PRODUCTION IMPROVEMENT BY LINE BALANCING AND 5S

A Project Report

Submitted in partial fulfillment of the requirements of the degree of (Bachelor of Engineering)

by

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CERTIFICATE

This is to certify that the project report titled, **Production Improvement by Line balancing & 5S** submitted to **Anjum-I-islam's Kalsekar Technical Campus, Panvel,** submitted by **Abdulrahiman Mohd Javed,Ansari Fahad , Ansari Salman, Kungle Tabish,** In **MECHANICAL ENGINEERING** is the bonafide record of project work done by them under our supervision of **Prof. Momin Nafe**. The contents of this report, in full or in parts, have not been submitted to any other institute or university for the award of any degree or diploma.

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ACKNOWLEDGEMENTS

In the name of Allah, the Most Benevolent, the most Merciful. I wish to record immeasurable gratitude and thankfulness to the One and The Almighty Creator, the Lord and Sustainer of the universe, and mankind in particular. It is only through His mercy and help that this work could be completed and it is ardently desired that this little effort be accepted by Him to be of some service to the cause of humanity.

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ABSTRACT

For continuous improvement in an organization, Japanese philosophy Kaizen is very popular. flawless. Concepts of kaizen methodology and proper implementation of tools can lead to a successful kaizen program in a company. Various other companies also adapt to various disciplines and methods as per need and ease of application. Few are JIT (Just In Time), Manufacturing organizations typically have raw materials, components, sub-assemblies, tools and equipment's; semi-finished goods etc., the inventory of an item should not be neither too high nor too less. It should be optimal. The recent development in inventory management is JIT (Just-in-Time). JIT implies handling of inventory in a much disciplined way. It requires changes in culture. It also encompasses the Japanese managerial characteristics i.e., Lifetime employment, implicit control.The design of assembly lines is an important issue in manufacturing engineering management and control. The idle time is the most interesting performance index for assembly line design. The classical simple line-balancing problem (SALBP) consists of assigning tasks, necessary for processing a product, to workstations such that the idle time (number of stations, cycle time, cost) is minimized while precedence constraints between tasks are satisfied. From the worst-case analysis point of view, the SALBP problems are NP-hard in strong sense. In this company initial the concept of Line Balancing was tried to implemented but due to unnecessary hardships of shifting of stations a new concept was learnt and applied in the company. New concept which was implemented was *'The Concept of 5S'*. 5S is a basic foundation of Lean Manufacturing systems. It is a tool for cleaning, sorting, organizing and providing the necessary groundwork for workpiece improvement. This paper dealt with the implementation of 5S methodology in the small scale industry. By following the 5S methodology, it shows significant improvements to safety, productivity, efficiency and housekeeping. The improvements before and after 5S implementation is shown by pictures in the paper. It also intends to build a stronger work ethic within the management and workers who would be expected to continue the good practices.

About Company:

Name : Navkar Fittings & Forgings Pvt Ltd

Location: Taloja,MIDC, Panvel

Type : Manufacturing Industry

We are a leading manufacturer of high quality steel pipe fittings, nickel alloy fittings, butt weld pipe fittings & socket weld pipe fittings that are made according to the national and international standards in different metallurgy.

CHAPTER 1

INTRODUCTION

Different types of Production Improvement techniques used:

- **KAIZEN**
- **Lean Manufacturing**
- **5S**
- **PDCA Cycle**
- **JIT (Just In Time)**
- **Line balancing**

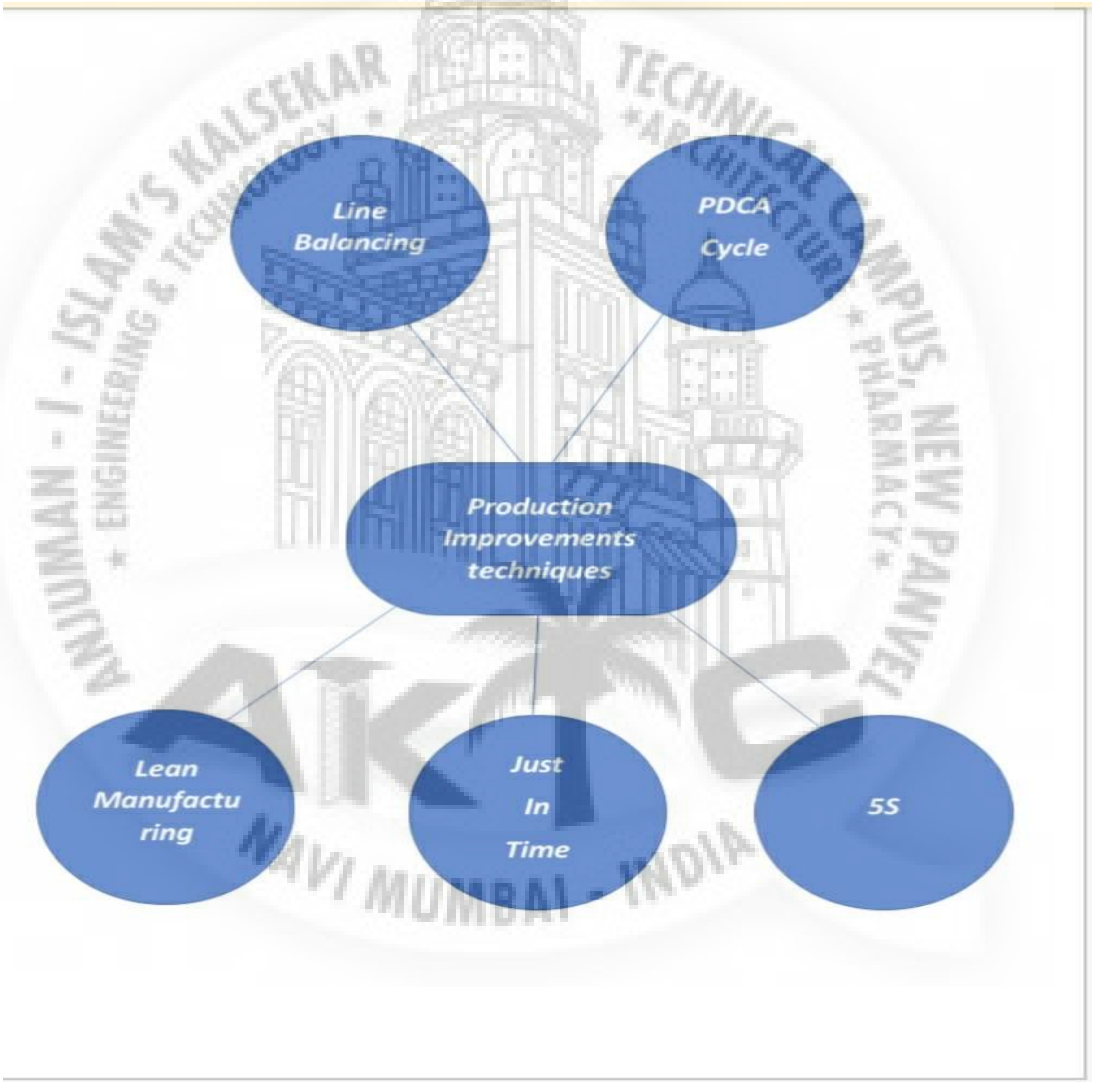


Fig 01: Different types of Production Improvement techniques used in Industry

1.1 KAIZEN

1.1.1 Introduction

Some types of change inevitably need a key project; meaning months of hard work, big budgets and upheaval. But, often undervalued, an alternative or complementary approach to improving systems, processes and so on, is through subtler, ongoing changes and continuous improvements. Once a new foremost change has happened, perhaps a new system or structure put in place, is everything perfect? Will the new processes stay set in stone until the next major change in a few years? Almost certainly not. With the continuation of such attitude, gradual decline in benefits has occurred after the initial step improvement, as inefficiencies and bad practice crept in. There is always room to make small improvements, challenge the status quo, and tune processes and practice on an everyday basis. Any employee with his/her colleagues probably does this week in, week out without calling it "change" or even "continuous improvement". They're already getting real benefits from the intuitive approach to continuous improvement. And over time, all of these incremental changes add up and make a significant positive impact on the team as well as the organization. One approach to continuous improvement is called kaizen. It originated in Japan, and the word translates to mean change (kai) for good (Zen).

The philosophical belief that potential improvement of everything is the foundation of kaizen:

Some organizations look at a process and see that it's running fine; Organizations that follow the principle of Kaizen perceive a process that can be improved. This means that nothing ever comprehends as a status quo – there are continuous efforts to recover which result in small, often unnoticeable, changes over time. These incremental changes add up to substantial changes over the longer term, without having to go through any radical innovation. It can be a much gentler and employee-friendly way to institute the changes that must occur as a business grows and adapts to its changing environment.

Its history begins after World War II when Toyota first implemented in a group of workers performing the same or similar work, who meet regularly to identify, analyze and solve work-related problems in its production process. This revolutionary concept became very popular in Japan in the 1950s and the term kaizen became famous around the world through the works of Masaaki Imai.

When Kaizen is applied as an action plan through a consistent and sustained program of successful Kaizen events, it teaches employees to think differently about their work. In other

words, consistent application of Kaizen as an action plan creates tremendous long-term value by developing the culture that is necessary for truly beneficial continuous improvement.

Kaizen is a system that involves everyone – upper management to the cleaning team. Everyone is encouraged to come up with small improvement suggestions on a regular basis. The concept of Kaizen focuses on improving the work environment of an organization in step by step upgrading the process and eliminating wastes. The review indicates that the application of Kaizen promises to reduction/elimination of wastes and improves process efficiency.

Usually, a consumer will want a product or service which is the best quality with the lowest price and available when they want it. Failure of the market leader in meeting this demand will pave the way for the

Competitors. This is why a business must continually improve to maintain their market share, not wait until they lose their position and then make panic reactions to gain back what they have lost.

The focus here is to show how can incorporate kaizen event into company kaizen program – the companies that undertake a Kaizen philosophy place an emphasis on the processes – on the 'how' of achieving the required results. A process emphasis goes beyond designing effective processes; it requires the teams to understand why a process works, whether it can be modified or replicated somewhere else in the company and how it can be improved.

The philosophy, concept, and tools of kaizen have been adopted not only in Japanese firms but also in many multinational corporations in the US and Europe. Many studies note that in both Japan and abroad (especially in the cases of American and European companies), leadership is the single most important factor for successful implementation of kaizen. This implies that it is possible to apply kaizen in countries with different socio-cultural contexts, but that application must be conducted under proper leadership and with adjustments that reflect the uniqueness of the targeted society.

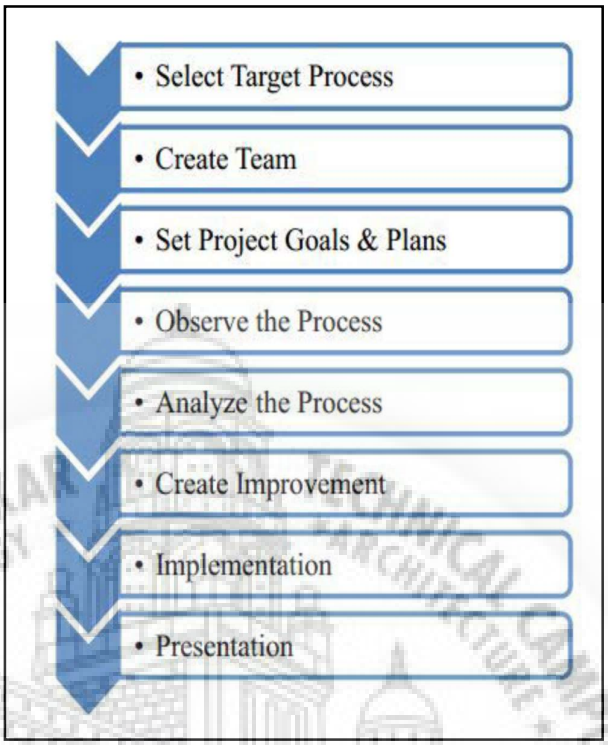


Fig 02: Methodology of Kaizen

1.2 5S:

1.2.1 Introduction:

5 S is an approach to organize, order, clean, standardize and continuously improve a work area. 5S is not just about housekeeping, It is one of the efficiently working tools of Lean Manufacturing. The program gets its name from five activities beginning with the letter S, which were derived from five Japanese words. The words are Seiri, Seiton, Seiso, Seiketsu and Shitsuke, which when translated mean Sort, Set in Order, Shining, Standardize and Sustain, respectively. Sort helps to remove all unneeded items: only what is needed stays. Set establishes locations and quantities needed for efficient operation. Shine represent cleaning through inspection. Standardize implements visual displays and controls. Sustain helps to keep the organization effort in place through training and total employee involvement. The aim of this paper is to implement 5S methodology and measure the performance improvement in V.M. Auto Pvt. Ltd. A small scale industry situated at Satpur (M.I.D.C), Nasik. 5S is a lean manufacturing tool for cleaning, sorting, organizing and providing necessary ground work for work place improvement. 5S is already selected using Analytic Hierarchy Process (AHP), a multi criteria design making (MCDM) tool by considering different criteria for case company. AHP is a problem solving framework based on the innate human ability to make sound

judgement about small problem. It is a quantitative technique use to facilitate decision that involves multiple competing criteria**.**

1.2.2 5S-The Beginning of Lean:

5S is the one of the essential steps in motion and bring about a flourishing Lean culture. It provides the ground work and the workplace as a way to modify how people approach their planned future state. Van Pattern (2006) and Samuels (2009) concur that 5S is often understood as a simple strategy to clean the shop floor but it can be potent application for developing a successful business for deploying a new standard of workplace practices. When everything has a place and there is a position for all things, a 5S program will serve for supporting a clear picture of the workplace.

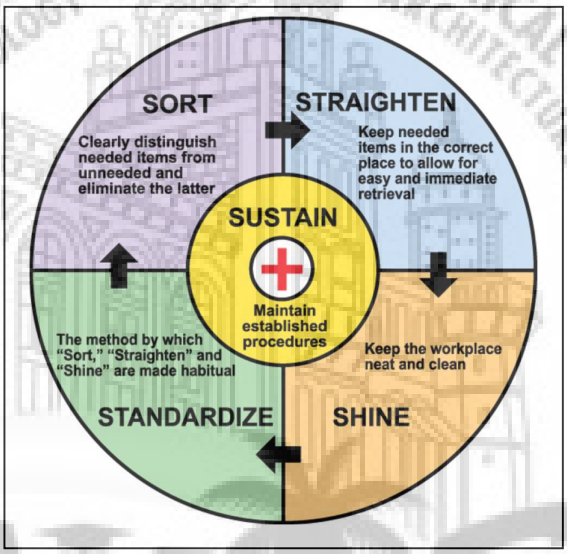


Fig 03:. *The Schematic Diagram of 5S principles.*

1.2.3 5S THE PROCESS

1. Sort (Seiri)

Sorting is the first step-removing all surplus items from the work center which are not needed for the immediate continual operations (Hough,2008). At this stage it is decided what is really needed and what is not. Any item or tool that is unaccounted out of place or unnecessary needs to be clearly documented. A red tag is a document made on red colored paper that is attached to potential junk items in a workplace. The items are stored temporarily until assignable action can be undertaken, it is usually the starting point of a 5S exercise. Items are red tagged with the best description of use or placement recorded on it. All red tagged articles are moved to a temporary holding area, and that area clearly is identified as the red tag or Seiri area. Equipment

or anything else that is not of use, should be discarded as refuse to be thrown out (Howell, 2009). To implement the first step of 5S, a production team needs to know what material is used when the material in storage are to used where the required materials are, and what the users requirement are (Hirano 1993). This is an opportunity for every team to re-evaluate the tools at their disposal and make sure that they are using the best available tools for the process (Cooper et. al 2007).

2. Set in Order (Seiton)

The second step in a 5S launch is taking the stored items and putting them where they best support the function they provide. Workers should be motivated to place items at their point of use and improve the workplace's visual management (Van Pattern 2006). Before and after photos should be taken to document progress and explain activity benefits are of key importance at this stage (Samuels, 2009). One important advantage of Set in order is that everything needed for the job is clearly visible. Another objective of this step is to arrange the work in such a manner that missteps can be easily identified and corrected which is one oof the main reason why the implementation of visual controls is encouraged during this step. Associates may apply these philosophies by referring to checklists, designing tool boards, parts container and improving workplace design. The practice of shadow boarding can be quickly identify when a piece of equipment is missing from a work station (Becker 2001). The main advantage of tool ―shadowing‖ is that people instantly know which tool is missing and where it stored. Further more if one is missing its easy to guess what shop users are looking for and where it belongs.

3. Shine (Seiso)

Once the unneeded is thrown away and sorting and set in order has taken place, it is now time for the sanitize phase (Howell, 2009). A cross functional team should agree on what the cleaning standards need to be (Samuels, 2009). This is sometimes referred to as shine or sweep stage where teams thoroughly remove clutter and fix equipment or building components (Hough 2008). The objective of this phase is to identify and eliminate the root cause of waste, dirt and damage as well as clean up the work station (Van Pattern, 2006). 5S projects that are almost entirely focused on cleaning and painting, prevent recording the valuable information that can be gained from assessing it (Van Pattern, 2006). This step needs to have the full involvement of employees to gather the data of what they feel needs to be cleaned and how often it should be cleaned (Samuels, 2009). Although it is imperative to create a cleaning schedule along with appointed duties for all personal working in designated areas, some employees may mistakenly believe that they are not being paid to clean. In that situation,

Cooper. Et. al (2007) make the suggestion to list all applicable responsibilities in detail, including all areas to be cleaned and desired expectations where they are assigned. Another issue worth considering is that an unclean area is more susceptible to safety hazards that could potentially cause worker injury (Howell, 2009). This is of such importance that Cooper, Et al (2007) also recommend this particular event be followed as a daily regimen.

4. Standardize (Seiketsu)

After the organizing and cleaning of a production area, it is essential that the area is maintained (Cooper, et. al, 2007). This stage requires that the improvements of the previous three phases are maintained. That‘s why organization develop standardized procedures, rules and expectations for maintaining continuous activity in all of the areas shift by shift and crew. This is a means of creating consistent ways for implementing the tasks outlined above on daily basis (Cooper. Et. al.2007). The challenge is to visually maintain known agreed upon conditions rather than to write work instructions (Van Pattern, 2006). Teams can develop their own standards by using the 5M‘s borrowed from Kaoru Ishikawa‘s Fishbonediagram. In it, he lists Manpower, Methods, Materials, Machines and Measurements as the 5 components of the standardizing step (Ishikawa, 1986). An organization achieves conformity when employees value working to one common metric, rather than working however they feel like working or how they think a job should be done (Van Pattern, 2006).

5. Sustain (Shitsuke)

The benefits of the above four phases of 5S are powerful, visual and easily measured. However without self discipline, elements for sustainability the success of 5S program is brief and everything will atrophy or revert to the previous messy state (Maggie, 2006). In daily life, when we diet to lose weight, we still need discipline to help us maintain our objective. Therefore discipline and motivation go hand and hand to reach your goals (Santos Wysk& Torres, 2006). Several Studies identify the fifth phase as the most difficult phase to perform of this program (Bullington, 2003 ; Cooper et. al, 2007 ; Womack & Jones 1991). To continue the gains from implementing the 5S system, efforts should be taken to instill the importance of maintaining employee dedication for a neat, orderly and safe workplace and reinforcing good work habits (Maggie, 2006). Every employee needs to understand the importance of safety, order and cleanliness and be willing to take the necessary steps that guarantee the prescribed standards are accommodated (Cooper et. al 2007) when every square foot of a production floor is assigned to an associate then clutter will not build up (Samuels, 2009).

1.3 Lean manufacturing:

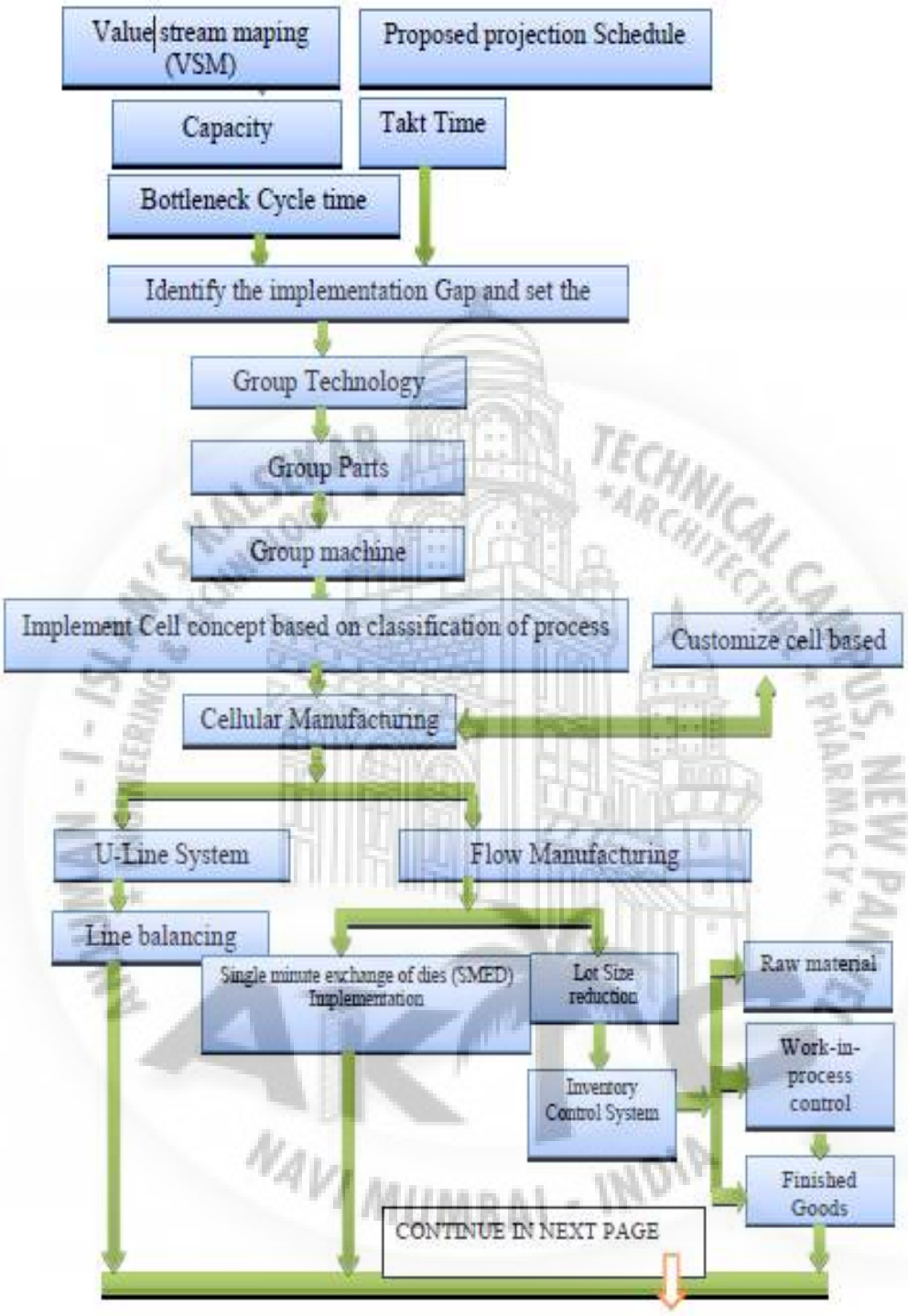
1.3.1 Introduction:

Lean concepts are mostly evolved from Japanese industries especially from Toyota. Lean Manufacturing is considered to be a waste reduction technique as suggested by many authors, but in practice lean manufacturing maximize the value of the product through minimization of waste. Lean principles defines the value of the product/service as perceived by the customer and then making the flow in-line with the customer pull and striving for perfection through continuous improvement to eliminate waste by sorting out Value Added activity(VA) and Non-Value Added activity(NVA). The sources for the NVA activity wastes are Transportation, Inventory, Motion Waiting, Overproduction, Over processing and Defects. The NVA activity waste is vital hurdle for VA activity. Elimination of these wastes is achieved through the successful implementation of lean elements. Various Survey demonstrate that most of the researcher focus on one or two elements for finding out the existence of wastes and suggest their views on implementing these elements.

1.3.2. Overview of Lean Elements:

The major elements considered by the earlier researchers for the implementation of the lean manufacturing system are Value stream Mapping (VSM)which defines value stream as "Each and every activity including Value-Added activity (VA) and Non-Value-Added activity (NVA) required to convert the raw material into finished product through the mapping of process and information flows essential to every product" [2], Push and Pull System which describes, the Pull system rely on customer requirement whereas push system rely on predetermined schedule. [1],Cellular Manufacturing defines the facility grouping in order to produce the product with minimum process time, waiting time, and transportation by smoothen the process flow. Further fluctuating line flow is improved by U-line concept and line balancing concept,Kanban is Material Flow Control mechanism (MFC) which delivers the right quantity of parts at right time [3]. Stages of this Kanban implementation are production stage and withdrawal stage. One piece flowensure just-in-time production system in order to adopt straightforward schedule without interruption, backflow or scrap, relaxing the Takt time and decreasing the risk of machine failures and operator mistakes [4]. Single Minute Exchange of Dies (SMED)/One-Touch exchange of Die (OTED) is systematic reduction of changeover time by converting possible internal setting time (Carry out during machine stoppage) to external time (performed while the equipment is running) and to simplify and streamline the remaining activity [5]. Production Levelling enhances production volume as well as production mix and

production efficiency by means of reducing waste, unevenness, and overburden of people or equipment [6]. Levelling of parts leads to successful implementation ofEvery Part Every Interval (EPEI) concept, Employee perceptions include Belief, commitment, work method and communication, for lean transition the motivation for cultural change is needed to improve employee perception. The other supporting elements such as TPM, TQM are not considered in this review article.


Value stream maping (VSM)
Proposed projection Schedule
Capacity
Takt Time
Bottleneck Cycle time
Identify the implementation Gap and set the
Group Technology
Group Parts
Group machine
Implement Cell concept based on classification of process
Customize cell based
Cellular Manufacturing
U-Line System
Flow Manufacturing
Line balancing
Single minute exchange of dies (SMED) Implementation
Lot Size reduction
Raw material
Work-in-process control
Inventory Control System
Finished Goods
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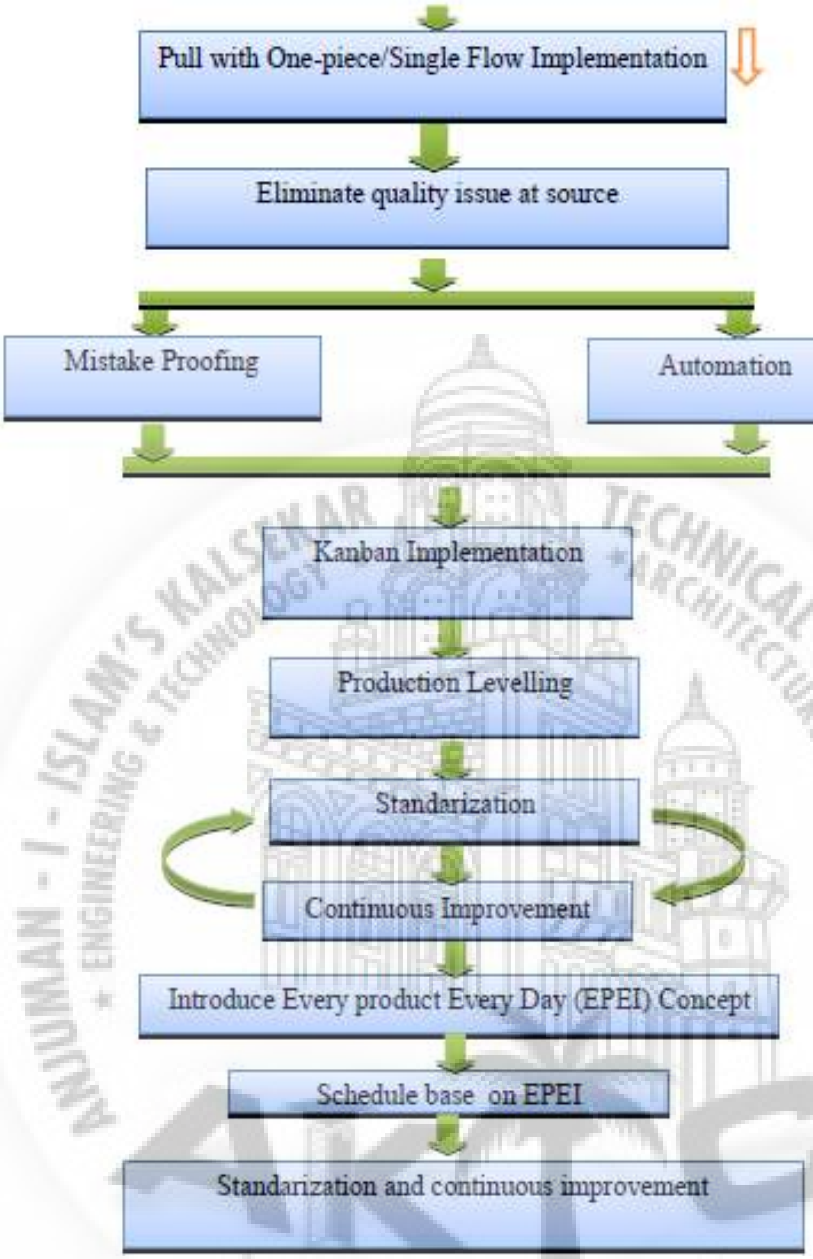


Fig 04:. Proposed Road Map for the Implementation of Lean Manufacturing System

1.4 Line Balancing:

1.4.1 Introduction:

Process planning is mainly relevant to generating line balancing set of steps required to approach specified aims, with given constraints, as an attempt to enhance a part of the criteria. Balancing assembly lines becomes one of the most important parts for an industrial manufacturing system that should be supervised carefully. The success of achieving the goal of production is influenced significantly by balancing assembly lines. Since then, many industries and for sure researchers, attempt to find the best methods or techniques to keep the assembly line balanced and then, to make it more efficient. Furthermore, this problem is known as an assembly lines balancing problem. An assembly line consists of workstations that produce a product as it moves successively from one workstation to the next along the line, which this line could be straight, u-line or parallel until completed. To balance an assembly line, some methods have been originally introduced to increase productivity and efficiency. These objectives are achieved by reducing the amount of required manufacturing time to produce a finished product, by reduction in number of workstations or both of them .This study involved applying the three heuristic algorithms to study the Ginning machine process planning gaining a reduced production time. In this paper, three assembly balancing methods were studied: largest Candidate Rule (LCR), Kilbridge and Wester (KWC), and Ranked Positional Weight (RPW) to select best one for Manual Assembly Line of Ginning machine.

1.4.2 ASSEMBLY LINE BALANCING TERMINOLOGIES:

The important terminologies involved in Assembly Line Balancing are explained in this section.

1.Workstation:

It is an assigned location where a given amount of work is performed. Normally a workstation is manned by one operator only. Sometimes, work stations are manned by several operators, e.g. aircraft production line.

2.Minimum rational work element:

It is an indivisible element of work, or natural minimum work unit, beyond which assembly work cannot be divided rationally. In an automobile assembly, fixing fuel pump, fuel tank, wheel drum etc., are some of the examples of minimum rational work element.

3.Cycle Time (CT):

Cycle Time may be defined as the ratio between the effective time available per period and the production volume per period. Effective time available = (Time per period) X per period (%Utilization of period) the cycle time may also be interpreted in the following ways: It is the time between consecutive releases of finished assembly's frail the last station of the line. It is the time between consecutive releases of semi - finished products between any two adjacent stations. It is the naxiniumti me allocated per station. The relationship between Cycle Time and duration of different work elements is explained with help of the following expression: where t, = duration of it" work element t "i,, = maximum work element duration from the above equation, we understand that cycle time (ct) must equal or exceed the maximum element time t,,,. but, it cannot exceed the total work content time, ct, total idle time (tit) the difference between the time required by any station to complete its operations and the cycle time is called the idle time of that station. it essential to treat the minimization of the sum of all stations' idle time, namely 'total idle time (tit) as an objective while designing an assembly line.

1.4.3. BENEFITS OF ASSEMBLY LINE BALANCING:

The benefits of assembly line balancing may be classified into two categories as represented here. Technical benefits -Minimizing the number of workstations for a given cycles. -Minimizing the cycle time for a given number of numbers of workstations. -Minimizing the balance delay (or) maximizing the balancing efficiency. -Minimizing the total idle time. -Minimizing the overall facility or line length.

1.4.4. Assembly line Balancing Objectives:

The main objective of line balancing is to distribute the task evenly over the work station and lime balancing aims at grouping the facilities or workers in an efficient pattern in order to obtain an optimum or most efficient balance of the capacities and flows of the production or assembly processes.

The aim of this is to minimizing workloads and workers on the assembly line while meeting a required output the most important objective of the assembly line balancing problem is to design an assembly line with the maximum balancing efficiency (be) or with the minimum balance delay. The aims and objectives of the present study are as follows:- -To reduce production cost and improve productivity -To determine number of feasible workstation. -To identify the location of bottleneck and eliminate them. -To determine machinery and equipment according to assembly mechanism. -To equally distribute the workloads among workmen to the assembly

line. -To optimize the production functions through construction of mix form of automation assembly and manual assembly. -To minimize the total amount of idle time and equivalently minimizing the number of operators to do a given amount of work at a given assembly line speed.

1.5. PDCA:

1.5.1 Introduction:

PDCA (plan–do–check–act or plan–do–check–adjust) is an iterative four-step management method used in business for the control and continuous improvement of processes and products.[1] It is also known as the Deming circle/cycle/wheel, the Shewhart cycle, the control circle/cycle, or plan–do–study–act (PDSA). Another version of this PDCA cycle is OPDCA.[2] The added "O" stands for *observation* or as some versions say: "Observe the current condition." This emphasis on observation and current condition has currency with the literature on lean manufacturing and the Toyota Production System.

The PDCA Cycle is a checklist of the four stages which one must go through to get from 'problem faced' to 'problem-solved.' The four phases are Plan- Do-Check-Act, and they are carried out in the cycle illustrated below (Fig.5)

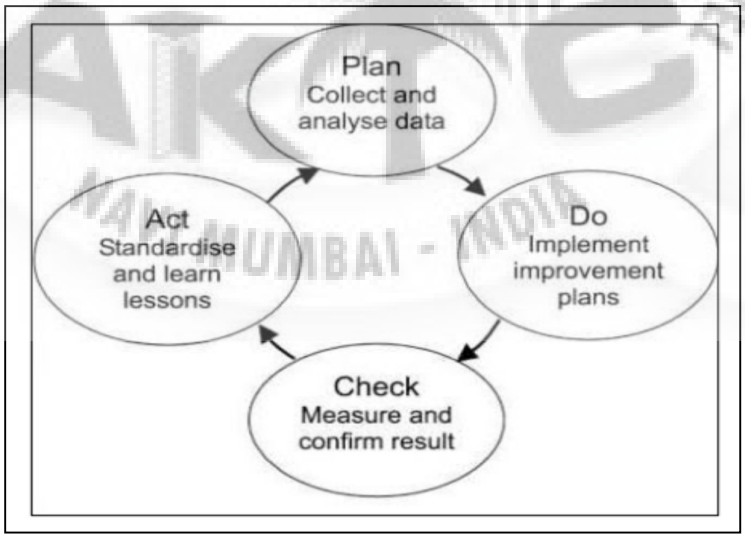


Fig.05: PDCA cycle

1. PLAN

- Identify the problem to be examined Formulate a specific problem. statement to clearly define the problem.
- Set measurable and attainable goals.
- Identify stakeholders and develop necessary communication channels to communicate and gain approval.
- Divide overall system into individual processes -map the process.
- Brainstorm potential causes for the problem Collect and analyze data to validate the root cause Formulate a hypothesis.
- Verify or revise the original problem statement.

2. DO

- Establish experimental success criteria
- Design experiment to test hypothesis
- Gain stakeholder approval and support for the chosen solution
- Implement the experiment/solution on a trial or pilot basis

3. CHECK

- Gather/analyze data on the solution
- Validate hypothesis
- If YES go to act
- Else go to plan, revise hypothesis/problem statement

4. ACT

- Identify systemic changes and training needs for full implementation
- Plan ongoing monitoring of the solution
- Continuous improvement
- Look other improvement opportunities

1.6. JUST IN TIME:

1.6.1 Introduction

Just - In – Time inventory is generally regarded as an efficient inventory management system. Many suppliers and retailers partner in the early 21st century to co-ordinate their Just – In – Time efforts. The JIT concept of production was introduced in Japan under the name of Kanban. It is generally associated with Japanese businessman Taichii Ohno. He introduced this production philosophy to meet the needs of the Japanese automobile market after World War II. Later JIT was adopted in United States, called as Learn Manufacturing. US companies seek to eliminate the wastes by calling it as Value Added manufacturing. It is a method that seeks to eliminate waste in processing Adhering to the edict that a stage of the process that does not add value to the product for the customer should be eliminated. By applying JIT many companies are improving their productivity.

Just- in – Time is both a philosophy and set of methods for manufacturing. According to this concept material and components are supplied to the work station just at the time they are required for use.

1.6.2 Purpose of JIT:

The purpose of JIT is to avoid waste associated with overproduction, waiting, excess inventory, total quality control and devotion to the customer. JIT inventory is intended to avoid situations in which inventory exceeds demand and places to manage the extra inventory. Manufactures using JIT processes want to use materials for production at levels that meet distributor or retailer demand but not in excess. Retailers only want to acquire and carry inventory that meets immediate customer demand as excess inventory requires storage and management cost. The list of seven wastes is the target for continuous improvement in production process. They are:

- Waste of overproduction: Eliminate by reducing setup times, synchronizing quantities and timing between processes, compacting layout, visibility, and so forth. Make only what is needed now.
- Waste of waiting: Eliminate through synchronizing work flow as much as possible, and balance uneven loads by flexible workers and equipment.

- Waste of transportation: Establish layouts to make transport and handling unnecessary if possible. Then rationalize transport and material handling that cannot be eliminated.
- Waste of processing itself: Extend thinking beyond economy of scale or speed, like why this part or product should be made at all, then why each process is necessary.
- Waste of stocks: Reduce by shortening setup times and reducing lead times, by synchronizing work flows and improving work skills, and even by smoothing fluctuations in demand for the product. Reducing all the other wastes reduces the waste of stocks.
- Waste of motion: Study motion for economy and consistency, economy improves productivity, and consistency improves quality.
- Waste of making defective products: Develop the production process to prevent defects from being made so as to eliminate inspection. At each process, accept no defects and make no defects.

1.6.3 The Features of JIT:

- There exist few reliable vendors that can deliver high quality inventory within very short time frames.
- Inventory is supplied in the nick of time in small lots which drastically reduces the carrying costs.
- Long term purchase contracts are entered into with suppliers at economical prices which curtail the paperwork and negotiation time associated with arriving at the supply price.
- The inspection of inventory takes place as and when received, paving the way for a lean inventory management department.
- Transportation costs with regard to the movement of inventory from the storage locations to the production sites can be avoided.
- Goods are produced as per the requirement of the end-user and hence over-production and the resultant excess holding of inventory can be avoided.
- Payments are made for batches of goods supplied as per contract terms, rather than for small lots, which leads to effective working capital management.

- The production cycle becomes shorter, as the waiting time and interruptions due to delays are avoided.
- Wastage due to production of defective products is eliminated as the output at every stage of production is inspected, before passing on to the next stage.

1.6.4 Advantages of Just- In-Time

- The use of just-in-time inventory has the following advantages:
- There should be minimal amounts of inventory obsolescence, since the high rate of inventory turnover keeps any items from remaining in stock and becoming obsolete.
- Since production runs are very short, it is easier to halt production of one product type and switch to a different product to meet changes in customer demand.
- The very low inventory levels mean that inventory holding costs (such as warehouse space) are minimized.
- The company is investing far less cash in its inventory, since less inventory is needed.
- Less inventory can be damaged within the company, since it is not held long enough for storage-related accidents to arise. Also, having less inventory gives materials handlers more room to manoeuvre, so they are less likely to run into any inventory and cause damage.
- Production mistakes can be spotted more quickly and corrected, which results in fewer products being produced that contain defects.

1.6.5 Disadvantages Associated with Just-In-Time Inventory:

- Despite the magnitude of the preceding advantages, there are also some disadvantages associated with just-in-time inventory, which are:
- A supplier that does not deliver goods to the company exactly on time and in the correct amounts could seriously impact the production process.
- A natural disaster could interfere with the flow of goods to the company from suppliers, which could halt production almost at once.
- An investment should be made in information technology to link the computer systems of the company and its suppliers, so that they can coordinate the delivery of parts and materials.
- A company may not be able to immediately meet the requirements of a massive and unexpected order, since it has few or no stocks of finished goods.

1.6.6 Examples of JIT Users:

TOYOTA

Toyota is considered by many to be the poster child for JIT success. The Toyota production strategy is highlighted by the fact that raw materials are not brought to the production floor until an order is received and this product is ready to be built. No parts are allowed at a node unless they are required for the next node, or they are part of an assembly for the next node. This philosophy has allowed Toyota to keep a minimum amount of inventory which means lower costs.

Important Factors to Toyota Success: Small amounts of raw material inventory must be kept at each node in production, so that production can take place for any product. These parts are then replenished when they are used. Accuracy in forecasting- is important so the correct amount of raw materials can be stocked.

DELL

Dell has also leveraged JIT principle to make its manufacturing process a success. Dell's approach to JIT is different in that they leverage their suppliers to achieve the JIT goal. They are also unique in that Dell is able to provide exceptionally short lead times to their customers, by forcing their suppliers to carry inventory instead of carrying it themselves and then demanding (and receiving) short lead times on components so that products can be simply assembled by Dell quickly and then shipped to the customer.

Important Factors to Dell's Success:

- Dependable suppliers with the ability to meet Dell's demanding lead time requirements.
- A seamless system that allows Dell to transmit its component requirements so that they will arrive at Dell in time to fulfil its lead times.

HARLEY DAVIDSON

Harley Davidson's use of JIT is mostly characterized by its transformation in the late World War II era from an inefficient manufacturer that solved all of its problems with extra inventory to a nimble manufacturer able to meet demand and provide short lead times.

Results of Harley Davidson's JIT Implementation:

- Inventory levels decreased 75 percent.
- Increased productivity.

Harley Davidson's success with the implementation of JIT had a lot to do with the fact that when JIT was put into practice, process problems could no longer be hidden by costly inventory that helped to meet ship dates. The inefficiencies in the processes were quickly identified and solved.

CHAPTER 2

LINE BALANCING

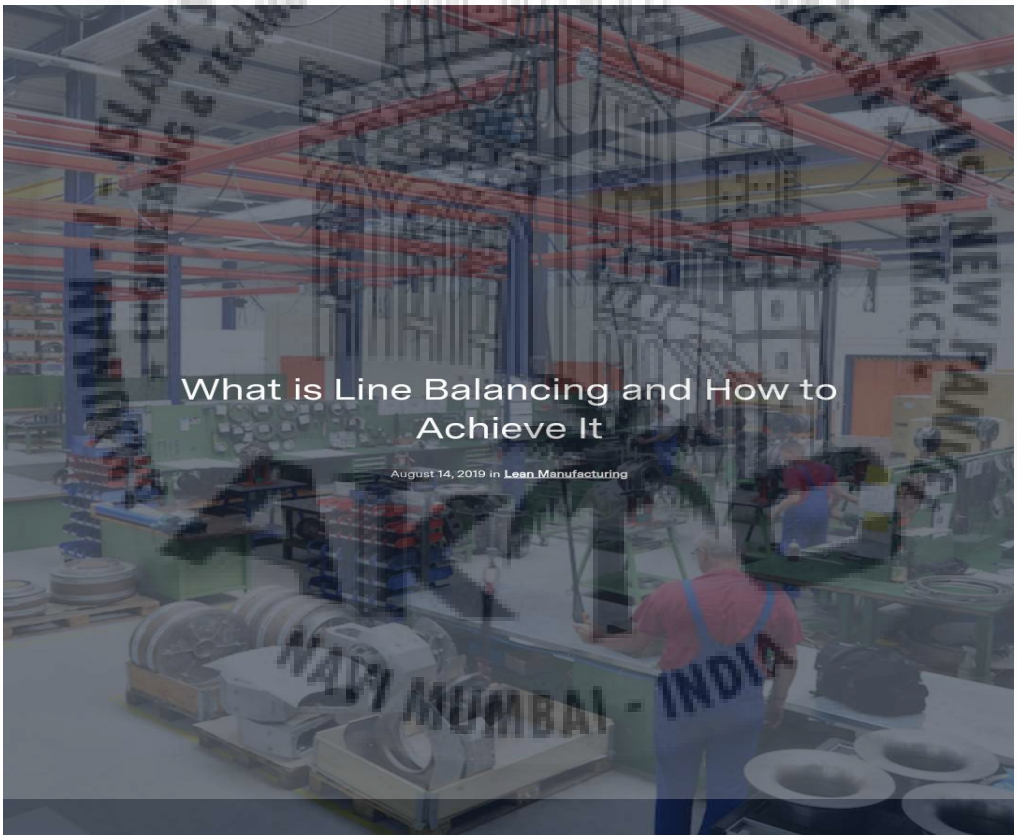
2.1 Line Balancing:

Line balancing is a production strategy that involves balancing operator and machine time to match the production rate to the Tact time.

Tact time is the rate at which parts or products must be produced in order to meet customer demand.

For a given production line, if production time is exactly equal to Tact time, then the line is perfectly balanced. Otherwise, resources should be reallocated or rearranged to remove bottlenecks or excess capacity. In other words, the quantities of workers and machines assigned to each task in the line should be rebalanced to meet the optimal production rate.

Fig 06: Line Balancing



2.2 LITERATURE REVIEW:

Assembly Line Balancing or simply Line Balancing (LB) is the problem of assigning operations to workstations along an assembly line in such a way that the assignment be optimal in some sense. Ever since Henry Ford's introduction of assembly lines, line balancing has been an optimization of production line problem to increase efficiency. The difference between an optimal and a sub-optimal assignment can yield economies (or waste) reaching millions of dollars per year (Falkenauer, unkown). The main objective of line balancing is to distribute the task evenly over the work station so that idle time of man of machine can be minimized. Line balancing aims for grouping the facilities or workers in an efficient pattern in order to; obtain an optimum or most efficient balance of the capacities and flows of the production or assembly processes (Mahto, Naveen Kumar & Dalgobind, 2013). The fundamental of line balancing problems is to assign the tasks to an ordered sequence of stations, such that the precedence relations are satisfied and some measurements of effectiveness are optimized. According to (Pianthong1), 2007) minimize the balance delay or minimize the number of work stations is one of the importance of line balancing techniques. The assembly line balancing problem has received considerable attention in the literature, and many studies have been made on this subject since 1954 (S. H.Eryuruk et al, 2006).The Largest Candidate, Kilbridge and Wester (column) and Ranked Positional Weights (RPW) are different heuristic methods commonly utilized in line balancing of bottleneck workstations and operations and also to arrange and distribute the description element time along the workstations in the system. Each of those methods could be results in a different type of workstations layout (P.Jaganathan, V., 2014).

2.2.1 Research Methodology:

To balance a production line Comparing the productivity and efficiency before and after implementing the balancing technique in line. Considering t-shirt production line selected from the sewing section. One garment order is chosen which was started in that line, style description, and fabric type and color was chosen & necessary data was accumulated from the selected line. Here in this line-3 is studied only for one sample model which is men's T-shirt for regular size and fabric type polyester. First the whole garment activity was analyzed and operational breakdown was created with operational description, process sequence, & machine requirements of the inputs to operating. Then workers were placed to different work stations based on operation sequence, experience of the operators and skills & machine types

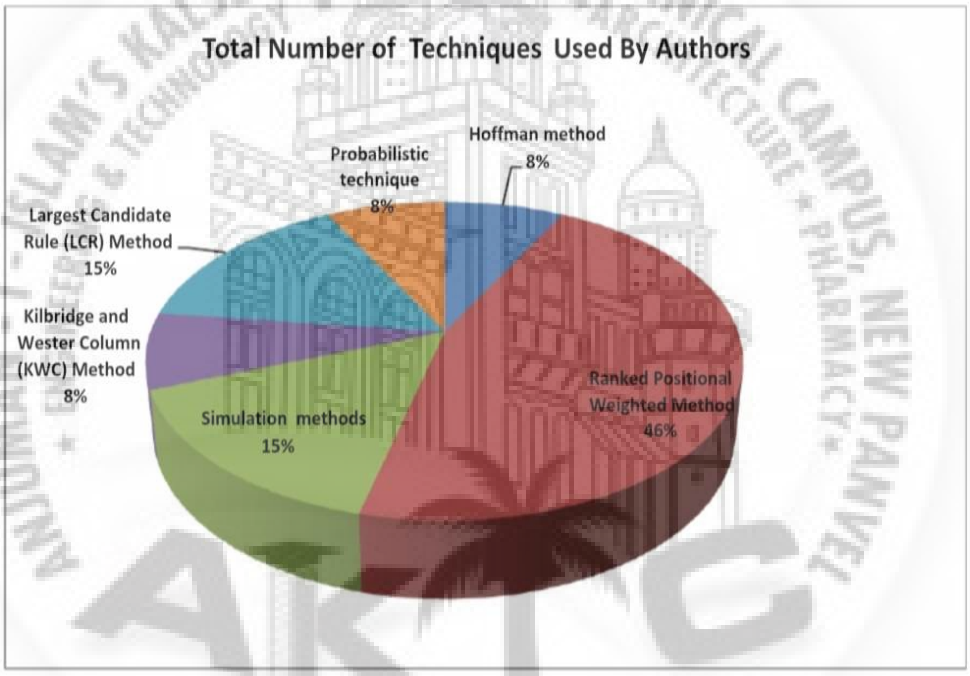


Fig 07 : Improvement techniques used by Author

and a standard time for each job was given to the operators. In the line researcher observing that the output for three day in the company and found that the company can't get the desired output or target output of the company plan which is 1000 shirts per day but the actual output (average output per day) is 850 up to 900 shirts per day. So that researcher try to develop standards time for each operation and individual workers performed by work study method which is sampling techniques and balancing the line by using Ranked positional weight and Largest Candidate techniques to increase the efficiency of the line, productivity, to decrease idle time in the line, to minimizes the bottlenecks and final to meeting the target output of the company

Benefits of Line Balancing

1. Reduce waiting waste

Waiting waste is one of the 8 types of waste of Lean manufacturing. It refers to any idle time that occurs when operations are not fully synchronized. For example, waiting waste occurs when operators are waiting for materials or for someone else to complete their task. Equipment downtime–time during which equipment is not operating–is another example of waiting waste. Line balancing ensures that all operators and machines work together in a balanced fashion. No operator or machine should be overburdened or idle. By minimizing downtime, line balancing reduces waiting waste.

2. Reduce inventory waste

Inventory waste is another type of waste. It corresponds to an excess of raw materials, work in progress (unfinished goods), or finished goods. Inventory waste indicates the inefficient allocation of capital.

Line balancing standardizes production, meaning it is much easier to avoid build-ups or surplus inventory. By reducing idle time, line balancing ensures that there is minimum work in progress. And finally, by bringing production time closer to Takt time, it guarantees on-time delivery.

3. Absorb internal and external irregularities

Line balancing reduces variations within a production line. A balanced production line is stable and flexible enough to adapt to changes.

For example, if customer demand changes–meaning Takt time changes–operations can be realigned quickly through line balancing. The consequences of changes brought to a balanced production line are predictable. It is thus much easier to modify the line to adjust the production rate.

4. Reduce production costs and increase profits

Perfect line balancing leads to workers and machines that perform in a fully synchronized manner. No operator is paid for standing idle. All machines are used to their full potential. In other words, manpower and machine capacity are maximized. Such process efficiency represents fewer costs and more profits.

2.2.2 Review of 5s

5S initially based on the Japanese acronyms of seiri (organization), seiton (neatness), seiso (cleaning), seiketsu (standardization) and shitsuke (discipline), is used as a platform for developing an integrated management system by the parallel use of total productive maintenance (TPM) (Bamber et al., 2000). Osada (1991) refers to 5S as thefive keys to a total quality environment. 5S is a system to reduce waste and optimize productivity and quality through maintaining an orderly workplace and using visual cues to achieve more consistent operational results. The practice of 5S aims to embed the values of organization, neatness, cleaning, standardization and discipline into the workplace basically in its existing configuration, and it is typically the first lean method implemented by firms. Kobayashi et al. (2008) make a distinction between 5S as a philosophy or way and 5S as a technique or tool by comparing the frameworks provided by Osada (1991) and Hirano (1995) respectively. From their study, they conclude that 5S tends to be recognized as a philosophy in Japan, but in the other hand it is likely to be considered as a technique or tool in the United Kingdom and United State of America. Osada (1991) views 5S as a strategy for organizational development, learning and change, whereas Hirano (1995) considers 5S to be an industrial formula that differentiates a company from its competitors.A common definition of 5S in the West is housekeeping (Becker, 2001; Chin and Pun, 2002; Ahmed and Hassan, 2003; Eckhardt, 2001). In the West both 5S and TPM are sometimes disregarded or at least underutilized (Douglas, 2002). A framework of applying 5S within a business (as appose to a personal philosophy of way of life) was first formalized in the early 1980s by Takashi Osada (Ho et al., 1995).The practice of 5S aims to embed the values of organization, neatness, cleaning, standardization and discipline into the workplace (Osada, 1991). In Japan the 5S practice was initiated in the manufacturing sector and then extended to other industries and services sector. The Toyota Production System provides a well-known example of 5S principles in practice, the early versions were based on 3-S this,became 4-S (Ohno, 1988).Boeing in the USA pursues 5S as a world-class strategy (Ansari and Modarress, 1997). Even with these prestigious and complex examples it appears that manyresearchers and practitioners have difficulty going beyond the simplest 5S concept. This is suggested by Hyland and others where they believe that Australian manufacturing firms have only a basic perception of the importance and the potentiality of 5S (Hyland et al., 2000). These authors found of ten continuous improvement tools they investigated the usage and perceived importance of 5S was lowly ranked.Therefore, we can say that there is no consensus about the scope of 5S. Much of Western literature still acknowledges 5S as housekeeping (Ahmed and Hassan, 2003; Becker, 2001; Chin and Pun, 2002; Eckhardt, 2001). However, 5S

is more frequently framed in the ―lean‖ philosophy (James-Moore and Gibbons, 1997; Hines et al., 2004; Kumar et al., 2006), since it encourages workers to improve their working conditions.5S is a manufacturing technique for work place organization and it is used to the implementation of lean conditions.5S is a reference to five Japanese works which described standardized method to improve the work in the organization. Now we will see every method of 5S in detail.

2.2.3 Origins of 5S

5S as a methodology has come out of the techniques within Total Productive Maintenance (TPM) and from the Toyota Production System (TPS). However many of the individual components such as creating ergonomic and efficient work places can be seen to owe their roots to people such as Taylor for his work on "scientific management" and Frank Gilbreth's "time and motion studies."

Frank Gilbreth showed that by improving the ergonomics of a bricklayers working methods he could reduce the number of individual movements required and increase the hourly output from 120 to 350 bricks laid each hour.

2.2.4 The Concept of 5S

5S is a methodical way to organize your workplace and your working practices as well as being an overall philosophy and way of working. It is split into 5 phases, each named after a different Japanese term beginning with the letter "S"; (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) hence the name 5 S.Line balancing ensures that all operators and machines work together in a balanced fashion. No operator or machine should be overburdened or idle. By minimizing downtime, line balancing reduces waiting wasteLine balancing ensures that all operators and machines work together in a balanced fashion. No operator or machine should be overburdened or idle. By minimizing downtime, line balancing reduces waiting waste

2.2.5 Seiri

5S Seiri or Sort is the first step in 5S, it refers to the sorting of the clutter from the other items within the work area that are actually needed]. This stage requires the team to remove all items that clearly do not belong in the working area and only leave those that are required for the processes in question. The necessary and unnecessary items available in the workplace should be sorted and classified.By sorting one can identify the materials, tools, equipment and necessary items for this. Frequently used items are placed near to reach while not frequently used items are placed after that. It helps to maintain the clean workplace and improves the

efficiency of searching and receivingthings, shortens the time of running the operation.Following are the rules of performing Seiri:*If there is any unnecessary things which is causing mixing of things should be clear out.

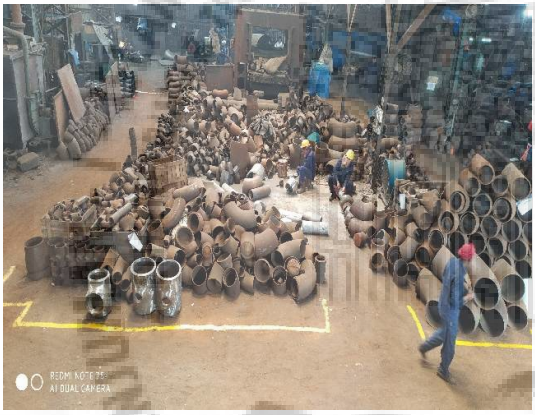


Fig 08 : Pre & Post applying of SORTING

2.2.6 Seiton

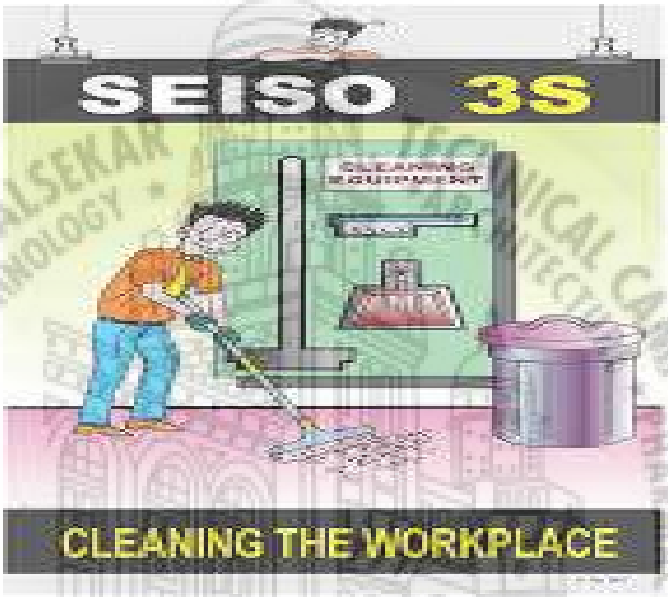
5S Seiton or Straighten is the process of taking the required items that are remaining after the removal of clutter and arranging them in an efficient manner through the use of ergonomic principles and ensuring that every item —has a place and that everything is in its place. It means cleaning & organizing the necessary items neatly andsystematically so that they can easily be taken and returned in the original place after use. By this we can increase the efficiency of production in the industry. The aim of this is to minimize the number of work that a worker has to perform during operation. Visualization of the workplace is also very important. Eg painting the floor helps to identify the places of storage of each material or transport ways, drawing out the shapes of tools makes possible the quick putting aside them on the constant places, colouring labels permit to identify the material, spare parts or documents. Tools, equipment, and materials must be systematically arranged for the easiest and the most efficient access. There must be a place for everything, and everything must be in its place

Fig 09: Set In Order

2.2.7 Seiso

5S Seiso or Sweep is the thorough cleaning of the area, tools, machines and other equipment to ensure that everything is returned to a —nearly new‖ status. This will ensure that any non-conformity stands out; such as an oil leak from a machine onto a bright, newly painted

cleanfloor. For asthetic view, it is essential to create a clean and regular working and living environment in the workplace. This is because dust, dirt and wastes can stop the efficiency of workplace. Cleaning should become a daily activity. Work place should be cleaned at regular intervals for better production. Regular cleaning permits to identify and to eliminate sources of disorder and to maintain the clean workplaces.During cleaning it is checked the cleanness of every item in the workplace on the regularbasis. A sheet of cleaning can also be made by



operator to check cleanness in the workplace. By providing this sheet, we can enhance the maintenance of the work place.

Fig 10: Seiso

2.2.8 Seiketsu

5S Seiketsu or standardize is the process of ensuring that what we have done within the first three stages of 5S become standardized; that is we ensure that we have common standards and ways of working[23]. Standard work is one of the most important principles of Leanmanufacturing[23]. It maintains the habit or standard of cleanness all time in the industry. It maintains good practices at the workplace. Standards should be very clear and easy to understand. There is a need after some period to choose the best ways to practice sort, set in order and cleaning. It is assumed that standards should not be implemented only in the processes such as production, maintenance, storing, but also in the administrative processes, for example: book-keeping, customer service,etc.

Fig 11: Seiketsu

2.2.9 Shitsuke

The final stage is 5S Shitsuke or sustain, ensuring that the company continue to continually improve using the previous stages of 5S, maintain housekeeping, and conduct audits and so forth[23]. 5S should become part of the culture of the business and the responsibility of everyone in the organization. It makes the habit for staffs of industry to learn all the above 4S.Trained skilled persons teaches the staff about the all 4S.The task here is undertaken by the leader directors. The directors should explain the importance of 5S to the personnel through various trainings. The knowledge of the personnel about 5S should be kept updated through the 5S boards to be formed at the workplace. To maintaining the standards and keeping the technique in safe and efficient order. It is also important to understand the need of executing the 5S rule on a fixed interval. The learning of the 5S rule is executed once a month by chosen team.

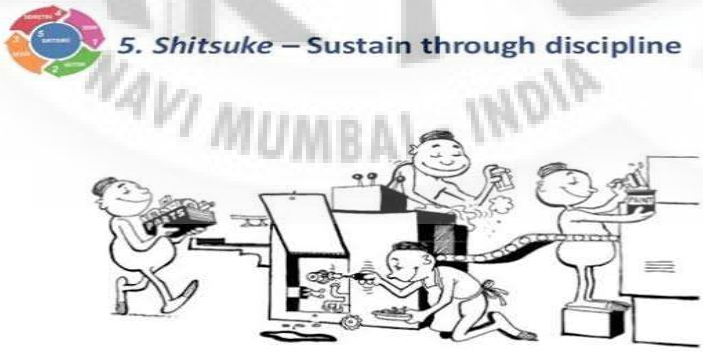


Fig 12: Shitsuke

CHAPTER 3

METHODOLOGY

3.1 Line Balancing

Line balancing is a production strategy that involves balancing operator and machine time to match the production rate to the Takt time.Takt time is the rate at which parts or products must be produced in order to meet customer demand.For a given production line, if production time is exactly equal to Takt time, then the line is perfectly balanced. Otherwise, resources should be reallocated or rearranged to remove bottlenecks or excess capacity. In other words, the quantities of workers and machines assigned to each task in the line should be rebalanced to meet the optimal production rate.

Steps in Line Balancing

There are four steps in solving line balancing described by G. Andrew (2006).

1. Drawing Precedence Diagram: Precedence diagram needs to be drawn to demonstrate a relationship between workstations. Certain process begins when previous process was done.
2. Determining Cycle Time: Cycle time is longest time allowed at each station. This can be expressed by this formula:

$$\text{Cycle time} = \frac{\text{Available time}}{\text{Desired output}}$$

This means the products needs to leave the workstations before it reaches its cycle time.

3. Assigning tasks to workstation: The tasks distributions should be taken after completing a time cycle. It's good to allocate tasks to workstation in the order of longest task times.

$$\text{Number of work Stations} = \frac{\Sigma \text{ Task Time}}{\text{Desired Actual Time}}$$

4. Calculating an Efficiency Line: This is done to find effectiveness of the line. The formula is given by:

$$\text{Line Efficiency} = \frac{\text{Sum of task times}}{\text{Number of workstation X Desired cycle time}}$$

Types of Line Balancing

There are two types of line balancing that include Static Balance and Dynamic Balance. Static Balance denotes long-term differences in capacity over a period of several hours or longer. Static imbalance results in underutilization of workstations, machines and people. Dynamic Balance refers to short-term differences in capacity such as over a period of minutes, hours at most. Dynamic imbalance occurs from product mix changes and difference in work time dissimilar to product mix.

Line balancing operates under two circumstances:

Precedence Constraint: Products cannot progress to other station if it doesn't complete necessary task at that station. It should not across other station because certain part needs to be performed before other activities.

Cycle time Restriction: Cycle time is maximum time for products spend in every workstation. Different workstation has different cycle time.

3.2 5s Methodology

5S is a workplace organization method that uses a list of five Japanese words: seiri (整理), seiton (整頓), seisō (清掃), seiketsu (清潔), and shitsuke (躾). These have been translated as "Sort", "Set In order", "Shine", "Standardize" and "Sustain".] The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The decision-making process usually comes from a dialogue about standardization, which builds understanding among employees of how they should do the work.

In some quarters, 5S has become 6S, the sixth element being safety(Safe)

Other than a specific stand-alone methodology, 5S is frequently viewed as an element of a broader construct known as visual control,visual workplace, or visual factory. Under those (and similar) terminologies, Western companies were applying underlying concepts of 5S before publication, in English, of the formal 5S methodology. For example, a workplace-organization photo from Tennant Company (a Minneapolis-based manufacturer) quite similar to the one accompanying this article appeared in a manufacturing-management book in 1986.

Fig 013:. 5S Cycle

3.2.1 Sort

Seiri is sorting through all items in a location and removing all unnecessary items from the location.

Yellow Tag. Red Tag

Fig 014: Sorting of materials into waste and usable components

Goals:

- Reduce time loss looking for an item by reducing the number of items.
- Reduce the chance of distraction by unnecessary items.

  Simplify inspection.

- Increase the amount of available, useful space.
- Increase safety by eliminating obstacles.

Implementation:

- Check all items in a location and evaluate whether or not their presence at the location is useful or necessary.
- Remove unnecessary items as soon as possible. Place those that cannot be removed immediately in a 'red tag area' so that they are easy to remove later on.
- Keep the working floor clear of materials except for those that are in use to production.

3.2.2. Set in order

Seiton is putting all necessary items in the optimal place for fulfilling their function in the workplace.

Goal:

- Make the workflow smooth and easy.

Implementation:

- Arrange work stations in such a way that all tooling / equipment is in close proximity, in an easy to reach spot and in a logical order adapted to the work performed. Place components according to their uses, with the frequently used components being nearest to the workplace.
- Arrange all necessary items so that they can be easily selected for use. Make it easy to find and pick up necessary items.

Fig 015 : Pre & Post Set in Order

3.2.3 Shine (seiso 清掃)

Seiso is sweeping or cleaning and inspecting the workplace, tools and machinery on a regular basis.

Goals:

- Improves the production process efficiency and safety, reduces waste, prevents errors and defects.
- Keep the workplace safe and easy to work in.
- Keep the workplace clean and pleasing to work in.
- When in place, anyone not familiar to the environment must be able to detect any problems within 50 feet in 5 sec.

Implementation:

- Clean the workplace and equipment on a daily basis, or at another appropriate (high frequency) cleaning interval.
- Inspect the workplace and equipment while cleaning.

Fig 016: Worker carrying out SHINE process

3.2.4. Standardize (seiketsu 清潔)

Seiketsu is to standardize the processes used to sort, order and clean the workplace.

Goal:

- Establish procedures and schedules to ensure the repetition of the first three 'S' practices.

Implementation:

- Develop a work structure that will support the new practices and make it part of the daily routine.
- Ensure everyone knows their responsibilities of performing the sorting, organizing and cleaning.
- Use photos and visual controls to help keep everything as it should be.
- Review the status of 5S implementation regularly using audit checklists.

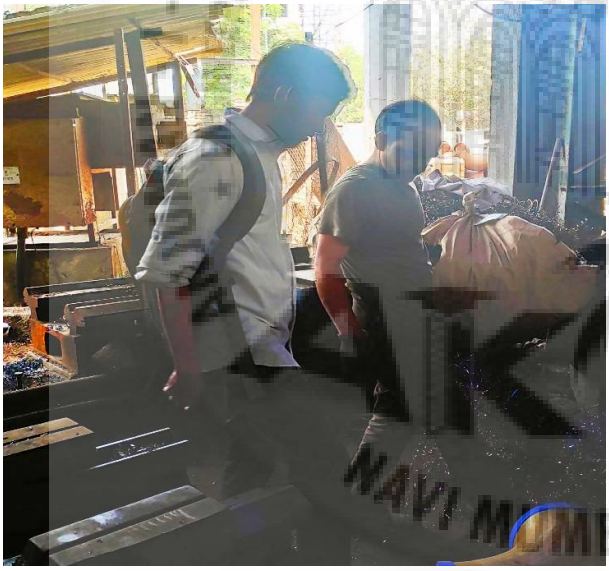


Fig 017 : Supervising workers to maintain Standardization

3.2.5. Sustain/self-discipline (shitsuke しつけ)

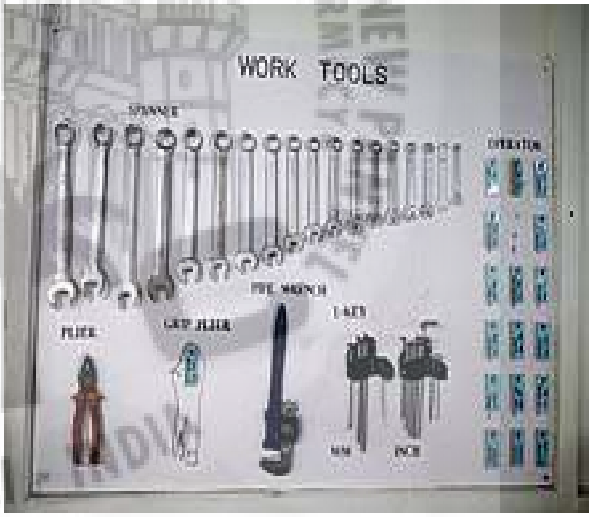


Fig 18 : Standardize

Shitsuke or sustain the developed processes by self-discipline of the workers. Also translates as "do without being told".

Goal:

- Ensure that the 5S approach is followed.

Implementation:

- Organize training sessions.
- Perform regular audits to ensure that all defined standards are being implemented and followed.
- Implement improvements whenever possible. Worker inputs can be very valuable for identifying improvements.
- When issues arise, identify their cause and implement the changes necessary to avoid recurrence.

3.2.6 Safety

It is a new 'S' introduced recently which means SAFETY. It is one of the most important aspect in any industry i.e. safety of components, machine, man etc.

Fig 019 : Workers practising safety measures while working

Fig 020 : Safety Protocol

CHAPTER 4

ANALYSIS

4.1 Operations occurring in Line Balancing

1. Cutting, Mandrel and forging -. 14.4mins
2. Blasting. - 15mins
3. Lathe machining, gas cutting,

   & Marking. -. 13 mins

4. Punching, surface finishing. - 12 mins
5. Coating and rounding. -. 8mins

4.2 Calculations:

By using Wester's & Kilbridges method of line balancing (In this method of line balancing the largest time taken for the operation is considered as the cycle time for purpose of analysis)....i.e. Here most time taken is for Blasting =15 mins

Before Grouping:-

Summation (te)= 14.4+15+13+12+8

=62.4mins+20mins(DELAY)

Balance Efficiency (Eff): (Summation te)/(n *tc)

=(62.4+20)/(10*15)

=0.6103*100=61.03%

After Grouping:-

Summation (te)=62.4mins

Balance Efficiency (Eff):(Summation te)/(n*tc)

=62.4/(5*15)

= 0.8332*100=83.32%

Hence,the effeciency, found

Before grouping= 61.03%

After grouping = 83.32%

4.3 Observation table for 5S

For Week 1 (Date: 02 March 2020)

1. Total Item (X) = 120
2. Defective Item (Y) = 48
3. Waste Eliminated (M) = 14
4. Total Waste (N) = 16
5. Total No. of Tools (A) = 26
6. Total No. of Tools (NOT IN SEQUENCE) (B) = 15
7. Total No. of Fall Arrangement (I) = 12
8. Total No. of Fall Condition (J) = 20
9. Required Cleaning (E) = 1
10. Cleaning Not done (F) = 0.6

4.3.1 SI (SORT/SEIRI)

1. Material Availability Rating = 1
2. Defective Goods (1- (Y/X)) = 0.66
3. Operating Condition Rating = 1
4. Elimination Of Waste (1- (M/N)) = 0.12

Total Rating =2.78

4.3.2 S2 (SET IN ORDER/SEITON)

1. Sequence Rating (1- (B/A)) = 0.4
2. Material Arrangement Rating = 1
3. Tool Arrangement Rating = 1

Total Rating = 2.4

4.3.3 S3 (SHINE /SIESO)

1. Process Path Cleaning Rating = 1
2. Working Environment Rating (1- (I/J)) = 0.4
3. Safety Rating = 1
4. Cleaning Consistency Rating (1- (F/E)) = 0.4

Total Rating = 2.8

4.3.4 S4 (STANDARDIZE / SEIKETSU)

Standardize Rating is the average of previous 3S, because standard of any system will rise and fall by mean rate depending factor.

STANDARDIZE = SEIRI + SEITON + SIESO

S4 = (S1 + S2 + S3)/ 3

= (2.78 + 2.4 + 2.8)/3

= 2.44

4.3.5 S5 (SUSTAIN/ SHITSUKE)

Sustain Rating will be depending on previous 4S, because without that regularity will not be maintained. Therefore, Shitsuke/Sustain Rating will be the average of previous 4S Ratings.

S5= (S1 + S2 + S3 +S4)/ 4

= (2.78 + 2.4 + 2.8 + 2.44)/ 4

= 2.44

4.4 Calculation (Efficiency for Week 1):

$$\eta = \frac{(S1+S2+S3+S4+S5)\times 100}{25}$$

$$= (2{,}78 + 2.4 + 2.8 + 2.44 + 2.44)X\ 100/_{25}$$

$$= \frac{12.86}{25} \text{ X } 100$$

= 51.19 %

4.6 Result:

Sr No.	Date	(S1 + S2 + S3 + S4 + S5) X100/ 25	Efficiency (%)
1	02 March '20	$\frac{(2.78 + 2.4 + 2.8 + 2.44 + 2.44) \times 100}{25}$	51.19
2	09 March '20	$\frac{(3.295 + 2.3 + 3.2 + 2.93 + 2.93) \times 100}{25}$	53.63

TABLE : EFFICIENCY OF THE SYSTEM

From the above table; it is evident from the table that the efficiency of the system has increased significantly over a week of implementation of 5S. Pertaining implementation of 5S will lead to ultimate quality of production increasing the profits to company. Also, it will enhance the working conditions for the employees which will ultimately reap best fruits to the company. It's a win-win for both company & the customer.

CHAPTER 5

EXPECTED OUTCOMES

5.1 The expected outcomes of the following 5S are as follows:

1S:

- Process development by cost reduction
- Stock confinement
- Better usage of workplace
- Prevention of losing tools

2S:

- Process growth
- Increasing Efficiency
- Shortening of time required for searching necessary things.

3S:

- Improvised working conditions for workers.
- The number of customers has been increased after maintaining a clean and neat layout.
- Machine maintenance cost has been reduced.

4S:.

- The standards of the company came to next level.
- Improvement in safety has supported in reducing the injuries of workers.
- Slips and falls of the material have been reduced.
- Travel time of materials is reduced which led to reduction of work hazards.

5S:

- It gives a scope for Workers participation in the work area design and maintenance.
- Workers absenteeism has been lowered down.
- Increasing of the awareness and morale.
- Decreasing of mistakes quantity resulting from the inattention.
- Proceedings according to decisions.
- Improvement of the internal communication processes.

Fig 021: 5S Expected Outcome

5.2 Line Balancing outcomes'

1. Experiment on a new heuristic assembly line balancing in real-life manufacturing of pipes joint assembly plant case results in shorter physical line length and production space utilization improvement, because the same number of workers can be allocated to fewer workstations.

Computerized Line Balancing:

Line Balancing sometimes becomes difficult to deal with as the size of the line balncing system increases.There are software packages that will balance large lines quickly and effectively.

IBM COMSOAL (Computer Method for Sequencing Operations for Assembly Lines) and **GEs ASYBL (** Assembly Line Configuration Programme) can assign hundreds of work elements to work stations on an assembly line.They use various *heuristics* to balance the line at an acceptable level of efficiency.

Simulation tools such as Fact-Model, Arena , to modeling the production line and the works estimated are used to reduce the line unbalancing causes and relocate the workforce associated to idle time, eliminating the bottleneck and improving the productivity.

The **POMs** for windows software lets the user select from 5 different heuristics :

1. Rank Position Method
2. Longest Operation Time
3. Shortest Operation Time
4. Most no. of following Task
5. Least no. of following Task

These heuristics specify the order in which the work elements are allocated to work stations.

CHAPTER 6

DISCUSSIONS & CONCLUSION

6.1 Conclusion:

From the study of **ASSEMBLY LINE BALANCING** it is found that assembly lines are flow-line production systems, where a series of workstations, on which interchangeable parts are added to a product. The product is moved from one workstation to other through the line, and is complete when it leaves the last workstation. Ultimately, we have to work for assigning the workstations so that predetermined goal is achieved. This can be done by minimization of the number of workstations and maximization of the production rate as studied in the literature survey. It has been also observed that equipment costs, cycle time, the correlation between task times and equipment costs and the flexibility ratio needs a great attention. After applying balancing methods to existing assembly line by using cycle time 15 min then methods give an more efficient assignment of work element with improvement of line efficiency from 61.03 % to 83.32 % reduced idle time upto some extent, increase production rate . So any one method from above methods is applicable for balancing of existing assembly line.

5S approach should not be treated as a short term programme; rather it requires standardisation and consistent policies for ensuring long term implementation plans for realisation of organisational objectives. A successful 5S application is dependent on updating the education and trainings to be provided by the organisation the employees. Therefore, it is recommended that future facilitators should recognise on several factors that contribute to the successful implementation of 5S and as well as to be aware with factors that influence the employees' active involvement in 5S programme. The 5S is an effective management tool which can improve housekeeping, environmental conditions and health and safety standards. 5S sort stage eliminates unused, unwanted material from the shop floor which reduces clutter. In **Navkar Fittings & Forgings Pvt Ltd,Taloja** Industries after sort stage approximately 200sq.ft. space is available for use. Set in order allocates space for components, materials and tooling in organisation results in reduction in searching time. As searching (non productive) time reduces, productivity in-creases. Materials are stored at its allocated space so that it becomes very easy to find out material stock level. Results of 5S are visible within short period of time as seen in the table of efficiency above. Employees in the organisation become self disciplined

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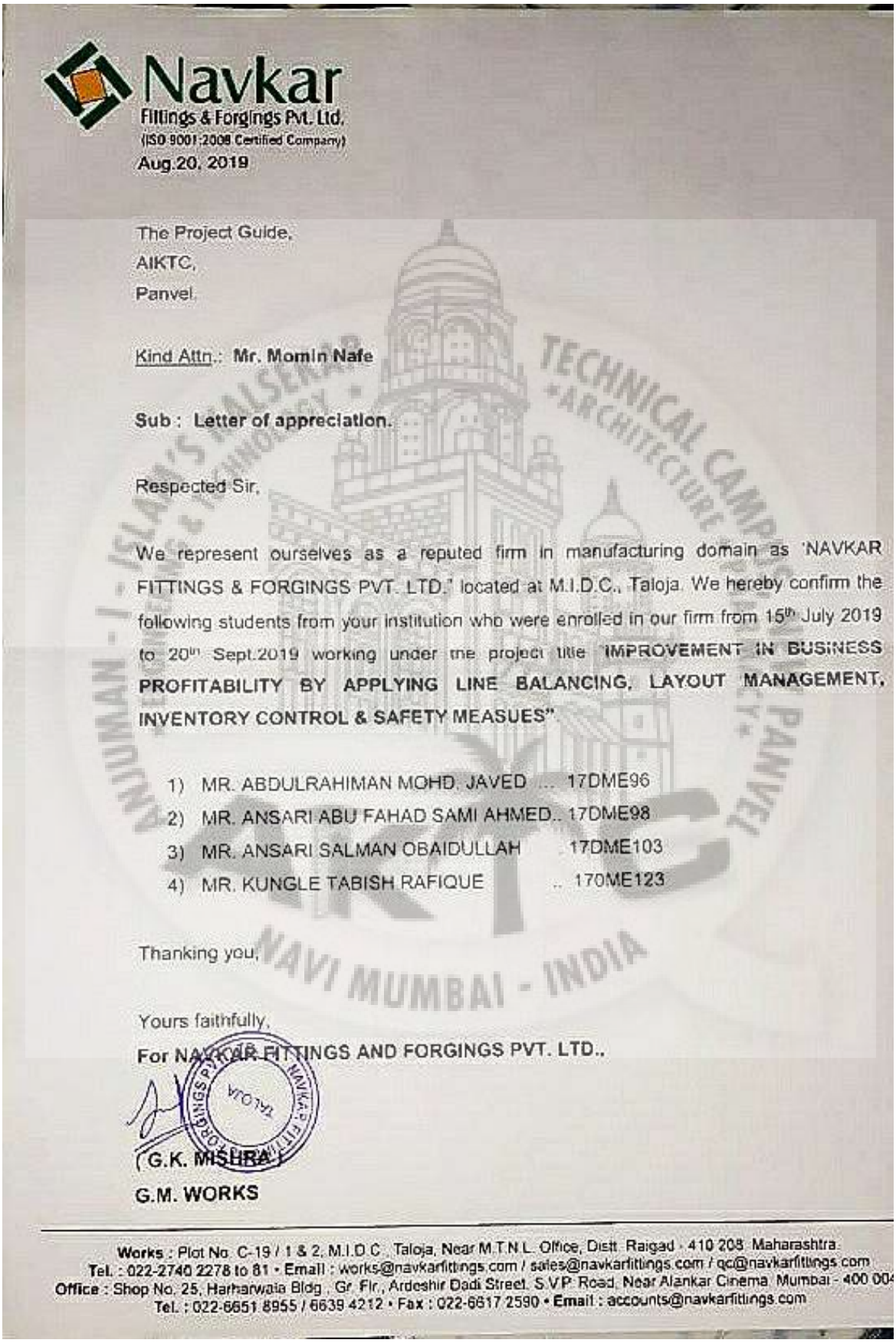

Navkar
Fittings & Forgings Pvt. Ltd.
(ISO 9001:2008 Certified Company)

Aug.20, 2019

The Project Guide,
AIKTC,
Panvel.

Kind Attn.: **Mr. Momin Nafe**

Sub : Letter of appreciation.

Respected Sir,

We represent ourselves as a reputed firm in manufacturing domain as 'NAVKAR FITTINGS & FORGINGS PVT. LTD." located at M.I.D.C., Taloja. We hereby confirm the following students from your institution who were enrolled in our firm from 15th July 2019 to 20th Sept.2019 working under the project title **IMPROVEMENT IN BUSINESS PROFITABILITY BY APPLYING LINE BALANCING, LAYOUT MANAGEMENT, INVENTORY CONTROL & SAFETY MEASUES"**

1) MR. ABDULRAHIMAN MOHD. JAVED ... 17DME96
2) MR. ANSARI ABU FAHAD SAMI AHMED.. 17DME98
3) MR. ANSARI SALMAN OBAIDULLAH 17DME103
4) MR. KUNGLE TABISH RAFIQUE .. 17DME123

Thanking you,

Yours faithfully,

For NAVKAR FITTINGS AND FORGINGS PVT. LTD..

(G.K. MISHRA)
G.M. WORKS

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