IMPROVING EFFICIENCY OF THE ASSEMBLY LINE BY IMPLEMENTING LEAN TECHNIQUES

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Abstract*—Assembly line is a manufacturing process in which the component moves from one workstation to another workstation where the parts are assembled in sequence up to the final assembly. Many companies are trying to make assembly line more efficient in order to remain competitive, however not many of them are successful in the process due to various reasons like Non value added time, Ergonomics aspects, inefficient training to the workers etc. These are all the causes why the assembly line does not perform up to the mark. This project identifies the various improvements by using various IE tools where the efficiency of the assembly line can be increased without increasing the efforts.

***Index Terms*— Lean, 5S, PDCA, Kaizen, Standardization**

I. INTRODUCTION

Lean Manufacturing or simply Lean is a systematic method for waste minimization ("Muda") within a manufacturing system without sacrificing productivity. Lean manufacturing makes obvious what adds value and eliminate anything that is not adding value. This philosophy is derived Mostly from Toyota Production System(TPS) and identified Lean only in 1990s.

In spite of the benefits India is still in the infancy stage of lean manufacturing. The awareness of Lean concept in Indian industry is still very less and only a handful of industry are adopting it.

Therefore, this paper deals with the various lean techniques that can be adopted in an assembly line to reduce waste "MUDA" and improve the efficiency of the assembly line.

The assembly line consists of 11 workstations and runs on 3 shifts. Primarily, the Assembly line had some problems like

i. The setup was in a manner that it physically stressed out workers quickly due to multiple bending and stretching
ii. Lead time increased as there was no proper workstation allocation.
iii. Inventory for 8 hours of production is maintained which required Large inventory space.
iv. No Standard Operating Procedure issued to working staff

In order to eliminate these problems we Redesigned the workplace, creating action plans, found better work combination and prepared Work Instructions which in turn will improve the Quality of the product, Ergonomics of the workstation ,Reduce non value added time and Improve Productivity of the Assembly line.

II. LITERATURE REVIEW

2.1 Lean

Shah R. and Ward P.T addresses the confusion and inconsistency associated with ‘‘lean production.’’ They attempt to clarify the semantic confusion surrounding lean production by conducting an extensive literature review using a historical evolutionary perspective in tracing its main components. They identified the key set of measurement items by charting the linkages between measurement instruments that have been used to measure its various components from the past literature, and using a rigorous, two-stage empirical method and data from a large set of manufacturing firms, we narrow the list of items selected to represent lean production to 48 items, empirically identifying 10 underlying components. In doing so, they mapped the operational space corresponding to conceptual space surrounding lean production. Configuration theory provides the theoretical underpinnings and helps to explain the synergistic relationships among its underlying components.[1]

As Robert B. Pojasek stated in his journal it's all too easy to dismiss process improvement initiatives as the “flavor of the month.” This may contain some truth but if we want to ensure a lasting effect and continuous improvement, we need approaches with more “staying power.” Two proven approaches that currently are very popular: “lean” and “six sigma.”He came to a Conclusion that both lean and six sigma work best when they are implemented using the structured decision-making tools featured in the Systems Approach for Process Improvement. The Systems Approach enhances both lean and six sigma -- and can even help integrate the two methodologies.[2]

Perumal Puvanasvaran, Hamdan Megat said in their paper that all Original Equipment Manufacturers (OEM) organizations in Aerospace, Automotive and Electronics industries had to upgrade their functions to improve through strategic initiatives. One such initiative is Lean Process Management. Lean Process Management has proven to aid organizations in developing manufacturing and administrative management solutions and make the organization a leaner at the same time a ‘fitter’ one, achieving World Class standards in terms of production, quality, marketing, etc. He has stated that formulating an effective lean process is a must and another important reason he suggested is the employee’s development aspect. This employee’s development is basically the problem solving capabilities of the employees while implementing the Lean through clear cutting protocols or processes of Lean Process Management. The employees need to be developed and equipped to contribute optimally to the process. Because of this he suggested to develop an employee’s development system which the author has trademark it as People Development System (PDS) to enhance problem solving capability among its employees while implementing the lean process management there. On the whole, the lean process management and the resultant PDS is having positive applications, and importantly could also have positive applications in the future as well.[3]

2.2 Kaizen

Jignesh A. Bhoi, Darshak A. Desai and Rohit M Patel stated in their journal that the ultimate goal of all industries is to enhance productivity through simplified system and incremental improvements by applying some modern available techniques. “Kaizen” is one of the

most recognized techniques of continuous improvement. This paper discusses various literatures and presents a Concept & Methodology of Kaizen which will helpful to new research in different fields. Besides this, one representative "Kaizen Idea Sheet Format" is presented in this paper which may be useful to different kinds of Industries and this will helpful to the Kaizen users and researchers.[4]

2.3 Poka-Yoke:

Poka-yoke is a concept in total quality management which is related to restricting errors at source itself. It deals with "fail-safing" or "mistake-proofing". A poka-yoke is any idea generation or mechanism development in a total productive management process that helps operator to avoid (yokeru) mistakes (poka). The concept was generated, and developed by Shigeo Shingo for the Toyota Production System.[5]

Yash Dave, Dr. Nagendra Sohani paper focuses their work on the Poka-Yoke eliminating the defects of human origination by reducing the opportunity for defects. Rejection of manufactured parts at various stages of manufacturing cannot be tolerated now days in production scenario due to tough competition worldwide. Most industries are moving towards zero defect production. To implement this, the first and most important thing is to prevent the error or completely eliminate the error with the application of some proven techniques used to solve the problem founding in frame body.[6]

2.4 Gemba

Md. Sarwar Hossen in his paper explained about Gemba walk and how it can be used in industries. he stated its walking around the real place of value addition which is, where the actual work is being done. However, he stated that precautions are required for practicing this management technique. Using Gemba Walk following specific guidelines will certainly result in enormous benefit to the organization.[7]

The aim of this research was to observe Manager's communication with employees and how it effects many things such as employee loyalty, organization performance. This paper stated that managers serve the same goal although the communication policies and techniques differ. Managers' face-to-face communication with their employees not only make workers feel good but also strengthen their connection to organization and employees who always feel the support of their managers and see them nearby could focus on their works much more. In order to ensure this, managers should spend less time in their offices and be together with their employees on field.[8]

2.5 5s:

5S is a basic foundation of Lean Manufacturing systems. It is a tool for cleaning, sorting, organizing and providing the necessary ground work for work piece improvement. RS Agrahari, P A Dangle and KV Chandratre 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. It also intends to build a stronger work ethic within the management and workers who would be expected to continue the good practices.[9]

There is a real need for empirical studies in field of new management systems and their impact on company's performance. As importance role of continuous improvement in today's organizations, and lack of sufficient evidence to show the positive impact of 5S on organizational performance, Arash Ghodrati, Norzima Zulkifli paper aims to determine performance factors and characteristics in industrial organizations and identifying the effectiveness of 5S implementation on organizational performance as well. Surveying method is used and data collection is done by distributing questionnaire among five target organizations which have implemented 5S techniques. The target organizations are chosen from different industries and diverse field of work. The results of this research obtained from a comparative measurement of organizational performance before and after 5S implementation. The results show that 5S is an effective tool for improvement of organizational performance, regardless of organization type, size, its production or its service. Consequently, 5S techniques would strongly support the objectives of organization to achieve continuous improvement and higher performance.[10]

2.6 Standard Work:

Lean Manufacturing is a concept frequently used by industries in order to reduce costs and for improve quality in manufacturing operations. Lean Manufacturing is a multi-step process to identify and prioritize waste in the form of non-value-adding activities also provides guidelines to reduce or eliminate these wastes. Rakesh Kumar and Dr.Vikas Kumar paper presents implementation of Standard work enabler of Lean Manufacturing in a manufacturing system .In due course of implementation of Standard work enabler of Lean manufacturing; machine-work is separated from operator-work so that machines work independently as much as possible. Standard work combination tables specify exactly how all work is performed. Practical examples of Takt time calculation, standardization of work including flow improvement with introduction of U-shaped lines, kaizen, visual management, and lost time analysis are reviewed. In Standard work value chain of one manufacturing cell is mapped in terms of flow of material, deployment of operator and utilization of man and machine is reviewed. Basic information about man and machines are recorded and analyzed hence making Standard work a dominating tool in Lean manufacturing implementation. This paper is an attempt to present real life example of improvement gained through implementation of Standard work enabler.[11]

2.7 PDCA

PDCA is based on the "Shewhart cycle," and was made popular by Dr. W. Edwards Deming, considered by many to be the father of modern quality control. During his lectures in Japan in the early 1950s, Deming noted that the Japanese participants shortened the cycle's steps to the now traditional plan, do, check and act. It is interesting to note that Deming preferred plan, do, study, act because the translation of "study" from Japanese to English has connotations closer to Shewhart's intent than does "check." This model has been around for 60 years and it is relevant in today's public health world, providing a defined and well tested process to achieve lasting improvement to the problems and challenges public health is now facing.[12]

Phases of the PDCA Model:

i. **Plan**- The objective for plan is to plan for changes and predict the results.
ii. **Do**- The plan is executed by taking small steps in controlled circumstances
iii. **Check**- The results are studied
iv. **Act**- The organization takes action to improve the process.

III. AIM

The Aim of this project was to

i. Specify standard operating procedure clearly by using
   a. Standard Operating Sheet
   b. Standard Work Combination
   c. Cycle time diagram
   d. Work combination Table.
ii. Create a setup that reduces the physical stress to worker.
iii. Reduction in lead time by removing the unnecessary tasks.
iv. Using GEMBA WALK to maintain quality and decrease component damage.
v. Deletion of non value adding activity leading to reduction in workstation.

IV. Methodology

4.1. PDCA

Plan: The purpose of this phase is to investigate the current situation, fully understand the nature of any problem to be solved, and to develop potential solutions to the problem that will be tested.

i. **Collect data on the current process**- Baseline data that describe the current state are critical to further understanding the process and establishing a foundation for measuring improvements. For collection of data on current process we do following techniques.
   a) Standard Operation Sheet
   b) Standard Work Instruction
   c) Cycle time Diagram
   d) Work Combination Table
ii. **Identify potential improvements-** to address the root cause. All the different techniques like Gemba Walk, 5s, Poka Yoke are kept in mind and various improvements are noted down.
iii. **Develop an improvement theory**-An improvement theory is a statement that articulates the effect that you expect the improvement to have on the problem. Writing an improvement theory crystallizes what you expect to achieve as a result of your intervention, and documents the connection between the improvement you plan to test and the measurable improvement objective.
iv. **Develop an action plan**-indicating what needs to be done, who is responsible, and when it should be completed.

Do-The purpose of this phase is to implement the action plan developed from the planning phase, Collect data after implementation And Document all the improvements done.

Check- This phase involves analyzing the effect of the intervention. Compare the new data to the baseline data to determine whether an improvement was achieved, and whether the measures in the aim statement were met. Reflect on the analysis, and consider any additional information that emerged as well. Compare the results of your test against the measurable objective.

Act-This phase marks the culmination of the planning, testing, and analysis regarding whether the desired improvement was achieved. Here 3 cases might arise

i. **Adopt-** Standardize the improvement if the measurable objective has been met. This involves establishing a mechanism for those performing the new process to measure and monitor benchmarks on a regular basis to ensure that improvements are maintained.
ii. **Adapt-** This might occur when the data collected were not sufficient, circumstances have changed, so The team may decide to repeat the test, gather different data, revise the improvements.
iii. **Abandon-** If the changes made to the process did not result in an improvement, consider lessons learned from the initial test, and return to the "Plan" phase. The team will then need to engage in the Plan cycle to develop a new action plan, and move through the remaining phases.

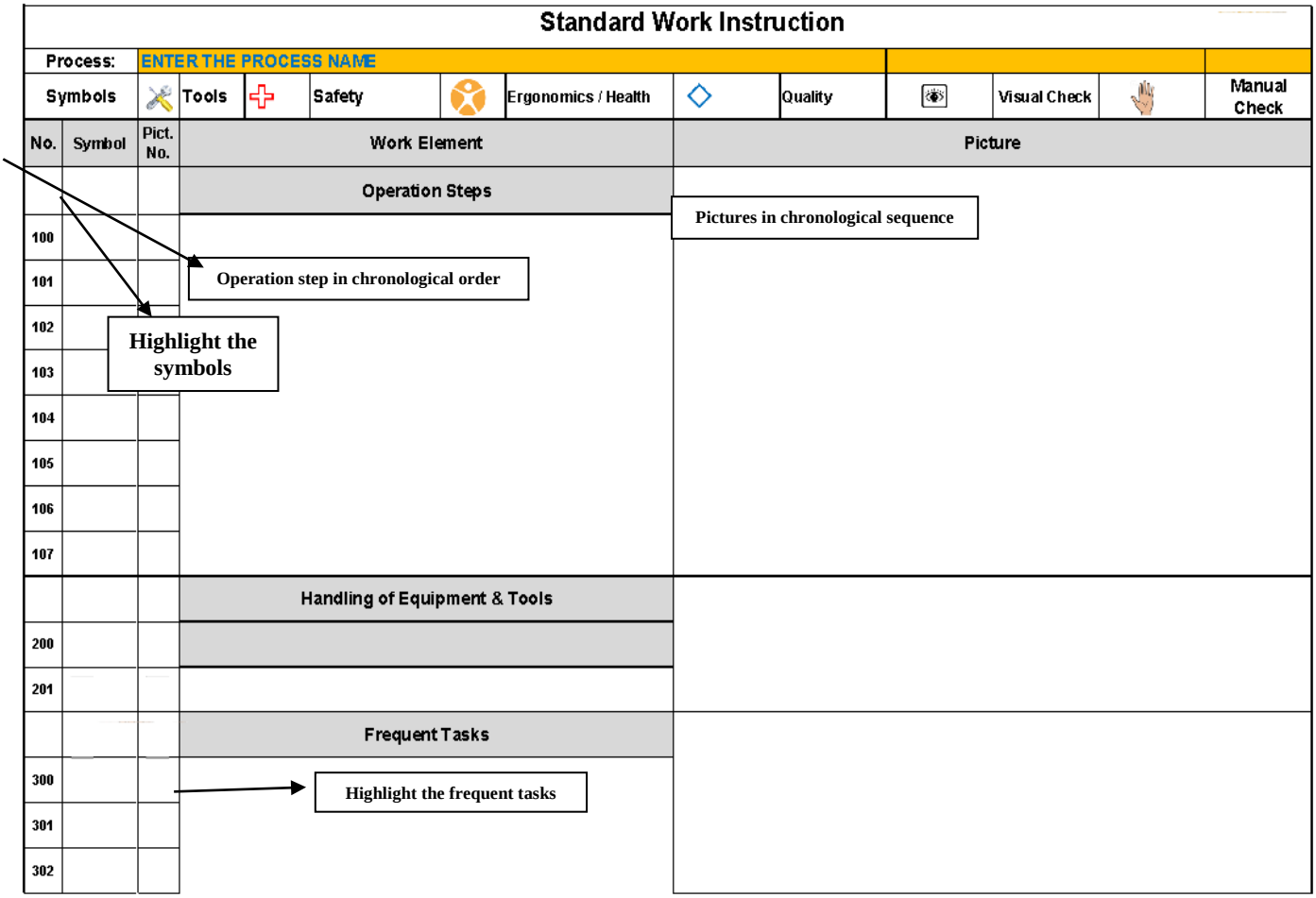
4.1.1 Standard work Instruction(SWI)

Standardized work instruction are instructions designed to ensure that processes are consistent, timely and repeatable, it is often printed and posted near the operator work station. This is used to train new operators and guide old operators. it lists the steps of the job , detailing any special attention that may be required to perform the job safely with utmost quality and efficiency.

Standard work instruction is done in 3 steps:

i. Go into each operation step and describe it with a meaningful sentence
ii. Use pictures for more details and link them to the related operation step
iii. Show in each operation step whether there is a special focus on key element

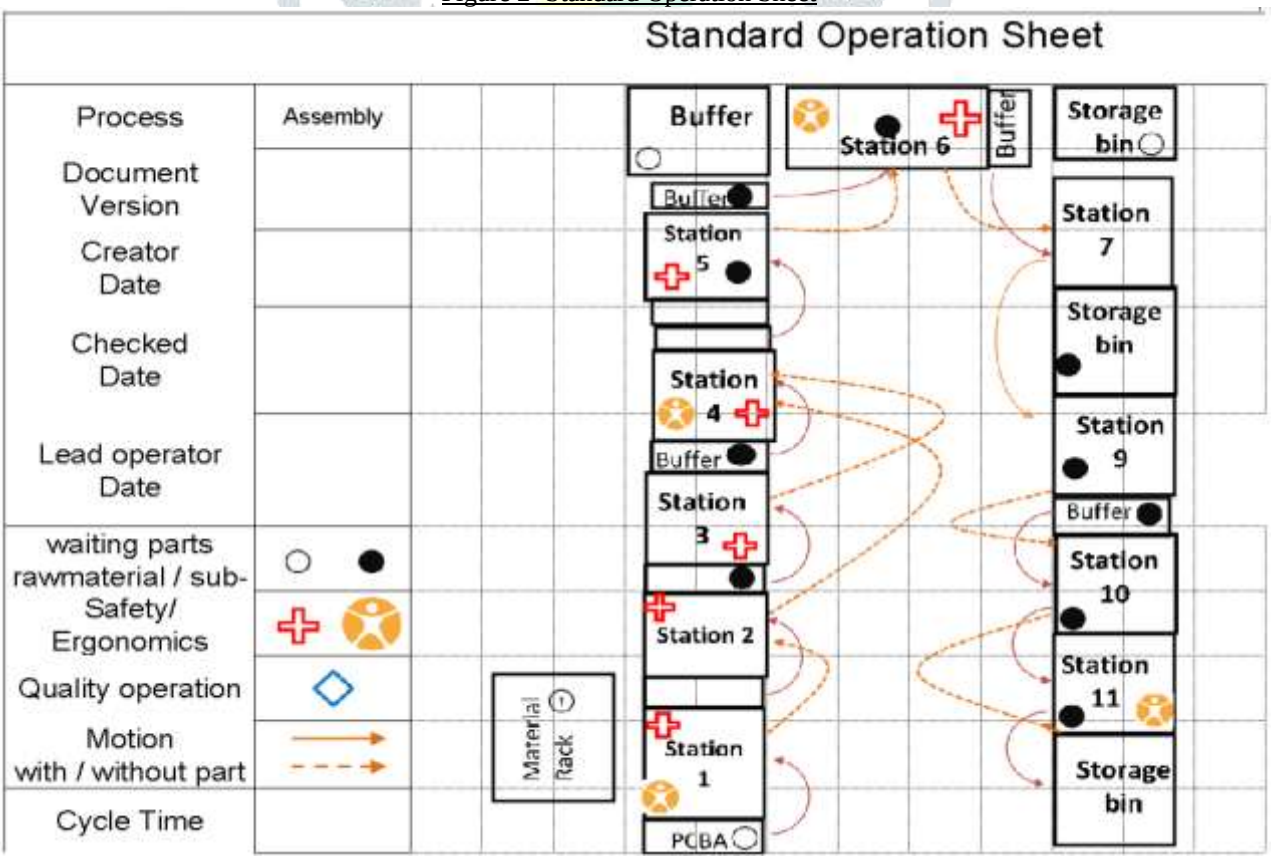
Figure1- Standard Work Table



4.1.2 Standard Operation Sheet(SOS):

Standard Operation Sheet is a detailed listing of all components related to a particular process. Standard operation sheet gives the bird view of the assembly line showing the equipments, materials, the operator and his movements.

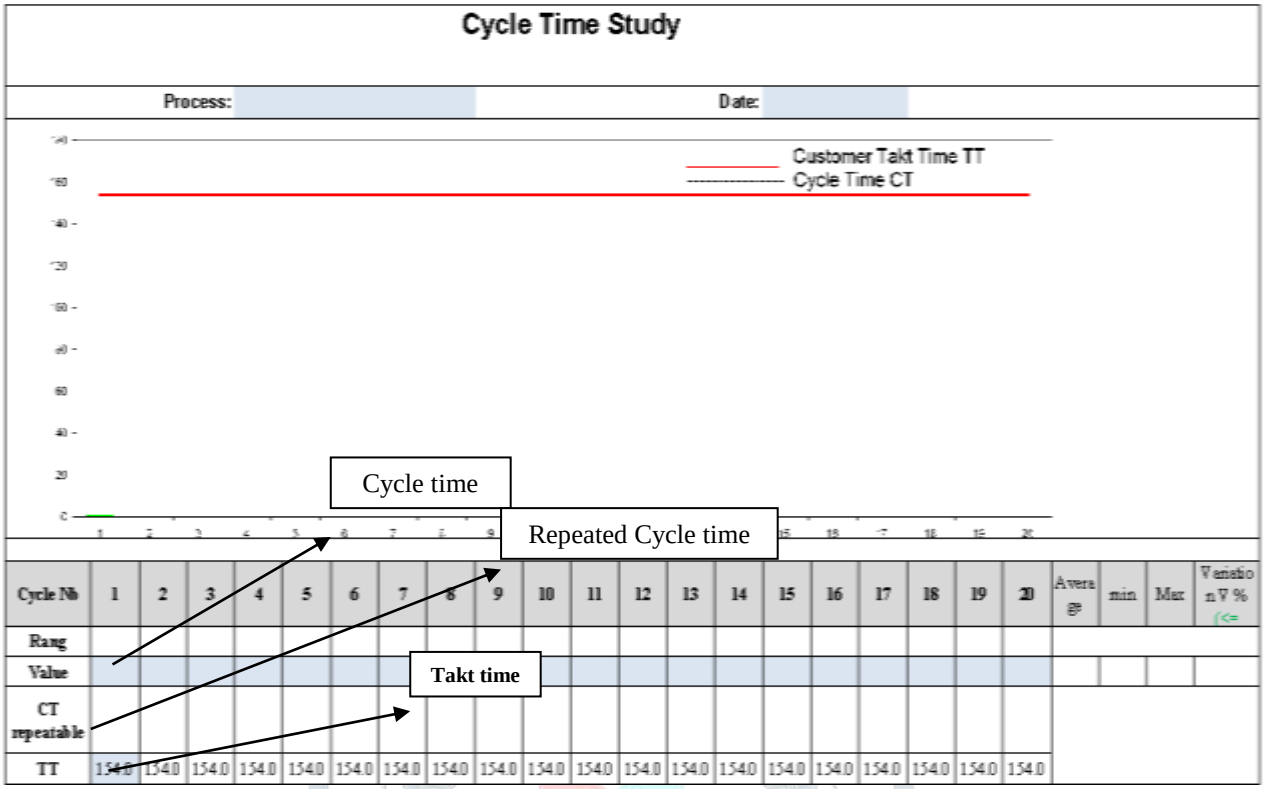
Figure 2- Standard Operation Sheet



4.1.3 Cycle Time Diagram(CTD):

Cycle time is the total time taken from the beginning to the end of the process. Cycle Time Diagram gives the total average time each station is taking to get the work done. Average Cycle Time should be less than the Takt Time (Cycle time < Takt Time)

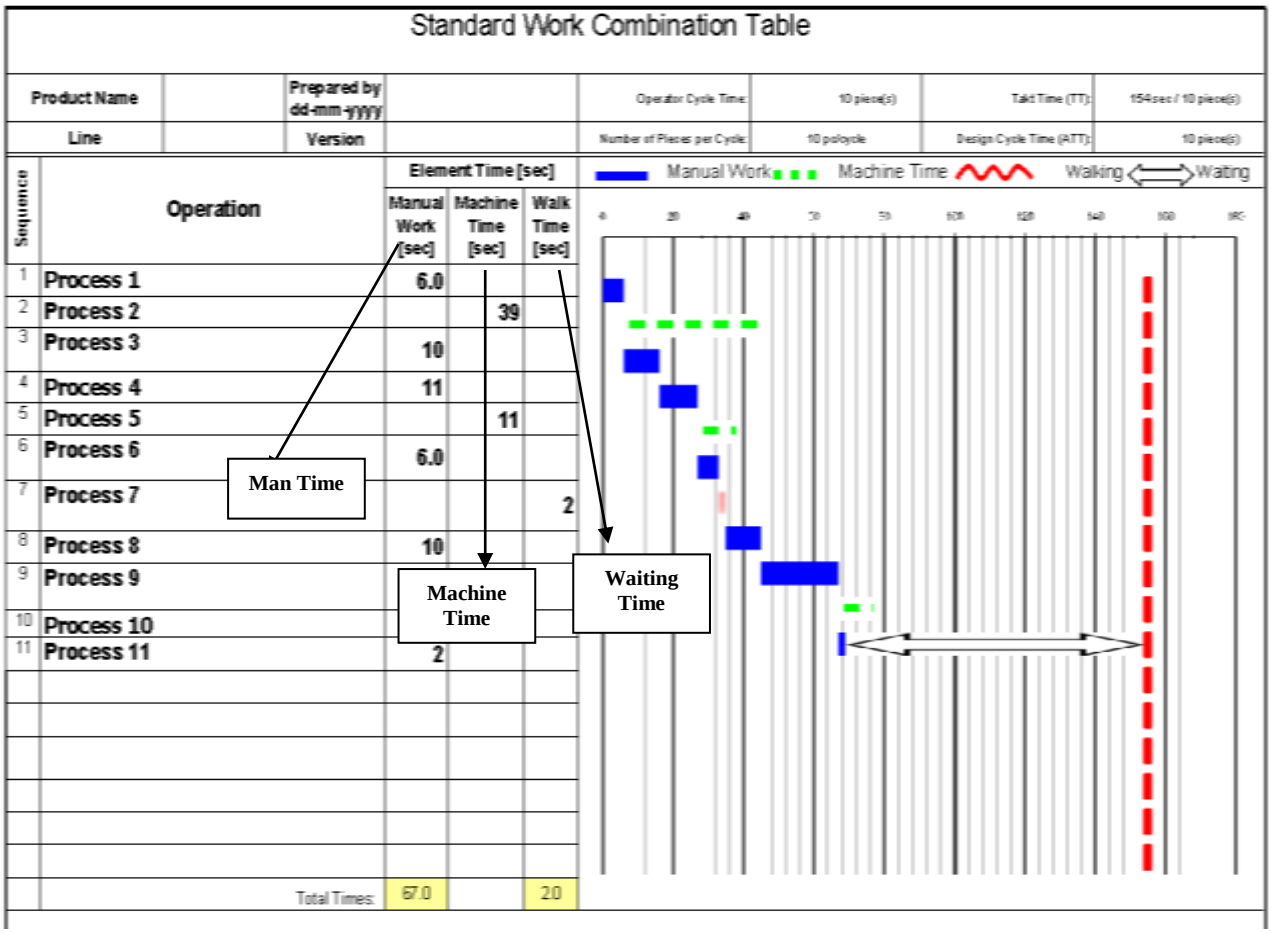
Figure 3- Cycle time Diagram



4.1.4 Work Combination Table (WCT):

Work Combination Table is used for analyzing jobs that have combined work, its purpose is to show the relationship in terms of time of two or more activities that occur simultaneously. From this table we can see Machine time Man time and waiting time.

Figure 4- Work Combination Table



4.1.5 Gemba walk-

Gemba is a Japanese term that loosely translates to "where the work takes place". Rather than solve problems in the conference room, management goes to the front line in the departments where the work takes place, thus the term "Gemba walk"

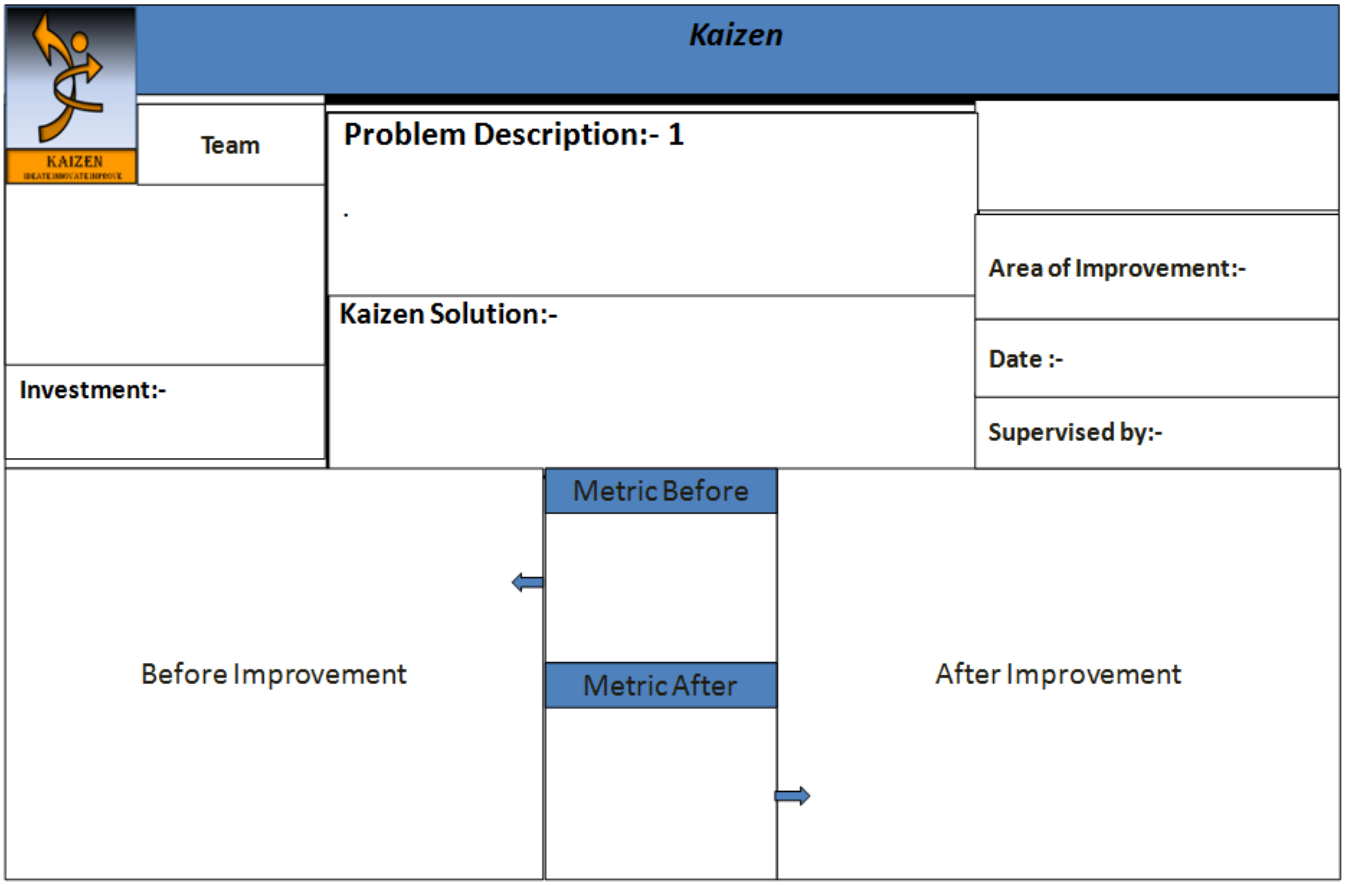
There are five golden rules of Gemba management that summarize the activities of Gemba walks:

i. When a problem arises, go to the Gemba first. Donot hypothesize what is happening.
ii. Assess the gembutsu, or relevent object. For example, If a MRI machine breaks down, the MRI machine is the gembutsu.
iii. Take temporary countermeasures on the spot.
iv. Find the root cause. This can be often identified by asking, "Why?" Keep asking why until you drill down to the issue.
v. Standardize to prevent recurrence. Once the problem is solved, the solution needs to be standardized to facilitate a permanent solution.

4.1.6 Kaizen Improvement

Kaizen is Japanese word for "continuous improvement". In business, kaizen refers to activities that continuously improve all functions and involve all employees from the CEO to the assembly line workers. While kaizen usually delivers small improvements, the culture of continual aligned small improvements and standardization yields large results in terms of overall improvement in productivity.

Figure 5- Kaizen Improvement Sheet



V. RESULT

Table- Results

Improvement	Previous Condition	Achieved	OPE
No of heads	14	12	14%
FPY	97.02%	99.04 %	2%
Performance	95.8%	97.6%	1.87%
Cycle Time	144 sec	108 sec	25%
Changing Bin in Back cover station	3.14 min	30sec	84%
No of Station	11	10	9%
	Problems	**Solved**	**OPE**
Carrying **Bending/stretching** **Safety points** **Quality**	4 8 4 12	4 8 4 11	100% 100% 100% 92%

VI. CONCLUSION

The basic aim of the paper was to show how to effectively increase productivity, reduce the non value added time, standardize the production process, improve Quality, improve the Ergonomics aspects and safety.

We analysed the present line and found many problems in it which was tackled by using various lean techniques. Primarily, the main improvements needed were in following fields

a) Productivity
b) Ergonomics
c) Space
d) Inventory
e) Quality

So, by implementing various Industrial Engineering tools like Method study, PDCA, POKA-YOKE, Gemba Walk, Kaizen to improve productivity and also provide ergonomic assistance to the workers.

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