analysis can be divided into the following three types:

- On a national or regional scale (also referred to as Material Flow Accounting): In this type of studies the material exchanges between an economy and the natural environment are analyzed. Indicators are calculated in order to assess the level of resource intensity of the system.

- Corporate material flow analysis, or along an industrial supply chain involving a number of companies: The goal of material flow analysis within a company is to optimize the production processes in such a way that materials and energy are used in the most efficient manner (e.g. by recycling and reduction of waste). Companies that implement a material flow analysis can use the results to improve their operations costs and environmental performance.
- In the life cycle of a product: This is another term for the life cycle inventory step of life cycle assessment.

Existing Material Storage

- In the existing storage the metal sheets, plastics are not stored properly. The different types of metal sheets, plastics are stored at the same place and they are not well classified.
- Large amount of metal sheets (without priority) is stored in front of the storage and currently used metal sheets for production are stored at the back side.
- Metal sheets which are been cut are stored near the heat-sealing machine. But the heat-sealing machine has no work with the processed metal sheets as it deals with sealing / riveting two plastics parts together.
- All types of metal sheets are stored at the same rack that too one over the other. This will cause heavy work to the worker to load and unload and also time loss.
- Defective metal automobile door handles are stored near riveting machine in large number.
- The metal sheets and the produced automotive products are stored higher than the level of the rack.
- Round shape rack is used which is so weak and broke easily.

Improved Material Storage

- In the improved storage layout separate places are allotted for the metal sheets and plastics raw materials and well classified.

- The old metal sheets types (without priority) are stored at back side of the storage and currently used metal sheet types stored in front. This will make the work easier.
- The gang way is made clear from tube storage.
- The end loops are made to store near the thermal riveting machine and LCD bracket twisting machine. This will reduce travelling distance of the metal sheets.
- The metal sheets are arranged to store at the same level by storing the bend ends at the opposite sides.
- The defective metal door handles are cleared from the work center and store separately.
- The metal sheets and finished products have to be stored within level of rack.

Existing Material Flow

- The metal sheets after the cutting process stored in the same place which cause negative flow.
- The tubes after end cleaning are stored beyond the glue dispensing machine. It is also negative flow.
- Beyond the glue dispensing machine. The cleaning and storage places gets inter changed. It causes negative flow.
- The input for glue dispensing machine should not cross the machine.
- The input for riveting machine and LCD bracket twisting machine should cross glue dispensing machine.

Flow chart for glue dispensing machine:

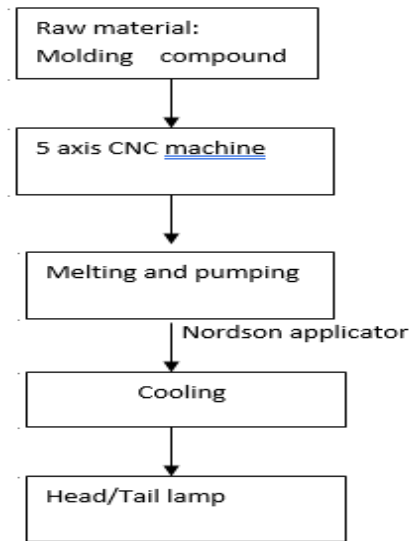


Chart 4.4.1-Chart showing Material flow of Glue Dispensing Machine

Flow chart for LCD bracket twisting machine:

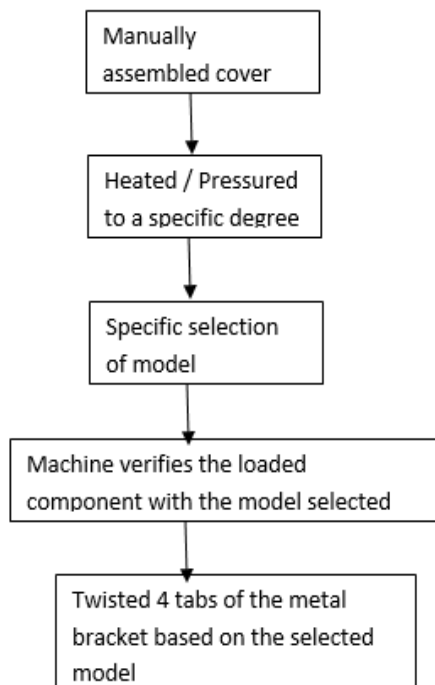


Chart 4.4.2-Chart showing Material Flow of LCD Bracket Twisting machine

Flow chart for riveting machine:

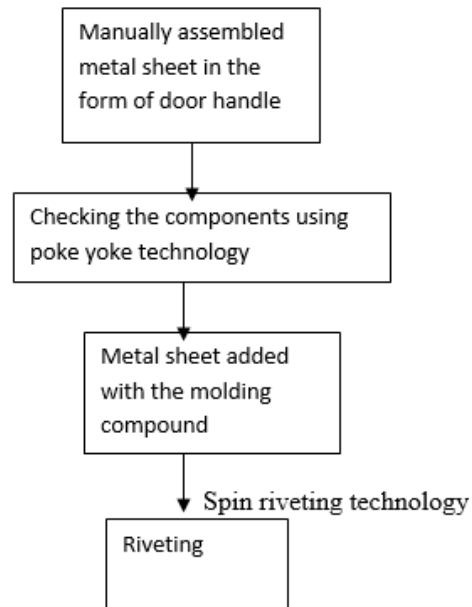


Chart 4.4.3-Chart showing Material Flow of Riveting Machine

Improved Material Flow

- The storage area for metal sheets before and after cutting are separated, thus negative flow is reducing.
- The input for glue dispensing machine after end cleaning is stored before the machine, thus negative flow is reduced.
- The glue dispensing machine and riveting, LCD bracket twisting machine are interchanged to reduce negative flow.

End Cleaning – Removed

- In the plant there is a separate area is allotted for the end cleaning of the products. If this work is done in the cutting machine itself the area for the end cleaning will get free. As the cutting machine has the facility of cleaning the ends of metal form dust and rust.
- This will result in providing a little freer area for storage of raw materials.

4.4 MATERIALS HANDLING EQUIPMENT

4.4.1 Moving, Handling, And Storing Materials

When manually moving materials, employees should seek help when a load is so bulky it cannot be properly grasped or lifted, when they cannot see around or over it, or when a load cannot be safely handled. When an employee is placing blocks under raised loads, the employee should ensure that the load is not released until his or her hands are clearly removed from the load. Metal sheets and lathe machines will be large and strong enough to support the load safely.

Handles and holders should be attached to loads to reduce the chances of getting fingers pinched or smashed. Workers also should use appropriate protective equipment. For loads with sharp or rough edges, wear gloves or other hand and forearm protection. To avoid injuries to the hands and eyes, use gloves and eye protection. When the loads are heavy or bulky, the mover should also wear steel-toed safety shoes or boots to prevent foot injuries if the worker slips or accidentally drops a load.

When mechanically moving materials, avoid overloading the equipment by letting the weight, size, and shape of the material being moved dictate the type of equipment used for transporting it. All materials handling equipment has rated capacities that determine the maximum weight the equipment can safely handle and the conditions under which it can handle those weights. The equipment-rated capacities must be displayed on each piece of equipment and must not be exceeded except for load testing. When picking up items with a powered industrial truck, the load must be centered on the forks and as close to the mast as possible to minimize the potential for the truck tipping or the load is falling. A lift truck must never be overloaded because it would be hard to control and could easily tip over. Extra weight must not be placed on the rear of a counterbalanced forklift to offset an overload. The load must be at the lowest position for traveling, and the truck manufacturer's operational requirements must be followed. All stacked loads must be correctly piled and cross-tiered, where possible.

Stored materials must not create a hazard. Storage areas must be kept free from accumulated materials that may cause tripping, fires, or explosions, or that may contribute to the harboring of rats and other pests. When stacking and piling materials, it is important to be aware of such factors as the materials' height and weight, how accessible the stored materials are to the user, and the condition of the containers maintained.

4.4.2 Using Materials Handling Equipment

To reduce potential accidents associated with workplace equipment, employees need to be trained in the proper use and limitations of the equipment they operate. This includes knowing how to effectively use equipment such as conveyors, cranes, and slings.

Conveyors

While using conveyors, workers' hands may be caught in nip points where the conveyor runs over support members or rollers; workers may be struck by material falling off the conveyor; or they may become caught on or in the conveyor, thereby being stable. To reduce the severity of an injury, an emergency button or pull cord designed to stop the conveyor must be installed at the employee's work station. Continuously accessible conveyor belts should have an emergency stop cable that extends the entire length of the conveyor belt so that the cable can be accessed from any location along the belt. The emergency stop switch must be designed to be reset before the conveyor can be restarted. Before restarting a conveyor that has stopped due to an overload, appropriate personnel must inspect the conveyor and clear the stoppage before restarting. Employees must never ride on a material handling conveyor. Where a conveyor passes over work areas or aisles, guards must be provided to keep employees from being struck by falling material. If the crossover is low enough for workers to run into, it must be guarded to protect employees and either marked with a warning sign or painted a bright color.

Screw conveyors must be completely covered except at loading and discharging points.

At those points, guards must protect employees against contacting the moving screw; the guards are movable, and they must be interlocked to prevent conveyor from moving.

Piston Transfer Conveyor:



Chart 4.4.2.1- Chart showing Piston Transfer Conveyor

This conveyor is used for transferring the pistons between machining centers. This conveyor is employed to introduce single piece flow concept and to eliminate the in-process inventory. Safety sensors are provided at the delivery end of the conveyor to stop the conveyor when the piston reaches the delivery end but not picked up by the operator. The conveyor resumes movement once the piston is picked up by the operator.

Inner Tube Conveyor:



Chart 4.4.2.2- Chart showing Inner Tube Conveyor

This conveyor is used for transporting inner tube of front fork assembly of 2 wheelers, between grinding machines in the centerless grinding line. The components are conveyed using round belts. The conveyor has the provision to adjust the height of the belt level to match with the grinding machine center when there is a change in the diameter of the tube to be ground. The machine also has another adjustment to match with the grinding machine center to accommodate the grinding wheel wear.

Cranes

Cranes are operated by thoroughly trained and competent persons. Operators should know what they are lifting and what it weighs. The rated capacity of mobile cranes varies with the length of the boom and the boom radius. When a crane has a telescoping boom, a load may be safe to lift at a short boom length and/or a short boom radius, but may overload the crane when the boom is extended and the radius increases.

All movable cranes must be equipped with a boom angle indicator; those cranes with telescoping booms must be equipped with some means to determine the boom length, unless the load rating is independent of the boom length. Load rating charts must be posted in the cab of cab-operated cranes. All mobile cranes do not have uniform capacities for the same boom length and radius in all directions around the chassis. Always check the crane's load chart to ensure that the crane is not going to be overloaded for the conditions under which it will operate. Plan lifts before starting them to ensure that they are safe. Take additional precautions and exercise extra care when operating.

Some mobile cranes cannot operate with outriggers in the traveling position. When used, the outriggers must rest on firm ground, on timbers, or be sufficiently cribbed to spread the weight of the crane and the load over a large enough area. This will prevent the crane from tipping during use. Loads should be attached to the load hook by slings, fixtures, or other devices that have the capacity to support the load on the hook. Sharp edges of loads should be padded to prevent cutting slings. Proper sling angles shall be maintained so that slings are not loaded in excess of their capacity.

All cranes must be inspected frequently by persons thoroughly familiar with the crane,

the methods of inspecting the crane, and what can make the crane unserviceable. Crane activity, the severity of use, and environmental conditions should determine inspection schedules. Critical parts, such as crane operating mechanisms, hooks, air or hydraulic system components and other load-carrying components, should be inspected daily for any maladjustment, deterioration, leakage, deformation, or other damage.

Slings



Chart 4.4.2.3: Chart showing webbing sling

While working with slings, employers must ensure that they are visually inspected before use and during operation, especially if used under heavy stress. Riggers or other knowledgeable employees should conduct or assist in the inspection because they are aware of how the sling is used and what makes a sling unserviceable.

The various types of slings are:

- Web Slings
- Round Slings
- Wire Rope Slings
- Chain Slings
- Mesh Slings

4.4.3 Analysis of Questionnaire Data:

Table 4.4.3.1

Table showing Age wise classification of respondents

Age	No. of Respondents	Percentage
21-30	37	33.03
31-40	40	35.71
41-50	33	29.46
51-58	2	1.78
Total	112	100

Source: Primary Data

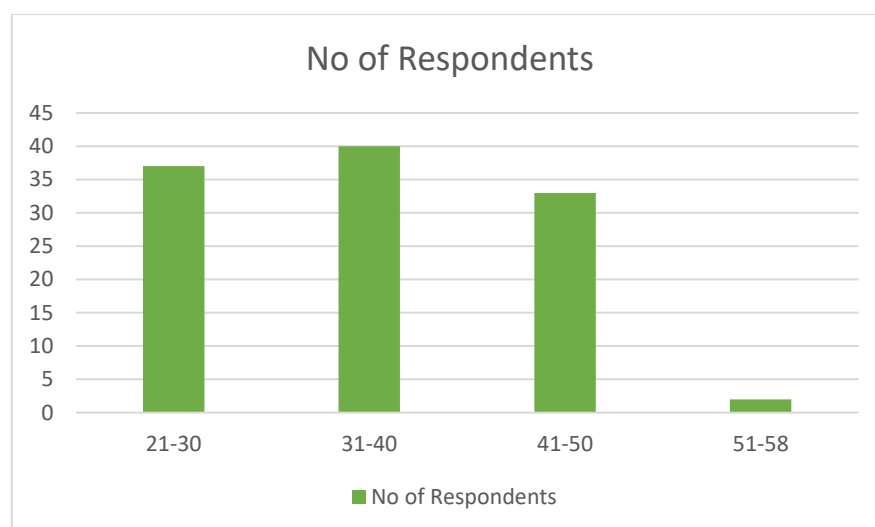


Chart 4.4.3.1- Chart showing Age wise classification of respondents

Interpretation

The Table 4.4.3.1 shows that, the majority of the employees fall under the age group of 21-30 and 31-40 which account to 33% and 36% respectively. There is about 30% of employees under the age group 41-50 and only 1.78% in the range 51-58.

Inference

The majority of the respondents belong to the age group 31-40 with 36%.

Table 4.4.3.2

Table showing Types of equipment required

Types of Equipment	No. of Respondents	Percentage
Transport equipment	35	31.25
Storage equipment	42	37.50
Unit storage	21	18.75
Positioning	10	8.92
Others	4	3.57
Total	112	100

Source: Primary Data

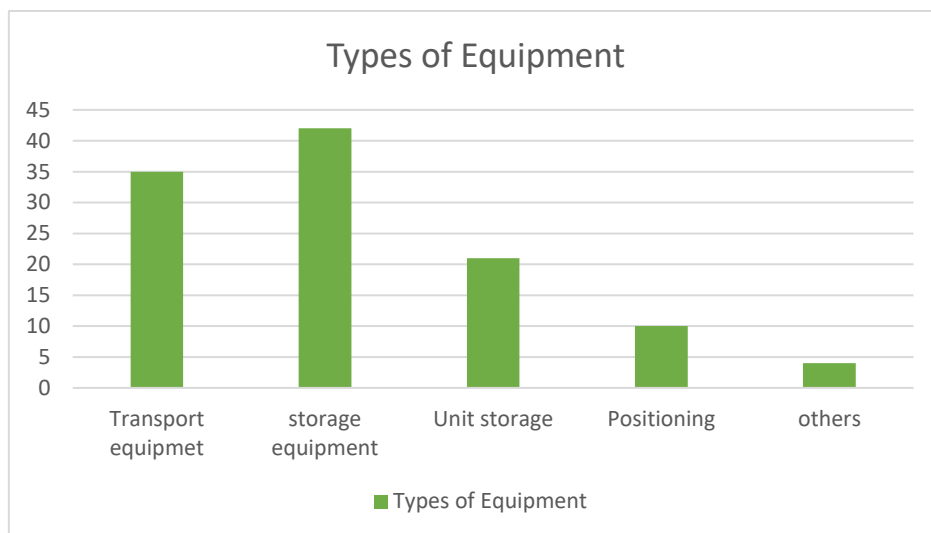


Chart 4.4.3.2- Chart showing Types of equipment required

Interpretation

Table 4.4.3.2 shows that, Transport, Storage, Unit storage, Positioning and Other equipment are preferred, 31.2%, 35.7%, 18.7%, 8.9% and 3.5% respectively.

Inference

The majority of the respondents preferred Storage equipment with 35.7%.

Table 4.4.3.3

Table showing Frequency of accident occurrence

Frequency of problem	No. of Respondents	Percentage
Once in more than a year	13	11.60
Once in a year	37	33.03
Once in 6 months	54	48.21
Once in a month	7	6.25
Once in less than a month	1	0.89
Total	112	100

Source: Primary Data

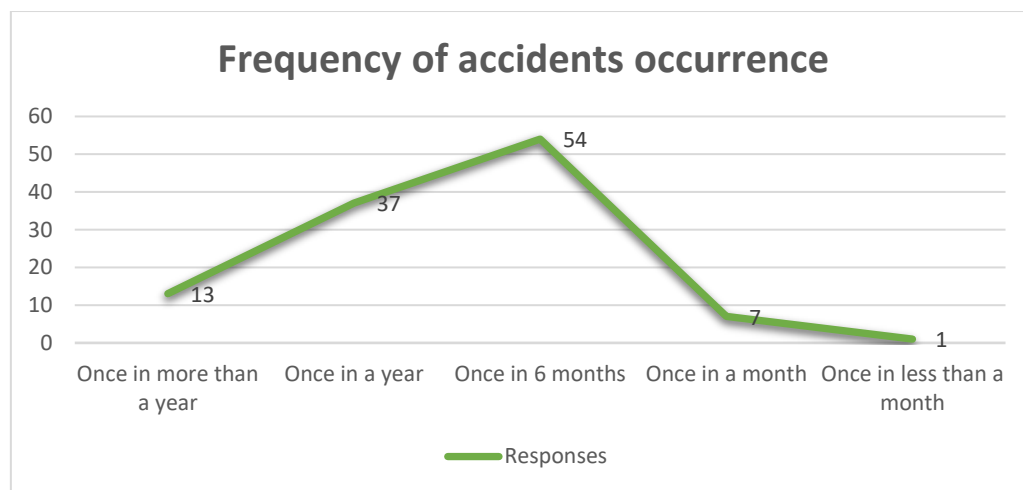


Chart 4.4.3.3- Chart showing Frequency of accident occurrence

Interpretation

Table 4.4.3.3 shows that, 11.6%, 33%, 48.2%, 6.25% and 0.89% have opted that, the accidents have occurred once in more than a year, once in a year, once in 6 months, once in a month and once in less than a month respectively.

Inference

The chart shows that, most of the accidents have happened in an interval between 6 months and one year according to the employees.

Table 4.4.3.4

Table showing Severity of Accidents

Severity of accidents	No. of Respondents	Percentage
No injury	12	10.71
Minor Injury, Cut or Scratch	23	20.53
Injuries, superficial scratches, cuts or bruises	63	56.25
Near miss major injury to self and others	14	12.50
Severe injury to self, others and property damage	0	0
Total	112	100

Source: Primary Data

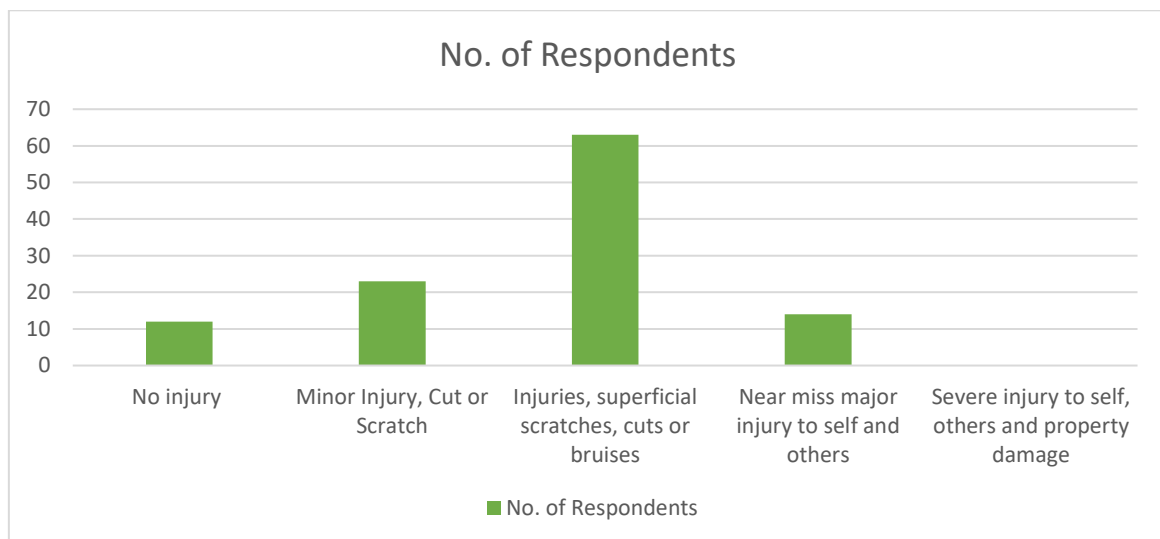


Chart 4.4.3.4 – Chart showing Severity of Accidents

Interpretation

Table 4.4.3.4 shows that, 10.7%, 20.5%, 56.2%, 12.5% respondents recorded, very low, low, moderate and high severity of accidents.

Inference

Majority of the respondents have recorded the injuries to be superficial scratches, cuts or bruises constituting 56.2%.

Table 4.4.3.5

Table showing Satisfaction of equipment handling

Satisfaction level	No. of Respondents	Percentage
Highly Satisfied	13	11.6
Satisfied	39	34.82
Neutral	57	50.89
Dissatisfied	3	2.67
Highly Dissatisfied	0	0
Total	112	100

Source: Primary Data

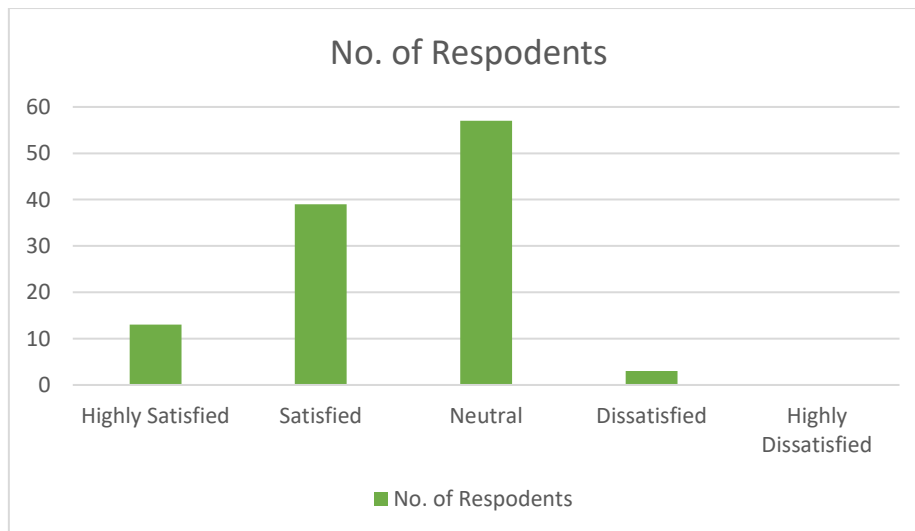


Chart 4.4.3.5- Chart showing Satisfaction of equipment handling

Interpretation

Table 4.4.3.5 shows that, 11.6%, 34.8%, 50.8% and 2.6% of the respondents are highly satisfied, satisfied, neutral and dissatisfied respectively with the current equipment handling.

Inference

Majority of the respondents (50.89%) have neutral views about it.

Table 4.4.3.6

Table showing Inclination to adapt

Inclination to adapt	No. of Respondents	Percentage
Strongly agree	23	20.50%
Agree	50	44.64%
Neutral	7	6.25%
Disagree	32	28.57%
Strongly disagree	0	0%
Total	112	100

Source: Primary Data

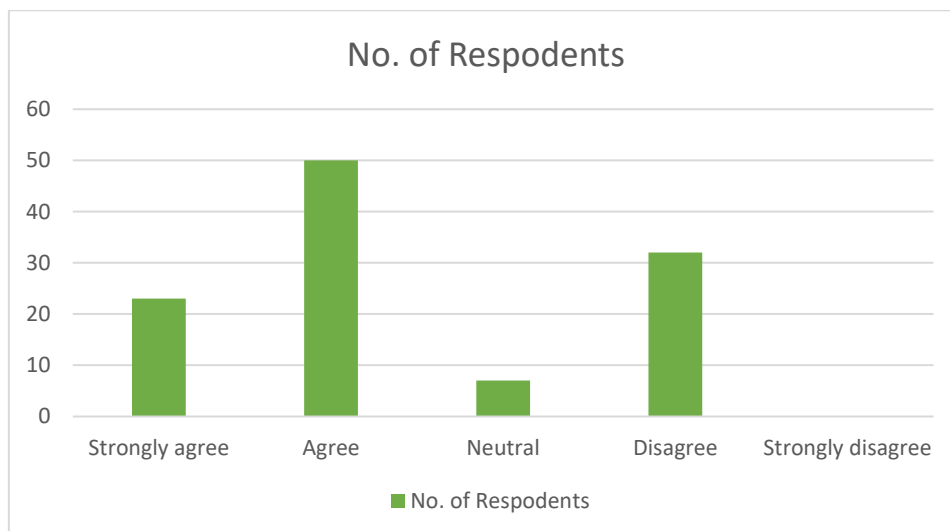


Chart 4.4.3.6-Chart showing Inclination to adapt

Interpretation

Table 4.4.3.6 shows that, 20.5%, 44.6%, 6.25% and 28.5% strongly agreed, agreed, were neutral and disagreed respectively to adapt to new technology.

Inference

Majority of the respondents (44.6%) agreed to adapt to advanced technology.

Table 4.4.3.7

Table showing Protective equipment required

Protective Equipment	No. of Respondents	Percentage
Eye and face protection	30	26.78
Hand protection	22	16.64
Body Protection	17	15.17
Respiratory protection	7	6.25
Hearing protection	36	32.14
Total	112	100

Source: Primary Data

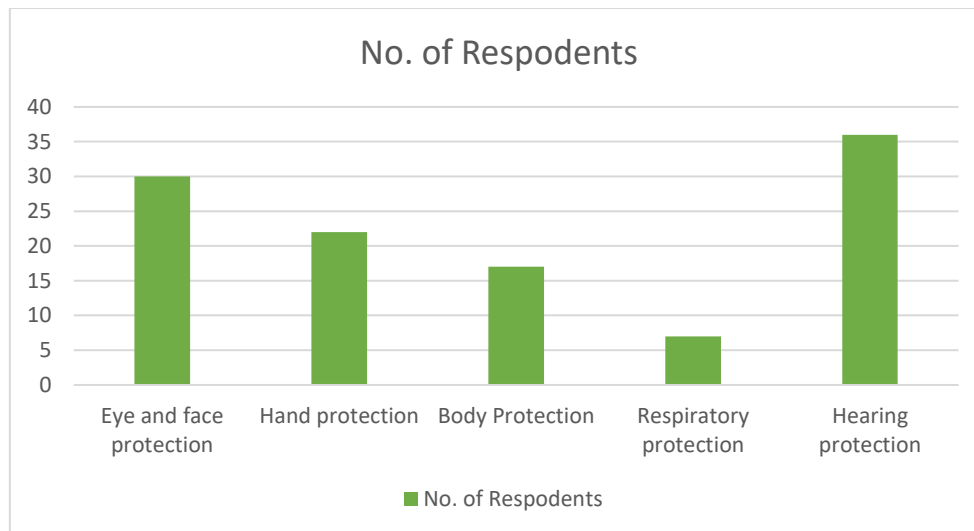


Chart 4.4.3.7- Chart showing Protective equipment required

Interpretation

Table 4.4.3.7 shows that, 27%, 17%, 15%, 6% and 32% responded they wanted eye and face protection, hand protection, body protection, respiratory protection and hearing protection respectively.

Inference

Majority of the employees opted to use Hearing Protection equipment which accounted to nearly 32%.

Table 4.4.3.8

Table showing Frequency of Training provided

Frequency of Training	No. of Respondents	Percentage
More than one year	51	45.53
1 year	22	19.64
6 months	23	20.53
3 months	15	13.39
1 month	0	0
Total	112	100

Source: Primary Data

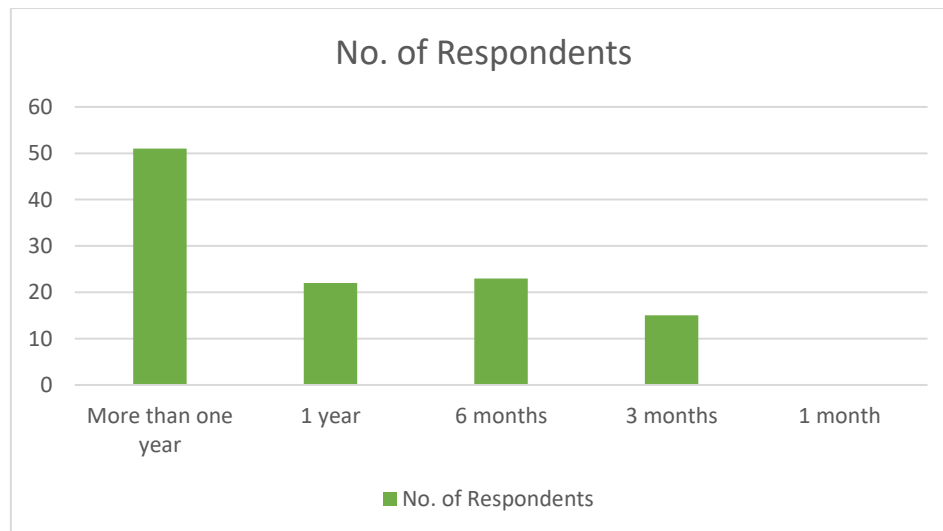


Chart 4.4.3.8- Chart showing Frequency of Training provided

Interpretation

Table 4.4.3.8 shows 45.5%, 19.6%, 20.5% and 13.3% respondent's record that, training has been provided once in more than a year, once in a year, once in 6 months and once in 3 months respectively.

Inference

Majority of the respondents have recorded that, training has been provided once in more than a year which is, 45.5%.

Table 4.4.3.9

Table showing Labelling of dangerous goods

Level of agreement on labelling	No. of Respondents	Percentage
Strongly Agree	13	11.60%
Agree	64	57.14%
Neutral	34	30.35%
Disagree	1	0.89%
Strongly Disagree	0	0%
Total	112	100

Source: Primary Data

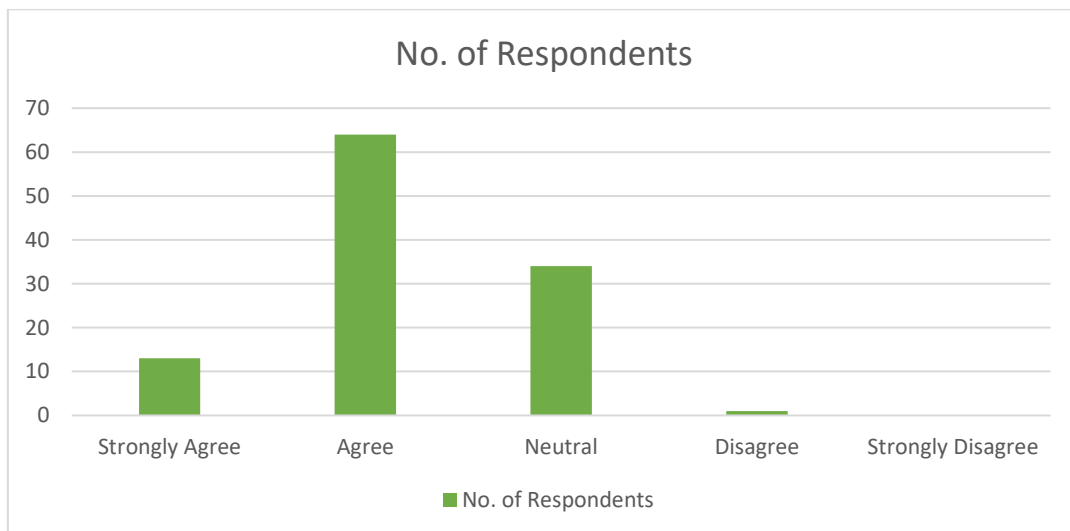


Chart 4.4.3.9-Chart showing Labelling of dangerous goods

Interpretation

Table 4.4.3.9 shows that, 11.6%, 57%, 30.3% and 0.89 strongly agreed, agreed, were neutral and disagreed for the labelling of dangerous goods.

Inference

Majority of the respondents agreed that, the dangerous goods were rightly labelled.

Table 4.4.3.10

Table showing Overall Rating of Equipment Handling

Overall rating of equipment handling	No. of Respondents	Percentage
Fair	25	22.32%
Good	60	53.57%
Very good	16	14.28%
Excellent	9	8.03%
Poor	1	0.89%
Total	112	100

Source: Primary Data



Chart 4.4.3.10- Chart showing Overall Rating of Equipment Handling

Interpretation

Table 4.4.3.10 shows that, 22.3%, 53.5%, 14%, 8% and 0.89% felt the overall equipment handling was fair, good, very good, excellent and poor respectively

Inference

Majority of the respondents (53.57%) have recorded that, the overall equipment handling is good.

4.4.4 Chi-Square analysis for preference of equipment used

H_0 (Null Hypothesis): There is no difference in the proportion of employees preferring different material handling equipment.

H_1 (Alternative Hypothesis): There is significant difference in the proportion of employees preferring different material handling equipment.

Table 4.4.4.1- Table showing Observed and expected frequencies

Equipment	Observed Frequency	Expected Frequency
Transport Equipment	35	22.4
Positioning Equipment	10	22.4
Unit load Information equipment	21	22.4
Storage equipment	42	22.4
Others	4	22.4
Total	112	112

Table 4.4.4.2- Table showing One sample Chi-square Test Summary

Total N (No. of Respondents)	112
Test Statistic	46.304 ^a
Degree of freedom	4
Asymptotic Significance	<0.001
a. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 22.400.	

Inference: The P-value is less than 0.001 which is much lesser than 0.05. Therefore H_0 (Null Hypothesis) is rejected and H_1 (Alternative Hypothesis) is accepted.

Result: There is significant difference in the proportion of employees preferring different material handling equipment.

4.4.5 Correlation Analysis

- Correlation between the severity of accidents encountered and the dissatisfaction level of Equipment handling systems at the organization:

Table 4.4.5.1- Table showing Severity & Dissatisfaction Correlation Analysis

Spearman's Rho			Severity	Dissatisfaction
	Severity	Correlation Coefficient	1.000	0.443**
		Significance (2-Tailed)	-	<0.001
		Total No of Respondents	112	112
	Satisfaction	Correlation Coefficient	0.443**	1.000
		Significance (2-Tailed)	<0.001	-
		Total No of Respondents	112	112
	** Correlation is significant at the 0.01 level (2-tailed)			

Inference: The Spearman's Correlation Coefficient is 0.443, which is a linear positive moderate correlation with a significance level of 0.01.

Result: The severity of accidents and dissatisfaction level of equipment handling are positively correlated, i.e., The more severe the accidents, the higher the dissatisfaction.

- Relationship between ease of reaching for the controls of the equipment and comfort of working with that equipment.

Table 4.4.5.2- Table showing Controls & Comfort Correlation Analysis

Spearman's Rho			Severity	Dissatisfaction
	Severity	Correlation Coefficient	1.000	0.402**
		Significance (2-Tailed)	-	<0.001
		Total No of Respondents	112	112
	Satisfaction	Correlation Coefficient	0.402**	1.000
		Significance (2-Tailed)	<0.001	-
		Total No of Respondents	112	112
	** Correlation is significant at the 0.01 level (2-tailed)			

Inference: The Spearman's Correlation Coefficient is 0.402, which is a linear positive moderate correlation with a significance level of 0.01.

Result: The ease of reaching for the controls and comfort of working with equipment are moderately positively correlated. The more the ease, the more the comfort.

4.4.6 Resistance to adapt to New Technology

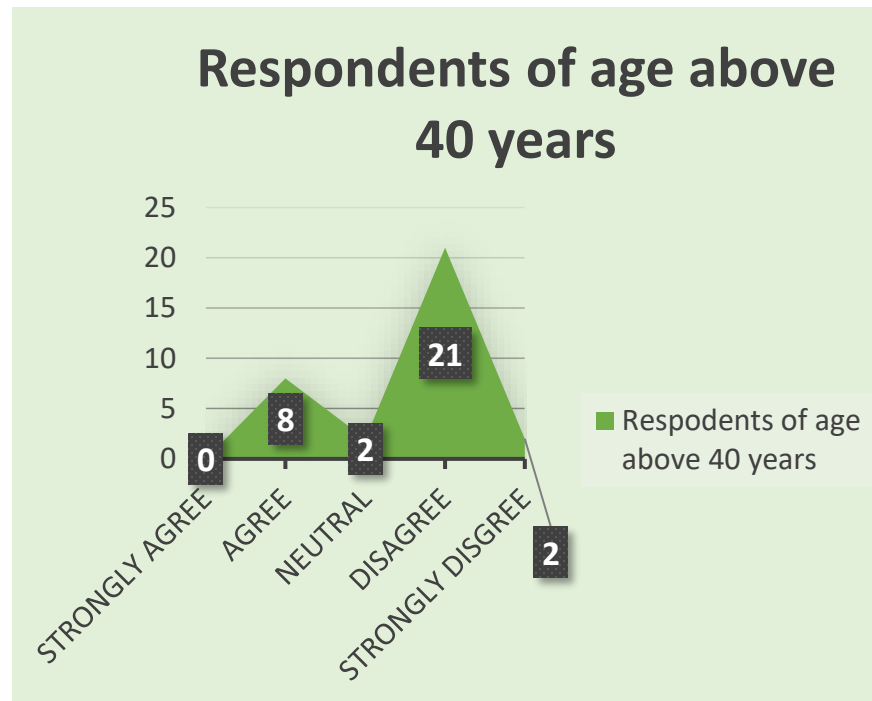


Chart 4.4.6.1- Chart showing Respondents of age above 40

Respondents above the age of 40 years show **resistance** to adapt to new and advanced equipment handling technology which has to be tackled by the management.

Overcome Resistance and Effectively Implement Change:

- Create personal rapport
- Ask open-ended questions
- Occupy less than 25% of the air time
- Establish and communicate the expectations
- Realize you are dealing with resistance
- Explain the change from the Target's Frame of Reference
- After the "why's" are agreed on, focus on "what we can do to work it out"
- Identify non-supporters and involve them in key roles
- Create "win-win" situations

4.5 COMPARISON OF OVERALL EQUIPMENT EFFECTIVENESS (OEE) AND TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP) BEFORE AND AFTER MAKING IMPROVEMENT, AS A METRIC FOR PRODUCTIVITY.

4.5.1 Overall Equipment Effectiveness (OEE)

Overall equipment effectiveness is a performance metric compiled from three data sources of the machine (or Process) being measured. The three data sources are Availability, Performance and Quality.

Availability Definition for calculating OEE Metric:

Availability is defined as the ratio between the available time (uptime) and the scheduled production time. An Availability of 80% implies that the equipment/process was actively producing product for 80% of the scheduled production time and for the remaining for 20% of scheduled production time the equipment/process was not available to produce (i.e., downtime losses).

$$\text{Availability \%} = \text{Uptime} / \text{Scheduled Production Time \%}$$

Performance Definition for calculating OEE Metric:

Performance is defined as the ratio between the theoretical production time for the total product produced during available time (uptime) and the available time (uptime). A Performance of 90% implies a Speed Loss of 10% (e.g. due to equipment speed being turned down, gaps in product feeding to equipment/process).

$$\text{Performance \%} = \text{Theoretical production time for throughput} / \text{Available time \%}$$

Quality Definition for calculating OEE Metric:

Quality is defined as the ratio between the good units produced and the throughput. A Quality score of 95% implies a Yield Loss of 5% due to scrapping and/or reworking of product (this reworking consumes capacity in the equipment/process).

Quality % = Good units produces / throughput %

OEE takes into account all three OEE Factors, and is calculated as:

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$$

Overall equipment effectiveness is a hierarchy of metrics which evaluates and indicates how effectively a manufacturing operation is utilized. The results are stated in a generic form which allows comparison between manufacturing units in differing industries. It is not however an absolute measure and is best used to identify scope for process performance improvement, and how to get the improvement. If for example the cycle time is reduced, the OEE can also reduce, even though more products are produced for less resource. Another example is if one enterprise serves a high volume, low variety market, and another enterprise serves a low volume, high variety market. More changeovers (set-ups) will lower the OEE in comparison, but if the product is sold at a premium, there could be more margins with a lower OEE.

OEE measurement is also commonly used as a key performance indicator (KPI) in conjunction with lean manufacturing efforts to provide an indicator of success.

OEE can be best illustrated by a brief discussion of the six metrics that comprise the system. The hierarchy consists of two top-level measures and four underlying measures.

Overall equipment effectiveness (OEE) and total effective equipment performance (TEEP) are two closely related measurements that report the overall utilization of facilities, time and material for manufacturing operations. These top view metrics directly indicate the gap between actual and ideal performance.

- Overall equipment effectiveness quantifies how well a manufacturing unit performs relative to its designed capacity, during the periods when it is scheduled to run.
- Total effective equipment performance (TEEP) measures OEE against calendar hours, i.e.: 24 hours per day, 365 days per year.

4.5.2 Total Effective Equipment Performance

Where OEE measures effectiveness based on scheduled hours, TEEP measures effectiveness against calendar hours, i.e.: 24 hours per day, 365 days per year.

TEEP, therefore, reports the 'bottom line' utilization of assets.

Calculation: $TEEP = \text{Loading} \times OEE$

It can be stated in another way, TEEP adds a fourth metric 'Loading', Therefore,

$$TEEP = \text{Loading} \times \text{Availability} \times \text{Performance} \times \text{Quality}$$

Loading: The Loading portion of the TEEP Metric represents the percentage of time that an operation is scheduled to operate compared to the total Calendar Time that is available. The Loading Metric is a pure measurement of Schedule Effectiveness and is designed to exclude the effects how well that operation may perform.

Calculation: $\text{Loading} = \text{Scheduled Time} / \text{Calendar Time}$

4.5.3 Analyses

Glue Dispensing Machine:

A given Work Centre is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given May Month, the Total Calendar Time is 31 Days at 24 Hours.

$\text{Scheduled Time} = (27\text{days} \times 24 \text{ hours}) + (4\text{days} \times 12 \text{ hours}) = 696 \text{ hours}$

$\text{Calendar Time} = (31 \text{ days} \times 24 \text{ hours}) = 744 \text{ hours}$

$\text{Loading} = \text{Scheduled Time} / \text{Calendar Time}$

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

A given Work Centre is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

The Work Centre experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = Available Time / Scheduled Time

Availability = 82.44%

A given Work Centre is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the part being produced is 30 Units/Hour or 2 Minutes/Unit

The Work Centre produces 141 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 141 Units x 2 Minutes/Unit = 282 Minutes

Performance = 282 Minutes / 540 Minutes = 0.5222 x 100 = 52.22%

Performance = (Parts Produced * Ideal Cycle Time) / Available Time

Performance = 52.22%

A given Work Centre produces 140 Good Units during a shift.

141 Units were started in order to produce the 140 Good Units.

Quality = 140 Good Units / 141 Units Started = 99.29%

Quality = Good Units / Units Started

Quality = 99.29%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

In the glue dispensing machine:

Availability of 82.44%

Performance is 52.22%.

Quality is 99.29%.

OEE = 82.44% Availability x 52.22% Performance x 99.29% Quality = 42.74%

OEE = 42.74%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

In the glue dispensing machine:

OEE of 42.74%

Glue dispensing machine loading is 93.54%

TEEP = 93.54% Loading x 42.74% OEE = 39.97%

TEEP = 39.97%

Heat Sealing Machine:

Heat sealing machine department is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given May Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = Scheduled Time / Calendar Time

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

Heat sealing machine department is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the department is expected to be down.

The Work Centre experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = Available Time / Scheduled Time

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

Heat sealing machine department is scheduled to run for an 12 hour (720 minute) shift with a 65 minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the plastic body being produced is 30 Units/Hour or 2 Minutes/Unit

The Work Centre produces 180 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 180 Units x 2 Minutes/Unit = 360 Minutes

Performance = (Parts Produced * Ideal Cycle Time) / Available Time

Performance = 360 Minutes / 540 Minutes = 0.6666 x 100 = 66.66%

Performance = 66.66%

A given Work Centre produces 179 Good Units during a shift.

180 Units were started in order to produce the 179 Good Units.

Quality = Good Units / Units Started

Quality = 179 Good Units / 180 Units Started = 99.44%

Quality = 99.44%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

The heat-sealing machine department involves:

Availability of 82.44%

Performance of 66.66%.

Quality of 99.44%.

OEE = 82.44% Availability x 66.66% Performance x 99.44% Quality = 54.64%

OEE = 54.64%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

The heat-sealing machine department involves:

OEE of 54.64%

Work Centre loading is 93.54%

TEEP = 93.54% Loading x 54.64% OEE = 51.11%

TEEP = 51.11%

Lcd Bracket Twisting Machine:

LCD bracket twisting machine is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = Scheduled Time / Calendar Time

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

LCD bracket twisting machine is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

The department experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = Available Time / Scheduled Time

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

A given Work Centre is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the brackets being produced is 30 Units/Hour or 2 Minutes/Unit

The Work Centre produces 165 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 165 Units x 2 Minutes/Unit = 330 Minutes

Performance = (Parts Produced * Ideal Cycle Time) / Available Time

Performance = 330 Minutes / 540 Minutes = 0.6111 x 100 = 61.11%

Performance = 61.11%

Work Centre produces 164 Good Units during a shift.

165 Units were started in order to produce the 164 Good Units.

Quality = Good Units / Units Started

Quality = 164 Good Units / 165 Units Started = 99.39%

Quality = 99.39%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

LCD bracket twisting machine centre involves:

Availability of 82.44%

Performance of 61.11%.

Quality of 99.39%.

OEE = 82.44% Availability x 61.11% Performance x 99.39% Quality = 50.07%

OEE = 50.07%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

LCD bracket twisting machine centre involves:

OEE of 50.07%

Work Centre loading is 93.54%

TEEP = 93.54% Loading x 50.07% OEE = 46.83%

TEEP = 46.83%

Riveting Machine:

Riveting machine is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = Scheduled Time / Calendar Time

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

A given Work Centre is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

The Work Centre experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = Available Time / Scheduled Time

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

Riveting machine centre is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the door handles being produced is 24 Units/Hour or 2.5 Minutes/Unit

Riveting machine centre produces 115 Total Units during the shift.

Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 115 Units x 2.5 Minutes/Unit = 287.5 Minutes $\approx$ 288

Performance = (Parts Produced * Ideal Cycle Time) / Available Time

Performance = 288 Minutes / 540 Minutes = 0.5333 x 100 = 53.33%

Performance = 53.33%

Riveting machine centre produces 114 Good Units during a shift.

115 Units were started in order to produce the 114 Good Units.

Quality = Good Units / Units Started

Quality = 114 Good Units / 115 Units Started = 99.13%

Quality = 99.13%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

Riveting machine centre involves:

Availability of 82.44%

Performance of 53.33%.

Quality of 99.13%.

OEE = 82.44% Availability x 53.33% Performance x 99.13% Quality = 43.52%

OEE = 43.52%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

Riveting machine centre involves:

OEE of 43.52%

Riveting machine centre loading is 93.54%

TEEP = 93.54% Loading x 43.52% OEE = 40.72%

TEEP = 40.72%

Improving OEE

- Implementing kaizen technique in SLB Industries we can improve the OEE.
- Through kaizen technique all employees can clean their workplace which will reduce the material wastage, ensure proper material flow and storage.
- Kaizen technique will evaluate the existing work flow and implement a strategy for continuous improvement of the production within the company.
- Evaluating and finding OEE is to drive system improvement.
- With continuous improvement and monitoring, both OEE and TEEP can be enhanced.
- If OEE significantly increases and TEEP remains the same, it will be evident that, the machineries have to be efficiently used to its fullest capacity by increasing the shift timings.

Table 4.5.3.1: Table showing Glue Dispensing M/C – Existing Vs Improved Data

	EXISTING OEE DATA		IMPROVED OEE DATA	
Shift duration	8 hours	12 (8+4 OT) hrs	8 hours	12 (8+4 OT) hrs
Jobs (units)	Head / Tail lamp units = 95	Head / Tail lamp units = 141	Head / Tail lamp units = 110	Head / Tail lamp units = 165
Working members	3		3	
Defective units	1	1	2	2

Glue Dispensing Work Center:

Glue dispensing machine is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

Glue dispensing machine is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

Glue dispensing machine experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

Glue dispensing machine is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the head/tail lamp being produced is 30 Units/Hour or 2 Minutes/Unit

The Work Centre produces 165 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 165 Units x 2 Minutes/Unit = 330 Minutes

Performance = 330 Minutes / 540 Minutes = 0.612 x 100 = 61.2%

Performance = 61.2%

A given Work Centre produces 163 Good Units during a shift.

165 Units were started in order to produce the 163 Good Units.

Quality = 163 Good Units / 165 Units Started = 98.78%

Quality = 98.78%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

Glue dispensing machine centre involves:

Availability of 82.44%

Performance is 61.2%.

Quality of 98.78%.

OEE = 82.44% Availability x 61.2% Performance x 98.78 % Quality = 49.84%

OEE = 49.84%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

Glue dispensing machine centre involves:

OEE of 49.84%

Work Centre loading is 93.54%

TEEP = 93.54% Loading x 49.84% OEE = 46.62%

TEEP = 46.62%

Table 4.5.3.2: Table showing Heat Sealing M/C – Existing Vs Improved Data

	EXISTING OEE DATA		IMPROVED OEE DATA	
Shift duration	8 hours	12 (8+4 OT) hrs	8 hours	12 (8+4 OT) hrs
Jobs (units)	Plastic parts units = 120	Plastic parts units = 180	Plastic parts units = 139	Plastic parts units = 208
Working members	3		3	
Defective units	1	1	2	2

Heat Sealing Work Center:

A given Work Centre is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

A given Work Centre is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

The Work Centre experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

Heat sealing machine is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the plastic parts being produced is 30 Units/Hour or 2 Minutes/Unit

The Work Centre produces 208 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 208 Units x 2 Minutes/Unit = 416 Minutes

Performance = 416 Minutes / 540 Minutes = 0.77 x 100 = 77.03%

Performance = 77.03%

A given Work Centre produces 206 Good Units during a shift.

208 Units were started in order to produce the 206 Good Units.

Quality = 206 Good Units / 208 Units Started = 99%

Quality = 99%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

Heat sealing machine centre involves:

Availability of 82.44%

Performance of 77.03%.

Quality of 99%.

OEE = 82.44% Availability x 77.03% Performance x 99% Quality = 62.86%

OEE = 62.86%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

Heat sealing machine centre involves:

OEE of 62.86%

Work Centre loading is 93.54%

TEEP = 93.54% Loading x 62.86% OEE = 58.79%

TEEP = 58.79%

Table 4.5.3.3: Table showing LCD Twisting_M/C–Existing Vs Improved Data

	EXISTING OEE DATA		IMPROVED OEE DATA	
Shift duration	8 hours	12 (8+4 OT) hrs	8 hours	12 (8+4 OT) hrs
Jobs (units)	LCD display brackets units = 110	LCD display brackets units = 165	LCD display brackets units = 132	LCD display brackets units = 198
Working members	3		3	
Defective units	1	1	2	2

LCD Bracket Twisting Machine

LCD bracket twisting machine is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

LCD bracket twisting machine centre is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

The Work Centre experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

A given Work Centre is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the part being produced is 30 Units/Hour or 2 Minutes/Unit

The Work Centre produces 198 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 198 Units x 2 Minutes/Unit = 396 Minutes

Performance = 396 Minutes / 540 Minutes = 0.7333 x 100 = 73.33%

Performance = 73.33%

A given Work Centre produces 196 Good Units during a shift.

198 Units were started in order to produce the 196 Good Units.

Quality = 196 Good Units / 198 Units Started = 98.98%

Quality = 98.98%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

LCD bracket twisting machine involves:

Availability of 82.44%

Performance of 73.33%.

Quality of 98.98%.

OEE = 82.44% Availability x 73.33% Performance x 98.98% Quality = 59.84%

OEE = 59.84%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

LCD bracket twisting machine involves:

OEE of 59.84%

Work Centre loading is 93.54%

TEEP = 93.54% Loading x 59.84% OEE = 55.97%

TEEP = 55.97%

Table 4.5.3.4: Table showing Riveting M/C – Existing Vs Improved Data

	EXISTING OEE DATA		IMPROVED OEE DATA	
Shift duration	8 hours	12 (8+4 OT) hrs	8 hours	12 (8+4 OT) hrs
Jobs (units)	Door handle units = 76	Door handle units = 115	Door handle units = 98	Door handle units = 147
Working members	3		3	
Defective units	1	1	2	2

Riveting Machine

Riveting machine centre is scheduled to run 27 Days per Month, 24 Hours per Day, with 4 days Sunday work per month, 12 hours per day.

For a given Month, the Total Calendar Time is 31 Days at 24 Hours.

Scheduled Time = (27days x 24 hours) + (4days x 12 hours) = 696 hours

Calendar Time = (31 days x 24 hours) = 744 hours

Loading = 696 hours / 744 hours = 0.9354 x100 = 93.54%

Loading = 93.54%

Riveting machine centre is scheduled to run for a 12-hour (8+4OT) (720 minute) shift.

The normal shift includes a scheduled 65-minute break when the Work Centre is expected to be down.

The Work Centre experiences 115 minutes of unscheduled downtime.

Scheduled Time = 720 min - 65 min break = 655 Min

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

Availability = 540 Avail Min / 655 Scheduled Min = 0.8244 x 100 = 82.44%

Availability = 82.44%

A given Work Centre is scheduled to run for a 12-hour (720 minute) shift with a 65-minute scheduled break.

Available Time = 655 min Scheduled - 115 min Unscheduled Downtime = 540 Min

The Standard Rate for the door handles being produced is 24 Units/Hour or 2.5 Minutes/Unit

The Work Centre produces 147 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.

Time to Produce Parts = 147 Units x 2.5 Minutes/Unit = 367.5 Minutes $\approx$ 367 min

Performance = 367 Minutes / 540 Minutes = 0.6796 x 100 = 67.96%

Performance = 67.96%

A given Work Centre produces 145 Good Units during a shift.

147 Units were started in order to produce the 145 Good Units.

Quality = 145 Good Units / 147 Units Started = 98.63%

Quality = 98.63%

OVERALL EQUIPMENT EFFECTIVENESS (OEE):

Riveting machine centre involves:

Availability of 82.44%

Performance of 67.96%.

Quality of 98.63%.

OEE = 82.44% Availability x 67.96% Performance x 98.63% Quality = 55.25%

OEE = 55.25%

TOTAL EFFECTIVE EQUIPMENT PERFORMANCE (TEEP)

Riveting machine centre involves:

OEE of 55.25%

Work Centre loading is 93.54%

TEEP = 93.54% Loading x 55.25% OEE = 51.68%

TEEP = 51.68%

Comparison Table of OEE and TEEP before and after improvement:

Table 4.5.3.5- Table showing Comparison of OEE

WORK CENTER	EXISTING OEE (%)	IMPROVED OEE (%)
Glue Dispensing M/C	42.74%	49.84%
Heat Sealing M/c	54.64%	62.86%
LCD Bracket Twisting M/C	50.07%	59.84%
Riveting Machine	43.57%	55.25%

Table 4.5.3.6- Table showing Comparison of TEEP

WORK CENTER	EXISTING OEE (%)	IMPROVED OEE (%)
Glue Dispensing M/C	39.97%	46.62%
Heat Sealing M/C	51.11%	58.79%
LCD Bracket Twisting M/C	46.83%	55.97%
Riveting Machine	40.76%	51.68%

4.5.4 Interpretation

- In the GLUE DISPENSING M/C with the same working members and production rate in a 12-hour shift when the no. of items produced increases,
 - OEE increase from 42.74% to 49.84%
 - TEEP increase from 39.97% to 46.62%
- In the HEAT-SEALING M/C with the same working members and production rate in a 12-hour shift when the no. of items produced increases,
 - OEE increase from 54.64% to 62.86%
 - TEEP increase from 51.17% to 58.79%
- In the LCD BRACKET TWISTING_M/C with the same working members and production rate in a 12-hour shift when the no. of items produced increases,
 - OEE increase from 50.07% to 59.84%
 - TEEP increase from 46.83% to 55.97%
- In the REVERTING MACHINE with the same working members and production rate in a 12-hour shift when the no. of items produced increases,
 - OEE increase from 43.52% to 55.25%
 - TEEP increase from 40.72% to 51.68%

CHAPTER 5

FINDINGS, SUGGESTIONS AND CONCLUSION

5.1 FINDINGS

- Majority of the respondents (36%) fall under the age group 31-40.
- Majority of the respondents (38%) preferred storage equipment.
- Majority of the respondents (48%) recorded that accidents occurs once in 6 months.
- Majority of the respondents (56%) recorded that moderately severe accidents including injuries, superficial scratches and cuts or bruises has taken place.
- Majority of the respondents (51%) showed neutral views about the satisfaction level of equipment handling.
- Majority of the respondents (45%) were readily accepting to adapt to new and advanced material handling equipment.
- Majority of the respondents (32%) were in requirement of hearing protection equipment.
- Majority of the respondents (46%) recorded that training and updating was done once in more than a year.
- Majority of the respondents (57%) agreed that dangerous goods were labelled appropriately.
- Majority of the respondents (54%) voted that, the current equipment handling procedure was good and there is room for ample of improvement.
- From Correlation analysis, the more severe the accidents, the higher the dissatisfaction.
- From Correlation analysis, the more the ease of reaching for controls, the more comfortable employees are.

5.2 SUGGESTIONS

- To avoid accidents in equipment handling and optimize the processes, regular training and updating should be provided to the employees that can result in better performance and adaptability.
- The provision for Proper Protective equipment should also be channelized to ensure safety. Eye, Face and Hand protection equipment are provided adequately. However, there exists a requirement of Hearing Protection equipment like earplugs, ear muffs and canal caps which has to be brought about in the industry.
- Position of emergency button: 8-10 ft would be considered ideal for locating emergency button from the working position. However, the closer the emergency button, the lesser the risk of accidents.
- Risks can be reduced by implementing changes to designs of workstations, tools and work place within the company.

For Example,

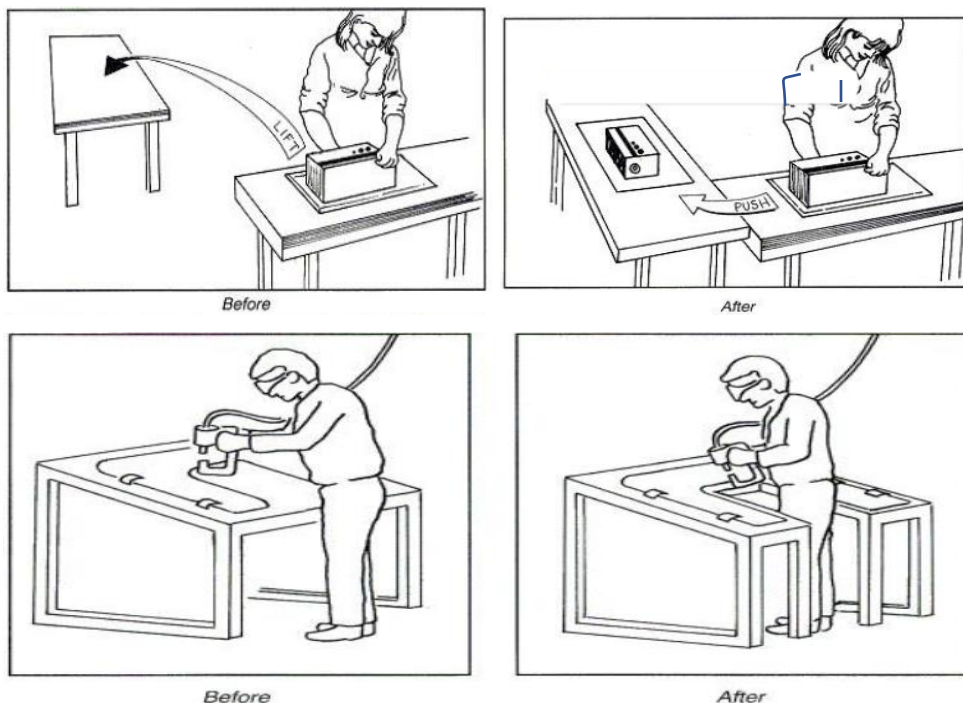


Chart 5.2.1- Chart showing Modifications in equipment handling

- The storage and flow of materials help optimize the inventory. This can be achieved through ABC analysis where materials are stored according to priority with respect to frequently sold or consumed items.
- With respect to storage of metal sheets, the metal sheets can be stored in Rollout Metal sheet racks or Rollout shelving which allows cranes and forklifts better access.
- The effect of enhanced material storage is reflected in the OEE and TEEP metrics for a period of 1 month. Thus, Kaizen can be implemented to go lean with manufacturing processes by improving standardized processes and programs to eliminate waste and increase efficiency.

5.3 CONCLUSION

All workplace environments are made by human for human, hence keeping it clean, efficient utilization of people and machines, efficient flow of materials, waste reduction, easy material flow and effective communication with customers will increase the production and revenue of the company. Thus, monitoring and continuous improvement of the process by applying Kaizen will increase the productivity within the organization. By channelizing the optimal flow of materials, the production time can be significantly improved to suit the demands and reduce wastes. Resources can be used to its optimal status thus showing better results in productivity. The equipment should also be suited to match the ergonomics prevailing in the organization. Thus, minor changes should be made to ensure that, the employees are comfortable to work with the equipment.

REFERENCES

- Angappa Gunasekaran (1999), Enablers of total quality management implementation in manufacturing: A case study
- Ardavan Asef-Vaziri, Gilbert Laporte (2005), Loop based facility planning and material handling
- Ateekh-Ur-Rehman Lateef-Ur-Rehman, Yusuf S. Usmani, Usama Umer (2009), Lean Approach to Enhance Productivity: A Case Study of Saudi Arabian Factory
- Ayman Bahjat Abdallah, Samer Eid Dahiyat, Yoshiki Matsui (2019), Lean management and innovation performance: Evidence from international manufacturing companies
- Fatine Chouiraf, Anas Chafi (2020), A new steps of Value Stream Mapping for the Moroccan Artisanal Enterprise
- James C. Green, Jim Lee, Theodore A. Kozman (2010), Managing lean manufacturing in material handling operations
- Jaroslava Kadarova, Michal Demecko (2016), New approaches in Lean Management
- John T. Mentzer (2001), Defining Supply Chain Management
- Juthamas Choomluksana, Monsiri Ongsaranakorn, Phrompong Suksabai (2015), Improving the Productivity of Sheet Metal Stamping Subassembly Area Using the Application of Lean Manufacturing Principles
- K.C. Ng, Kuan Eng Chong, Gerald Guan Gan Goh (2015), Improving Overall Equipment Effectiveness (OEE) through the six-sigma methodology in a semiconductor firm: A case study
- Man Mohan Siddh, Gaurav Gadekar, Gunjan Soni, Rakesh Jain (2014), Integrating Lean Six Sigma and Supply Chain Approach for Quality and Business Performance
- Maozhu Jin, Rongqiu chen (2008), Production Planning and Operational Control Using Real-Time Data

- Nabeel Mandahawi, Rami H. Fouad, Suleiman Obeidat (2012), An Application of Customized Lean Six Sigma to Enhance Productivity at a Paper Manufacturing Company
- Paul Brunet (2000), Kaizen: From Understanding to Action
- Péter Bikfalvi, Ferenc Erdélyi, Tibor Tóth (2004), The “Production Triangle” Model in Production Planning and Control
- S. Nallusamy^{*} and V. Saravanan (2016), Lean Tools Execution in a Small-Scale Manufacturing Industry for Productivity Improvement- A Case Study
- T. M. Shahada, I. Alsyoud (2004), Design and Implementation of a Lean Six Sigma Framework for Process Improvement: A Case Study
- Tushar K. Acharya (2011), Material Handling and Process Improvement Using Lean Manufacturing Principles
- Vincent S. Palmer (2001), Inventory Management Kaizen

BIBLIOGRAPHY

- <https://www.toolshero.com/management/materials-management/>
- <https://www.google.com/webhp?hl=en&sa=X&ved=0ahUKEwiUvb7z68rvAhXvyDgGHXhJBocQPAgl>
- https://en.wikipedia.org/wiki/Material-handling_equipment
- <https://www.oeo.com/>
- [https://www.oeo.com/teep.html#:~:text=TEEP%20\(Total%20Effective%20Equipment%20Performance,\(as%20measured%20by%20Utilization\).](https://www.oeo.com/teep.html#:~:text=TEEP%20(Total%20Effective%20Equipment%20Performance,(as%20measured%20by%20Utilization).)
- <https://createdigital.org.au/measure-manufacturing-equipment-efficiency/>

APPENDIX- I QUESTIONNAIRE
A STUDY ON MATERIALS AND EQUIPMENT HANDLING AT SRI LAKSHME
BALAJI INDUSTRIES

PART-A

1. Name _____

2. Age

- ☐ 21-30
- ☐ 31-40
- ☐ 41-50
- ☐ 51-58

3. Experience

- ☐ 0-2
- ☐ 3-5
- ☐ 6-8
- ☐ 9-11
- ☐ More than 11

PART-B

4. Material Handling Equipment required widely for operation at SLB Industries:

- ☐ Transport Equipment
- ☐ Positioning Equipment
- ☐ Unit load Information equipment
- ☐ Storage equipment
- ☐ Others

5. How frequently do you face major or minor accidents in material handling at SLB industries?

- ☐ Once in more than a year
- ☐ Once in a year

- Once in 6 months
- Once in a month
- Once in less than a month

6. How would you rate the severity of accidents that has happened, if any:

Minor ☐ ☐ ☐ ☐ ☐ Major/Severe

7. Are you satisfied with the equipment handling currently used in SLB Industries?

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

8. Training and updating regarding equipment handling is provided once in

- More than a year
- 1 year
- 6 months
- 3 months
- 1 month

9. Do you agree to adapt to advanced material handling equipment?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

10. How do you assess the safety in materials handling equipment in SLB Industries?

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Very Good
- ☐ Excellent

11. Proper Protective Equipment that you need the most while working:

- ☐ Eye and Face protection
- ☐ Hand protection
- ☐ Body protection
- ☐ Respiratory protection
- ☐ Hearing Protection

12. Materials are stored according to the labelling with respect to dangerous goods:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly Disagree

13. The emergency button is within the range of:

- ☐ Less than 6ft
- ☐ 6-8 ft
- ☐ 9-11 ft
- ☐ 12-14 ft
- ☐ More than 14 ft

14. Rate the comfort of reaching for the controls of the equipment you handle:

Comfortable ☐ ☐ ☐ ☐ ☐ Uncomfortable

15. Rate the overall comfort of handling the equipment:

Easy to handle ☐ ☐ ☐ ☐ ☐ Hard to handle

APPENDIX- II ARTICLE
A STUDY ON MATERIALS AND EQUIPMENT HANDLING AT SRI LAKSHME
BALAJI INDUSTRIES

ATSHAYA S, STUDENT, SCHOOL OF MANAGEMENT STUDIES, SATHYABAMA INSTITUTE OF
SCIENCE AND TECHNOLOGY, CHENNAI-600119, atshaya.suresh@gmail.com

DR. DHIVYA SATHISH, ASSISTANT PROFESSOR, SCHOOL OF MANAGEMENT STUDIES,
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI-60019,
dhivya.sathish05@gmail.com

Abstract:

The reason for this investigation is to help us discover the holes in Materials and Equipment dealing with at Sri Lakshme Balaji Industries and upgrade it to streamline the creation interaction. The investigation could give us data on the current materials and hardware taking care of cycles received at the association and empowers us to recommend methods of upgrading it. The examination additionally extends to investigate approaches to keep away from working environment mishaps since the representatives are overwhelmingly captivating with taking care of materials and hardware. The solace of the workers is affected by their experience, their flexibility to new hardware, convenient preparing gave, use of defensive gear and the solace of going after the controls. An organized Questionnaire is conveyed to the representatives to break down these elements. Minor changes are made in the association utilizing Kaizen strategy and the efficiency measurements, for example, Overall Equipment Effectiveness and Total compelling hardware execution are evaluated when rolling out the improvements in materials and gear taking care of. It was discovered that, carrying out Kaizen showed critical improvement in the profitability measurements.

Keywords: Lean Manufacturing, Kaizen, OEE, TEEP, Material handling, Equipment Handling.

Introduction:

Material Handling

Material Handling refers to the maneuver, safe keeping, stockpiling and administration of goods and items across all the processes like production, repositioning finished goods, dissemination to dealers and consumers, utilization by

consumers and scrapping. With advanced technology like Artificial Intelligence, IoT (Internet of things) or Industry 4.0, Material handling has escalated to operate completely automatic or partially automatic that suits the requirement of logistics. With the consensual and smooth functioning of the material handling systems, the companies can achieve a significant enhancement with customer satisfaction, reduce lead time, manage warehouses and inventory more efficiently and reduce ample amount of costs relating to management of materials. Materials handling system has to be designed in such a way that it suits the ergonomics of the employees working on it. This will ensure comfortable and productive functioning of both men and machines.

Overall Equipment Effectiveness

Generally, OEE is an upkeep KPI that actions a resource's degree of profitability. OEE is a mix of three factors that disclose to you how effective a resource is during the assembling interaction: resource accessibility, resource execution, and creation of quality. Everyone can reveal to you something else about how a resource works.

1. Accessibility – How regularly does the resource work when required?
2. Execution – How much does the resource produce?
3. Quality – what number great things does the resource produce?

At the point when a resource works with an OEE of 100%, it implies that each thing it produces is without imperfection (quality), it is delivering as quick as could be expected (execution), and it encounters no spontaneous vacation (accessibility).

Generally, gear viability is an instrument for assessing the proficiency of resources during the assembling cycle. It can likewise be utilized to explore individuals, cycles and devices that sway how resources work. At the point when joined with the knowledge from other support measurements, OEE gives an extraordinary establishment to recognizing zones of an activity that can be improved and a quantifiable method to quantify progress.

TEEP: Total Effective Equipment Performance

TEEP (Total Effective Equipment Performance) is an exhibition metric that is utilized to quantify the genuine limit of assembling tasks – showing how huge of an extension is holding back to be opened. This measurement gives makers understanding into how much potential their manufacturing plant has dependent on

their present gear. TEEP thinks about Equipment Losses (OEE estimation) and Schedule Losses (Utilization estimation).

TEEP – comparatively to OEE – is utilized by makers to see how to improve their manufacturing plant's cycles and upgrade to dynamic practices in the business. What's more, to comprehend your organizations' adaptability, every one of these variables should be taken into account. The principal contrast between the two measurements is the greatest time accessible for creation. Since TEEP considers unsurpassed, the greatest time accessible for creation is day in and day out, 365 days per year.

TEEP additionally goes one stage past OEE, by accentuating the effect of planned personal time, and in doing as such, revealing the genuine undiscovered capability of a processing plant. Estimating TEEP is fundamental so you can effectively gauge and timetable schedules. By understanding your production line's misfortunes, you can start to deal with those issues to improve dependability.

Literature Survey

John T. Mentzer (2001): This globalization of supply has constrained organizations to search for more compelling approaches to facilitate the progression of materials into and out of the organization. Key to such coordination is a direction toward closer associations with providers. Further, organizations specifically and supply chains overall contend all the more today based on schedule and quality. Getting a deformity free item to the client quicker and more dependably than the opposition is not, at this point seen as an upper hand, however just a necessity to be on the lookout.

Ardavan Asef-Vaziri (2005): A sizeable extent of assembling costs can be credited to office design and material taking care of. Office format choices include planning the course of action of components in assembling frameworks. Among the most basic material taking care of choices around there are the plan and plan of material stream designs.

Ateekh Ur Rehman (2019): In a present serious market, producing businesses are constrained to follow an orderly way to deal with comprehend and improve fabricating plant execution. An assortment of the executive's apparatuses and methods of reasoning are embraced by various enterprises to recognize regions of chance for minimization of waste and expansion of creation profitability. Lean

assembling is a way of thinking of waste minimization, profitability upgrade and consistent improvement.

Ayman Bahjat Abdallah (2018): The connection among LM and advancement is bantered in the current writing, however the discussion is portrayed by an absence of experimental proof. This is one of the principals contemplates that experimentally researches the connections between IO, LM and advancement execution. It recognizes some new bits of knowledge to coordinate future examination, especially viewing diverse development types just as in help associations.

Fatine CHOUIRAF (2018): The combination of lean assembling in the association of specialty undertakings would add to this improvement. Lean is a Japanese way to deal with creation the board, in view of the end of squanders "mudas". Lean and specialty creation share a few targets, in particular creation in little arrangement, unitary creation and the draw plan of action.

Angappa Gunasekaran (2015): The essential focal point of absolute quality administration (TQM) is consumer loyalty. Persistent improvement and specialist strengthening are essential vehicles for accomplishing consumer loyalty. Viable TQM pivots likewise on administration execution in arranging, organizing, influencing and controlling exercises taking all things together utilitarian regions, (for example, marketing, purchasing, plan and designing, creation, appropriation, money and bookkeeping, HR, and so forth)

Analysis:

The existing material handling equipment has been observed physically. Further, questionnaire has also been distributed to collect responses from the employees with regards to material handling equipment. The material storage and material flow has been physically observed and the existing pattern was recorded. This helps in identifying the gaps in the practices adopted. In the existing practices, Lean process has not been adopted. This led to wastages in material, time and efficiency. To keep a track of it, the OEE (Overall Equipment Efficiency) and TEEP (Total Effective Equipment Performance) has been analyzed.

Some of the problems observed in Equipment handling is, mishandling of machines. This caused minor accidents and posed a hazard to both employee and equipment. This study aims to reduce accidents. In material storage, the materials

were not stored according to priority which caused delay in the production process. Further due to inefficient material storage, the material flow was also affected which caused negative flow. The study helps to analyze the minor inefficiencies in materials and equipment handling to improve production.

Methodologies:

The strategy that was at that point existing in the organization is, Make to Order. Notwithstanding it, Lean idea of Kaizen can likewise be embraced. This guarantees ceaseless improvement of cycles existing in the organization. Kaizen alludes to the progressions made in the cycles that will upgrade it and guarantee productive utilization of assets. By carrying out Kaizen in Materials and Equipment taking care of, the overall process can be improved. The productivity metric has been estimated and examined utilizing the measurements OEE and TEEP.

The reactions recorded from workers has been investigated utilizing measurable tests in particular,

- Correlation Analysis

n = number of data points of the two variables

d_i = difference in ranks of the "ith" element

Spearman's Rho = $1 - \{6 \sum d^2 / [n(n^2 - 1)]\}$

- Chi-Square Analysis

$$\chi^2 = \sum (O_i - E_i)^2 / E_i$$

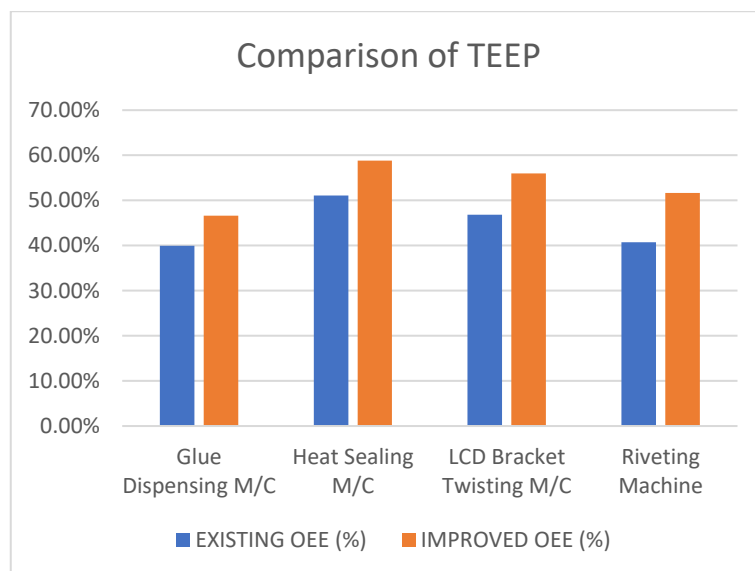
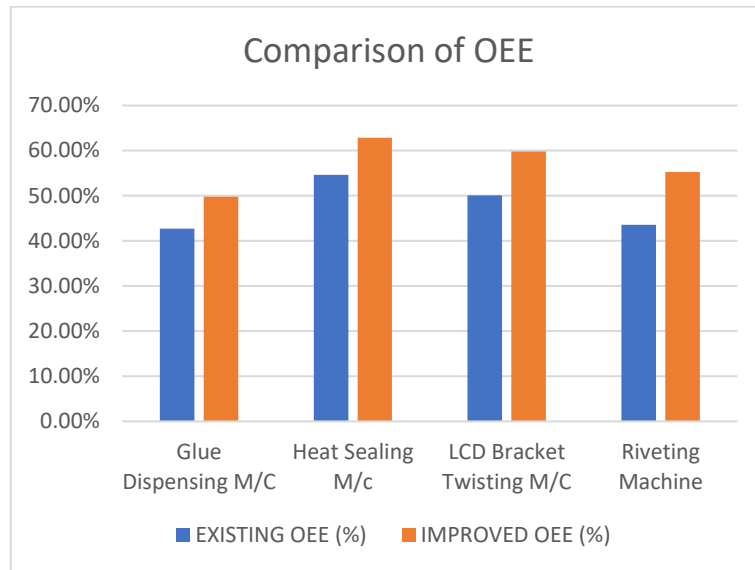
where O_i is the observed value and E_i is the expected value.

The Statistical Software utilized is, SPSS (Statistical Package for Social Sciences). From the outcomes along these lines inferred, the ends are drawn for additional improvement.

Results and Discussion:

The employees would prefer to adapt to new technology that helped in materials handling. The Correlation analysis revealed that, equipment handling is easier if the controls are within reach comfortably. After implementing Kaizen in material flow and storage, the productivity increased by a small proportion that was reflected in

OEE and TEEP. In the same way, if the processes are monitored periodically and enhancements are made, the whole of production process can be improved.



Conclusion

All workplace environments are made by human for human, hence keeping it clean, efficient utilization of people and machines, efficient flow of materials, waste reduction, easy material flow and effective communication with customers will increase the production and revenue of the company. Thus, monitoring and continuous improvement of the process by applying Kaizen will increase the productivity within the organization.

References

- Angappa Gunasekaran (1999), Enablers of total quality management implementation in manufacturing: A case study
- Ardavan Asef-Vaziri, Gilbert Laporte (2005), Loop based facility planning and material handling
- Ateekh-Ur-Rehman Lateef-Ur-Rehman, Yusuf S. Usmani, Usama Umer (2009), Lean Approach to Enhance Productivity: A Case Study of Saudi Arabian Factory
- Fatine Chouiraf, Anas Chafi (2020), A new steps of Value Stream Mapping for the Moroccan Artisanal Enterprise
- John T. Mentzer (2001), Defining Supply Chain Management