THOMSON REUTERS
ENDNOTE

[Mahto, January, 2017]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

KAIZEN FOR QUALITY AND PRODUCTIVITY IMPROVEMENT IN MANUFACTURING INDUSTRY

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ABSTRACT

The new uprising in the manufacturing goods and service sector has created formidable challenges for manufacturing industries. The daunting tasks ahead can be characterized by global competition, increasing the variety of products and lower demands. To survive in the era of fierce competition, companies need new standards to address the requirements of increased customization, heterogeneous markets, shorter product life cycle and production time, responsiveness towards customer and waste minimization which are increasingly becoming key features. To compete successfully in the market, adoption of lean manufacturing techniques will help the automotive firms to stay at the top.

The companies can improve their performance in the aforementioned areas by focusing on their strategies pertaining to continuous improvement in all the aspects of business and simultaneously developing and refining the manufacturing processes by minimizing the wastes present in the different levels of the organizations. Things such as equipment downtime (due to long setup and changeover requirements, or because equipment repeatedly breakdown), the large amount of raw materials, work-in-process, and finished goods inventory levels are usually seen, as standard operating inefficiencies which companies feel obligated to pass on to the customer as the cost of doing business. These are wastes. They are hidden because they are actually the offshoot of the production system itself and manufacturers are simply blind to them. Continuous improvement of the manufacturing process aims to minimize the wastes present in the system right from the design to dispatch and distribution.

This paper highlights the KAIZEN method(Continuous Improvement) of quality management approaches used by companies in Indian Manufacturing Industry in their endeavors to match global standards. This method is internationally acknowledged as techniques of focused improvement through various small move or idea for increasing productivity and quality of product and economically good for the industry. The small improvements applied to key processes will make the major multiplication of the profit of the industry. This ensures a secure way to obtain the loyalty/fidelity of client. The KAIZEN management represents a solid, strategic instrument, with a view to reaching and surpasses the company's objectives

Keywords: kaizen, Product life cycle, Continuous Improvement..

INTRODUCTION

Kaizen is Japanese word which means "improvement". It made up by adding two words Kai refers "change" and Zen refers good(for the better). When kaizen used in industry, it refers to activities of continuous improve. It involves high-level employees to simple workers. Sometimes it refers to a focused improvement or small improvement. A number of very small improvements make more effective than a heavy improvement in a single step. The aim of Kaizen is to obtain and sustain zero loss with respect to minor stops adjustment, defects and unavoidable times.

Kaizen was introduced in Japan after World War II, to restore for livelihood. The origin of Kaizen can be traced back to the Quality Guru Dr. W. Edwards Deming, but it was Masaki Imai who popularized the concept of Kaizen to become a revolution around the world. The emperor of Japan awarded the 2nd Order Medal of the Sacred Treasure to Dr. Deming in 1960.Kaizen is based on making a change in functions, process or anything else at any time which causes improvements in the quality or productivity of product. Kaizen model uses

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

operator model and traditional model. In operator model, improvement applied instantly or same day. In a traditional model, there is a long time between concept development and implementation.

There are two types of kaizen approach:

1. Flow Kaizen: This is related to the flow of material and information, and identified with the reorganization of entire workshops, the production unit and sometimes even an organization or company.

2. Process Kaizen: This involves improvement of the individual.Thus improving the way of quality or productivity is kaizen process.

LITERATURE REVIEW

The Kaizen concept has made a great impact on researchers because it enhances the quality and productivity of an industry and also helps in the production of high-quality products with minimum efforts.

The authors have a various view on a philosophy of kaizen as discussed:
According to Imai (1986), Kaizen is a continuous improvement process involving everyone, CEO, and workers.
Watson (1986) says that the origin of PDCA (Plan–Do– Check–Act) cycle or Deming Cycle is well- known statistics and Shewhart has introduced the method of PDCA. The PDCA cycle is also known as Deming Cycle/Deming Wheel/Shewhart Cycle.

Wickens (1990) highlights the impact of the teamwork on Kaizen. Teamwork and commitment do not mean only involving of all representatives of the different department of employees but from direct contact and communication between the individual and his top-level authorities.

Teian (1992) explains that Kaizen refers the daily challenges occurring in the work field and the method to overcome it. Thus it is more than just a means of improvement. Kaizen can be applied to any field where there is a requirement of improvement.

Deming (1995) describes that the growth rate of many organization is at a higher rate than at any time in recorded history. Thus a highly competitive and constantly changing corporate world recommends major managerial challenges. Many managers have adopted the philosophy of a Kaizen to effectively tackle this challenge.

Imai (1997) describes that the improvement can be divided into Kaizen and innovation. Kaizen refers small and focused improvements due to ongoing minimum efforts. Innovation is a drastic improvement which requires a large investment of resources in new technology or equipment as shown in Fig. 1.

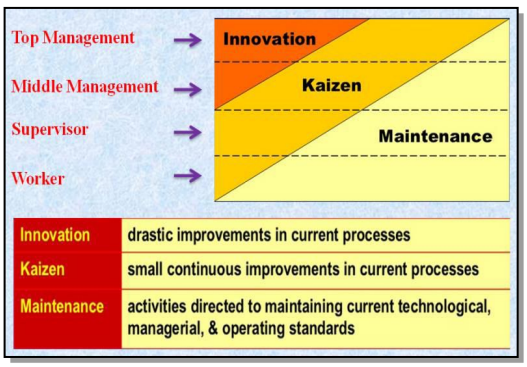

Fig 1.Source:Imai(1997)

Cheser (1998) describes that Kaizen refers to making small changes on a regular basis by reducing waste and continuously improving quality, productivity, safety, and effectiveness. Kaizen has historically been applied to manufacturing industries but it is now commonly applied to service business processes.

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Impact Factor: 4.116
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Kim and Mauborgne (1999) focus kaizen as a creation of new customers as well as sustaining existing customers.

Williams (2001) describes that kaizen techniques are the popular method of making a considerable reduction in production costs.

Jagdeep Singh and Harwinder Singh (2009) describe the review of literature for Kaizen concept, case studies, and survey. They illustrate that Kaizen is widely accepted techniques in manufacturing industries.
Vineet Kumar (2011) explains that the Kaizen philosophy assumes that our way of life should be the focus on constant improvement efforts. The life may be working life, social life, or our home life.

PRINCIPLES OF KAIZEN

1. Kaizen principle may vary from industry to industry.
2. Treat all employees same as you want to be treated.
3. Think positive and don't wait for 100% perfection, if there is 40% perfection then it is good.
4. Correct mistakes instantly when they are found.
5. It concentrates only to- find difficulties in quality and production.
6. Creativity comes before capital or money.
7. Keep asking questions until you find the main root cause.
8. Use knowledge of all i.e. from a worker to CEO.
9. It is almost action based and applied instantly.
10. It involves making the change either minor or major in quality and productivity.

PURPOSE OF KAIZEN

- To simply productivity improvement.
- To humanize workplace.
- To eliminate overly hard work.
- To teach people how to perform an experiment on their work using the scientific method.
- How to learn spot and eliminate waste in the manufacturing process

METHODOLOGY OF KAIZEN

Many organizations and industry are applying kaizen techniques to solve the problem identified in workshop or shop floor in organization and manufacturing industries. Kaizen is a focused and ongoing improvement in which participation of everyone required. Its main objective is focused improvement and maintenance of standard operating procedure. Maintaining standard involves training of employees and discipline in the industry. As kaizen means, minor improvement in current system operation or functions. Kaizen techniques can be developed by any member of industry who may be either CEO of organization, middle management employees, supervisor or workers, and every individual has to support kaizen techniques and must be fully dedicated to his responsibility. Sometimes Kaizen involves quality circle, small group activities as well as the permanent and continuous use of the PDCA cycle.

Many organization and manufacturing industry acquired the high economic growth only by eliminating nonvalue-added activities, reducing waste like longer waiting times, interruptions, travel time and keeping standardization in the industry. The concept of kaizen is to observe the process in industry and find out the problems in it. It also develops the idea and solution to solve the problem. If there is any drawback, refine the solution and set for final results with respect to quality and productivity.
Kaizen methodology is now applying different fields, such as production field, management field, and other organization. The methodology of Kaizen is also known as Deming's PDCA Cycle.
The methodology of Kaizen is illustrated in following Fig.2

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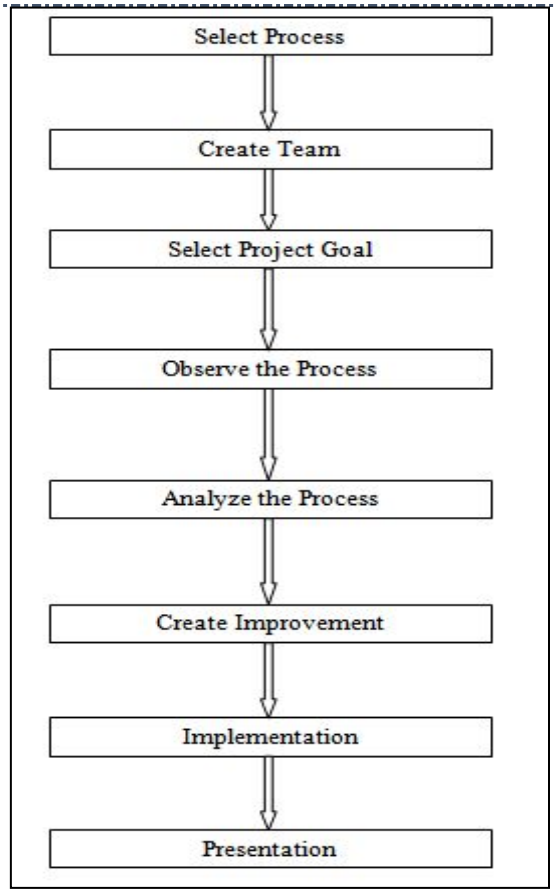

Fig.2-Methodology of Kaizen

SOME TOOLS RELATED WITH KAIZEN

There is various tool related with kaizen which is implemented for continuous improvement.
A. 5S (workplace organization):

The theory of 5S states that dirty, mix up or irregular things attract the eye, causes loss of time. Sometimes new instrument is covered by the old instrument which causes the reduction in productivity.

Thus it is a technique of cleaning, organizing and producing a productive workstation.
There are five 5S terms:

1. Sort (Seiri):
It makes production easier by eliminating unnecessary items, separate unwanted material from useful material at the workplace.

Define a Red-tag area where the unwanted material is placed which cannot be disposed of immediately. These are disposed of when required.

2. Set In Order (Seiton):
Place all necessary items in according to their use, to save time loss most useful items are placed nearest so that they can be easily selected for use.
Follow FIFO (First-in-First-Out) and label them.

3. Shine (Seiso):
Clean workplace both outside and inside on regular basis. Keep workplace safe.

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Impact Factor: 4.116
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When in place, anyone not familiar with the environment must be able to detect any problems within 50 feet in 5 seconds.

4. Standardize (Seikutsu):
Create a standard for everything such as putting instrument or equipment at the right place and every process must have a standard.
Maintain standard every time.

5. Sustain (Shitsuke):
Ensure that all 5s standard must be adherence to regular audits and self -discipline.
All employees must follow that "do without being told".

Fig.3-5S(workplace Organization)

B.5Why Technique

- The principle of 5 why technique is an iterative interrogative technique used to find out cause and effect of a problem in the industry.
- The main target of 5 why is to detect the root cause of the problem by the iterative question "Why".
- In this technique, each next question is based on the previous answer.
- Generally, it asks 5 why questions, but it is not sufficient then this "why" may be asked several times to detect the exact and deepest reason of problem which causes production lack.
- Let us consider fig.4 express an example of finding the root cause of why a car won't start.

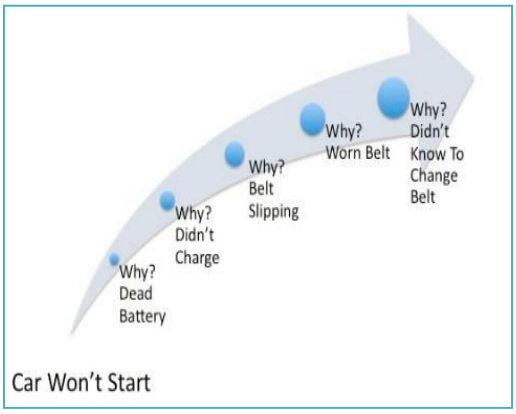

Fig.4- 5 Why Technique

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C. MUDA (Elimination of Seven Wastes)

- Muda is a Japanese term which means waste. Each industry desires to reduce all nonvalue -added activities or waste reduction to increase profitability.
- It is a tool in kaizen which implementation ensures that elimination of all nonvalue- added activities.

Muda consists of elimination of seven types of wastes:

1. Over-Production

- When production is more than ordered which generates nonvalue- added activities such as the increase in expenditure of resource, working staff and storage of excess inventory.

2. Transportation

- When the product is transported from one place to another then there is a risk of being damaged, lost delayed. Transportation aids to move parts or finished goods into or out of storage.

3. Over-Processing

- When unnecessary steps are involved in the production process. It occurs mainly due to the poor tool, complex product design, higher quality and excessive precise product.

4. Defects

- Whenever a defective part is produced, it requires rework for correction of the product. This rework and inspection mean the waste of time and effort.

5. Inventory

- Inventory refers to the raw material, work in progress and finished products also. This extra inventory causes production imbalance, storage problem.

6. Motion

- Wasted motion has to perform by the employee during their work. Motion refers to the inspection of damage product causes overtime of employees.

7. Waiting

- Now-a-days mostly industry uses automated machine, so workers stand around machine for the next processing step.

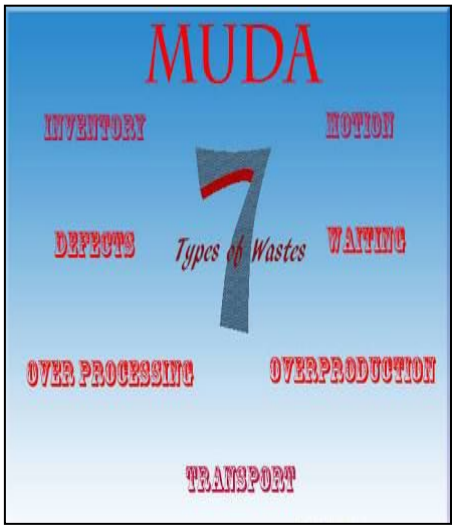

Fig.5-MUDA(Elimination of 7 wastes)

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D.PDCA Cycle

- PDCA stands for PLAN-DO-CHECK-ACT.
- It is an iterative four-step method for the control and focused improvement of product in the industry.
- It is also known as the Deming Cycle /Deming Circle / Deming Wheel as shown in fig.6.

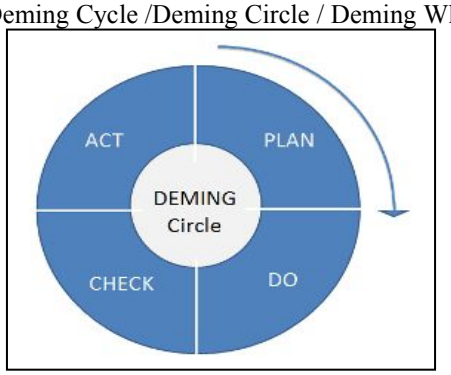

Fig.6- PDCA Cycle

- Plan: - The objective is to establish a plan and necessary processes on a small scale for changing the results as per expectation.
- Do: - The plan is implemented and the process is executed for production in controlled circumstances.
- Check: - The results are monitored and it compares against expected output result according to plan.
- Act: - The industry decides whether the implemented plan improves the prior process of production or not. If there is not improvement then it is rejected and if it shows improvement then it will be new standardize the process for production. E.Poka-Yoke
- Poka-Yoke is a Japanese term, means "Mistake-Proofing".
- Poka-Yoke is a lean manufacturing tool that prevents mistakes.
- Its target is to achieve no defective products by preventing, correcting or drawing attention to human errors as they occur.
- It is applied any step of the manufacturing process where it seems that something is going to be wrong or an error may occur.

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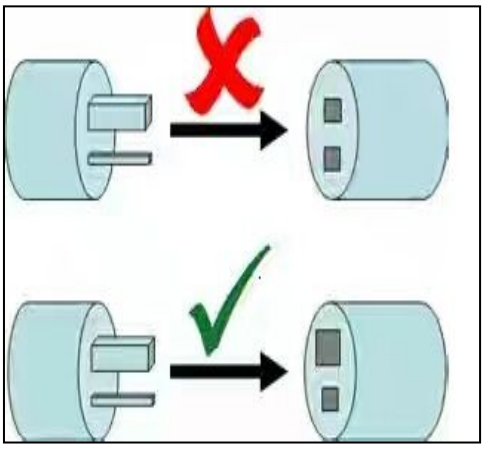

Fig.7- Example of Poka-Yoke

ISSN: 2277-9655
[Mahto, January, 2017] Impact Factor: 4.116
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This case study is done at XYZ manufacturing industry at Jamshedpur, Jharkhand in India. This industry manufactures rear axle, front axle and dummy axles which are used in various heavy transport vehicles. A Dummy Axle, also known as a dead axle, is not a part of driver train but is instead free floating. Many Heavy Weight Vehicles use dead axles for strictly load-bearing purposes. A dummy axle located immediately in front of a drive axle is called a pusher axle. In some designs the wheels on a lazy axle only come into contact with the ground when the load is significant, thus saving unnecessary tire wear.

Current production of this industry is 180 axles per shift(7 hours). But target production is 250 axles per shift. For completing a dummy axle assembly 23 stations corresponding to 28 operators. The reason behind this is the lack of short-term training courses, wastes of resources and most important is non-involvement of each member or employee of industry in kaizen techniques. Hence, the main target was to achieve an increase in production and find the reason which causes lack of production. For finding these causes of lack of production, the whole process is analyzed. The figure: product flow diagram of dummy axle shows the various processes of manufacturing of dummy axle.

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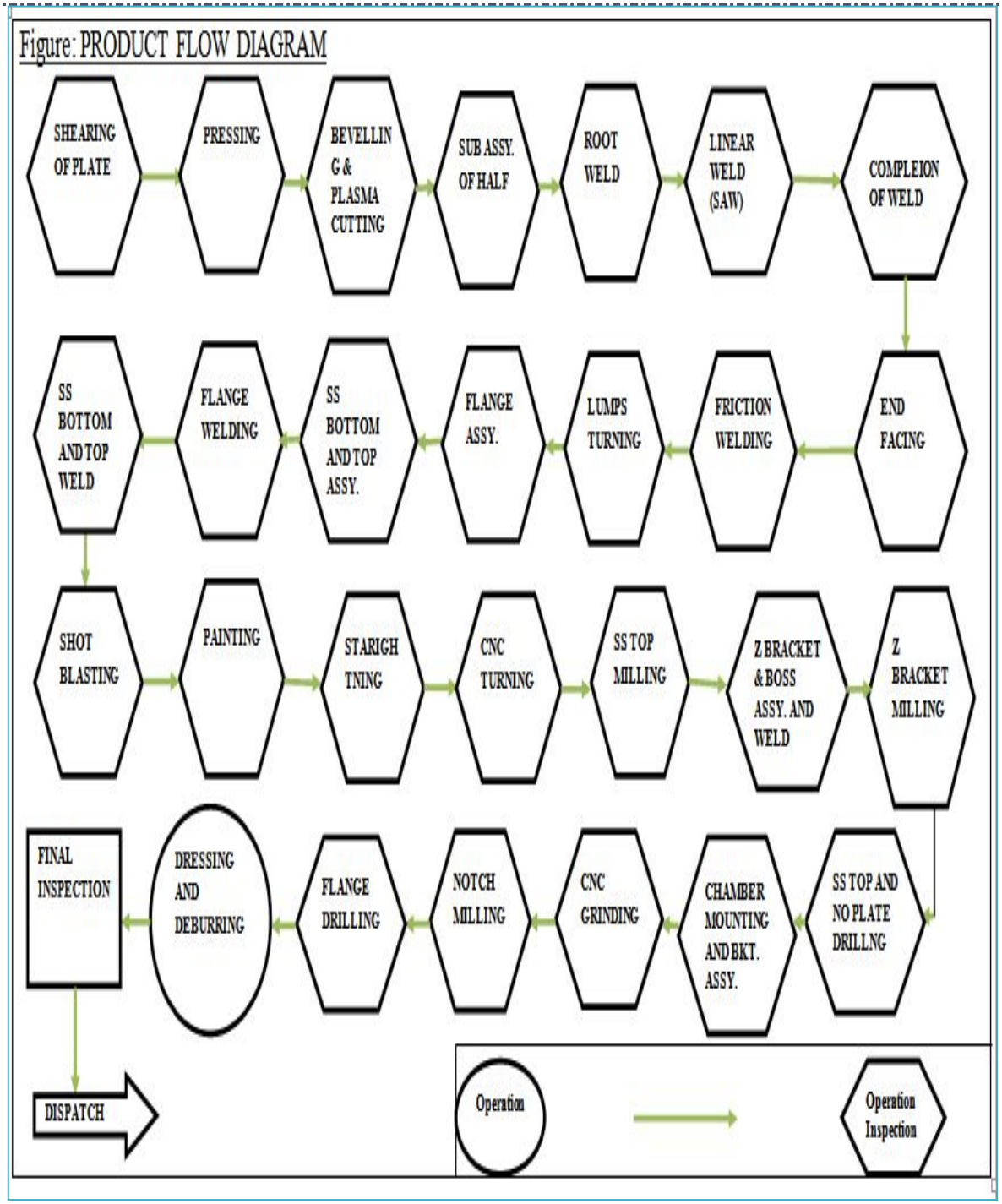

Fig.8: Product Flow Diagram

The Problem identified in the industry is:

- More numbers of operators are required for working in the assembly line.
- Decrease in productivity.
- Profitability of industry
- Quality problem.

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IMPLEMENTATION OF KAIZEN

These problems were discussed with many personals, operators by considering the different industrial environment and found it can be improved by Kaizen techniques. Kaizen involves improvement in the level of training by various short term courses. The idea of everyone either he is CEO or a worker must be considered to improvement. Kaizen tool is that which can be easily used in the improvement of productivity and quality of the product. To achieve the target, cycle time and takt time must be equal.

Table 1 details the station wise operator's work and time spent for completion of the task at their station. Let T1 and T2 are time spent by the operator in a completion of the job in two iterations. Mean-time is calculated by taking average time for completion of the job by two iterations at workstations.

Table 1: Station Wise Details and Time Taken to Complete theJob (Before KAIZEN)

Station No.	Operator No.	Component task	Time T_1	Time T_2	Mean Time
1	1	SHEARING OF PLATE	82	78	80
2	2	PRESSING	78	76	77
3	3	BEVELLING & PLASMA CUTTING	80	81	81
4	4	SUB- ASSY. OF HALF	70	72	71
5	5	ROOT WELD	72	75	74
6	6	LINEAR WELD (SAW)	55	57	56
	7	COMPLETION OF WELD	24	26	25
7	8	END FACING	72	74	73
8	9	FRICTION WELDING	78	79	79
9	10	LUMPS TURNING	72	74	73
10	11	FLANGE ASSY.	70	74	72
11	12	SS BOTTOM AND TOP ASSY.	66	65	66
12	13	FLANGE WELDING	68	72	70
	14	SS BOTTOM AND TOP WELD	80	78	79
13	15	SHOT BLASTING	55	58	57
14	16	PAINTING	36	37	36
15	17	STARIGHTNING	44	45	45
16	18	CNC TURNING	80	78	79
17	19	SS TOP MILLING	75	72	74

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	20	Z BRACKET & BOSS ASSY. AND WELD	69	67	68
	21	Z BRACKET MILLING	65	63	64
18	22	SS TOP AND NO PLATE DRILLING	40	43	42
	23	CHAMBER MOUNTING and BKT. ASSY.	40	42	41
19	24	CNC GRINDING	95	85	90
20	25	NOTCH MILLING	61	63	62
21	26	FLANGE DRILLING	55	53	54
22	27	DRESSING AND DEBURRING	62	66	64
23	28	FINAL INSPECTION	56	55	56

Total mean time=1808 seconds

Calculation of takt time before kaizen:

Requirement 250 axles per shift(7 hours)

Available time:420 minutes(7 hours)

Lunch break:30minutes

Tea break:15 minutes

Net available time=(420-30-15)=375 minutes

Takt time= Net available time/Customer requirement

=(375/250)=1.5 minutes=90 seconds

Hence, Takt Time for each operator is 90 seconds at every workstation.

Theoretically calculation for number of operators

The sum of mean time=1808 seconds

Takt time=90 seconds

Number of operators required=(cycle time/Takt time)

=(1808/90)=20.08=21 operators.

Hence, only 21 operators are required to meet current customer demand. But now the numbers of operators are 28.Hence,7 operators are more than calculation.

For improving the operators time to meet the takt time, grouping of the operator is required

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Table 2: Station Wise Details and Time Taken to Complete the Job (After KAIZEN)

Station No.	Operator No.	Component task	Time T_1	Time T_2	Mean Time
1	1	SHEARING OF PLATE	82	78	80
2	2	PRESSING	78	76	77
3	3	BEVELLING & PLASMA CUTTING	80	81	81
4	4	SUB-ASSY. OF HALF	70	72	71
5	5	ROOT WELD	72	75	74
6	6	LINEAR WELD (SAW) and COMPLETION OF WELD	55+24	57+26	56+ 25
7	7	END FACING	72	74	73
8	8	FRICTION WELDING	78	79	79
9	9	LUMPS TURNING	72	74	73
10	10	FLANGE ASSY.	70	74	72
11	11	SS BOTTOM AND TOP ASSY.	66	65	66
12	12	FLANGE WELDING	68	72	70
	13	SS BOTTOM AND TOP WELD	80	78	79
13	14	SHOT BLASTING	55	58	57
14	15	PAINTING and STARIGHTNING	36+44	37+45	36+ 45
16	16	CNC TURNING	80	78	79
17	17	SS TOP MILLING	75	72	74
	18	Z BRACKET & BOSS ASSY. AND WELD	69	67	68
	19	Z BRACKET MILLING	65	63	64
18	20	SS TOP AND NO PLATE DRILLING	40	43	42
	21	CHAMBER MOUNTING and	40	42	41

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		BKT. ASSY.			
19	22	CNC GRINDING	95	85	90
20	23	NOTCH MILLING	61	63	62
21	24	FLANGE DRILLING	55	53	54
22	25	DRESSING AND DEBURRING	62	66	64
23	26	FINAL INSPECTION	56	55	56

Hence, number of operator after KAIZEN = 26

The Results Achieved Through Implementation of Kaizen

By using kaizen techniques number of operator reduced to 26 to perform the same operation. The reason behind the reduction of the operator is the multi-skilled and well-trained operators who are able to work at the different station. Some operators have to perform his tasks along with other operators because the mean time of doing his work is less. Thus after kaizen, they will meet the required production and target with the adequate quality. So production is improved by 180 axles to 250 axles per shift, and less number of operator i.e. only 26 operators are required for this productivity improvement. This types of techniques strength the industry.

CONCLUSION

Kaizen is a widely accepted philosophy in manufacturing industries. It improves setup time, productivity, process time reduction, inventory reduction and product quality. Continuous improvement of the lean manufacturing process is required for elimination/minimization of waste presents in form of layers in the industry.

So, it is imperative to have some well- researched manufacturing technologies (based on kaizen philosophy) with efficient algorithmic solutions which will maintain the ill- structured symptoms of the industries through constant monitoring of the processes and performance to keep it at the desired or standardized level. It can also be implemented in business, service, commerce and many more areas.

In this paper, emphasis should be given on reduction in throughput time,additional of the workstation is required to meet the takt time and also the elimination of unnecessary operation

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