IMPLEMENTATION OF KAIZEN AS A PRODUCTIVITY IMPROVEMENT TOOL IN SMALL MANUFACTURING COMPANY

Ms. Shubhangi P. Gurway  
Dept. of Mechanical Engineering,  
G. H. Raisoni Polytechnic,  
Hingna Road, Nagpur and 440016, India.  
Email: shubhangi.gurway@raisoni.net  
Mobile No.: 7774049500

Abstract - Thousands of small & medium scale industries are present in India. All are facing certain problems resulting in lack of productivity, greater lead time, processing time, stock out situations etc. The paper contains basics definition of Kaizen philosophy & a brief review of kaizen concept & its implementation. The purpose of this paper is to represent Kaizen, its related terms in a concrete way & its implementation in improving the overall effectiveness of small scale organization situated in India. This paper illustrate about kaizen implementation in small manufacturing industry & also focuses on the scenario of Indian manufacturing company while implementing Kaizen. The paper also reviews some of the papers which basically focuses on implementation of kaizen technique in small manufacturing companies. For detail justification a case study is conducted on the small manufacturing company who is dealing with manufacturing of PVC & HDPE pipes. The company is currently facing with the problem of increased lead time and stock out situation. In order to solve the faced problem we emphasize on two major alternatives & select Kaizen as a main productivity improvement tool. This implementation is focuses on reducing the lead time of sales order processing by mean of which the productivity of organization will be improved.

I. Introduction

Kaizen is Japanese philosophy which means continuous improvement. ’Kaizen’ means “Good” the whole purpose of which is betterment of work & improving the organization efficiency. The concept of Kaizen is so deeply ingrained in the minds of Japanese people that they often do not even realize that they are thinking Zen’ mean “Good” the whole purpose of which is continuous improvement. ‘Kai’ mean Change & ‘Zen’ mean “Good” the whole purpose of which is betterment of work & improving the organization efficiency. The concept of Kaizen is so deeply ingrained in the minds of Japanese people that they often do not even realize that they are thinking Kaizen. Japanese people uses the inborn instinct of being continuous change present in every human being & work for betterment by using existing resources available within the firm instead of spending lot much money on technologies. The kaizen implementation crucially includes the complete involvement of employees from worker to top level of management in the organization. Kaizen involve small but continuous improvement & this small change can improve the productivity in huge multiplication. In short Kaizen distinguish as the best method of performance improvement among all the techniques as it involve less implementation cost.

Similarly, Nowadays, organizations carry on seeking innovative ideas for improving their processes and retaining a competitive edge. Kaizen is a concept that focuses on improving a work area or an organization in incremental steps by eliminating waste. Kaizen can be applied to any area in need of improvement. Indeed, the overall concept of continuous improvement appears to be applicable to every area of industrial and logistics activity, from the production of basic materials such as steel, aluminum and timber to manufacturing industries as diverse as automotive, furniture, canning, food and drink (Leigh Pomlet, 1994). Many organizations have begun to incorporate the philosophy of kaizen through the use of kaizen methodology. Kaizen project typically focus on specific improvement goals like productivity improvement with small changes & improvement in the working area.

The objective is to focus on SME in India. In this paper we discuss the scenario of Indian SME & Their work toward the implementation of Japanese techniques Kaizen & 5S. The ultimate objective of Small medium manufacturing industries today is to increase productivity through system simplification, organizational potential and small incremental improvements by using modern techniques. Most of the manufacturing industries are currently encountering a necessity to respond to rapidly changing customer needs, desires and tastes. For industries, to remain competitive in market, continuous improvement of manufacturing system processes has become necessary. Competition and continuously increasing standards of customer satisfaction has proven to be the endless driver of organizations performance improvement. But in small & medium manufacturing industries in India there is a need of small & continuous improvement with the huge patience in Top management people.

Manufacturing industries is the best place to implement the Kaizen project & evaluating its efficiency. This paper illustrate about kaizen implementation in small manufacturing industry who is dealing with manufacturing the PVC & HDPE pipes. The implementation is done in each possible segment of the company from raw material storage to
II. Scope of the study:

The paper involves the implementation of Kaizen in a pipe manufacturing company which is facing the problem of increased lead time & stock out situations in seasons. In short the paper evolves in manufacturing company which practice Kaizen & 5S methods in its production arena. The main concern of the study is to highlight the importance and impact of the Kaizen & 5S a continuous improvement project approach in manufacturing companies. The scope is narrowed to small manufacturing company in PVC,HDPE pipe manufacturing. The company is having two units & unit I among the two specially need the improvement. What would be the manufacturing sector’s alternative way of increasing productivity or reducing waste rather than conventional method? This question is highlighted in the further discussion and literature surveys which have been done. Apart from that , case study was conducted through reference made from similar cases conducted in Indian small & medium manufacturing industries. A clear understanding of Kaizen & its application in manufacturing industry is the main concern why the study is performed.

III. Literature Review

Kaizen philosophy embraces three main principles proposed by Imai (1986) which are process orientation, improving and maintaining standard and people orientation. All principles are significant in order to implement the kaizen.

The brief ideas about the three basic principals are:

A. Process orientation

Imai stated that kaizen is process-oriented. Before results can be improved, processes must be improved, as opposed to result-orientation where outcomes are all that counts. Berger (1997) added to what Imai said that the principle has at least two practical consequences for the improvement process. First, management’s main responsibility is to stimulate and support the effort of organizational members to improve processes. In order to be improved, a process must be understood in detail. Second, process orientation calls for evaluating criteria which can monitor and bring attention to their improvement process itself, while at the same time acknowledging its outcome. And for process orientation the management should count the contribution of each and every employee who actively participate in continuous improvement. For effective participation the management should encourage the employee by giving some reward for contributing in betterment.

B. Improving and maintaining standard

Kaizen is distinctive in its focus on small improvements of work standards as a result of an ongoing effort. Furthermore, Imai (1986) said “There can be no improvement where there are no standards” which in essence denotes the relation between kaizen and maintaining standard procedures for all major operations (Standard Operating Procedures).

C. People orientation:

This principle basically referred to kaizen teian where the benefit gained from kaizen implementation can be seen on daily basis by all company employees. This principal simply focused on employee involvement in improvement process. In people orientation the suggestion of each & every employee from workers to the top management people is at least viewed & the suggestion which really contributing for improvement, actually implemented, which act as motivating factor for employee to participate in Kaizen activity.

Table 1 :Review of literatures in field of Kaizen implementation

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Author</th>
<th>Type &amp; Name of industry</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abhijit Chakraborty, Madhuri Bhattacharya</td>
<td>Front &amp; rear axle manufacturing company</td>
<td>Production rate per hour increases &amp; reduction of lead time</td>
</tr>
<tr>
<td>2</td>
<td>R.T. Salunkhe, G.S. Kamble, Prasad Malage</td>
<td>Irrigation pump manufacturing company</td>
<td>Productivity improvement with less processing time</td>
</tr>
<tr>
<td>3</td>
<td>D Rajenthirakumar &amp; P.R Thyla represent</td>
<td>Dead link &amp; centre link manufacturing company</td>
<td>Productivity improve with solving a problem of tube bending assembly line</td>
</tr>
<tr>
<td>4</td>
<td>Zadahmed Z. Khan, 2.Dr. Sanjay Kumar</td>
<td>Double Window sight flow indicator manufacturing company</td>
<td>Manufacturing lead time will be reduced</td>
</tr>
<tr>
<td>5</td>
<td>Pramod Kumar, Vineet Pandey</td>
<td>Wire harness manufacturing company</td>
<td>Productivity improved along with reduction in production cost</td>
</tr>
</tbody>
</table>
| 6      | Mr. Bhupendra Kumar Daiya | Cement manufacturing plant | Productivity improved with improved human
<table>
<thead>
<tr>
<th></th>
<th>Authors</th>
<th>Company</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Gundeep Singh, Dr. R.M. Belokar</td>
<td>Tractor manufacturing company</td>
<td>Productivity improved with reduction in production cycle time</td>
</tr>
<tr>
<td>8</td>
<td>Pratesh Jayaswal &amp; Hemant Singh Rajput</td>
<td>Automobile maintenance part manufacturing company</td>
<td>Productivity will be improved with improved OEE</td>
</tr>
<tr>
<td>9</td>
<td>According to Nor Azlin Binti Ali</td>
<td>Machine spare part manufacturing company</td>
<td>Productivity will be improved with reduction in losses</td>
</tr>
</tbody>
</table>

**Gap Analysis on Literature Reviews**

1) Few papers have been published on manufacturing industries dealing with manufacturing of PVC, HDPE pipes.
2) The Papers generally not focused on the Employee empowerment which are the main resources of any organization.

**IV. Methodology**

The KAIZEN methodology has been used extensively for improving the organizational work in factories and actual methods used to manufacture products. The results obtained are real-time with implementation occurring within one week. With good & sincere practice by the employee in organization this simple concept improve the productivity of the organization in a huge way. Not only immediate improvements are seen in the process but it will also develop a list of the improvement opportunities that the staff can investigate and implement after the Kaizen. Kaizen will provide the company with immediate tangible results, motivation and ongoing continuous improvement within the company.

The adopted methodology contain Initial research on related field, Problem identification, Data gathering collected by interviews, Analysis of study of the previous records and observations, Generation of alternative solutions & final selection of best possible solutions. Those relevant information have been taken into account and analyzed by inspecting the pitfalls of the existing system of the concerned SME.

The idea behind selection of Kaizen implementation process, after reviewing all the facts & consideration is the size & kind of industries in India which are generally small or medium scale & these industries need improvement without too much or negligible capital investment. The selected case company need improvement in productivity with less investment therefore we have selected Kaizen as an effective tool for implementation.

**Implementation Process:**

**Company Background**

The XYZ Company is located in Butibori, Nagpur, Maharashtra in India. The major product of the company is PVC & HDPE pipes used for water sprinkling & electric fitting purpose. This company is mainly focused on manufacturing as per customer’s specification & requirement. The company currently has a capacity of about 150 tonnes per month (inclusive of all varieties), total annual sales volume is 5 crores (in Indian rupees) and total employees are 12. The company is working in 2 shifts & 24 hours. Out of 13 workers 7 workers are working in first shift & remaining on second shift. For implementation of technique we first need to identify that what the management people actually want and after identifying all the requirement the work will be started. So, we started our work in some prescribed manner.

**Raw material used are:**
- HDPE RP
- HDPE Granules
- PVC Resin
- Starch acid

**Problem Statement:**

As XYZ company is manufacturing variety of product, the company sometime facing difficulties in sales order processing specially in summer as there is a large number of customer with varieties of specifications for forthcoming seasons. The company is facing with processing these varieties of order and hence not able to satisfy on time delivery of order. The niche for improvement in the lagging condition is the management people who are interested in applying the philosophies as well as they are very much concerned about the implementation of these ideas.

The project work basically focuses on improving the productivity of the XYZ company by using Kaizen as a problem solving approach, reducing the time losses in sales order processing which indirectly satisfy the target customer and introduces win-win
situation between customer & the company. Opportunities for productivity improvement through reduced time loss are critical to organizational survival and these efforts can be driven through kaizen initiative such as standard operating procedure or reflow the procedure of sales order processing which will be expose in this work.

But before actual implementation it is very necessary to study the standard operating procedure for completion of raw material into finished product.

The stepwise procedure for production is given below:

**Step 1:** Raw material is weight in proper proportion as per the specification of desired pipe. This activity is manual followed by automatic transfer of this raw material by auger filler which directly send the mixture for heating & mixing in proper proportion. The complete activity takes about 10.46 minutes.

**Step 2:** The mixture is then send to the hopper manually.

**Step 3:** The hopper transfer this raw material to the injection molding main machine chamber which consist of barrel & screw which heat & convert the raw material granules into hot plastic state. The size of the barrel can be change according to change in specification of product dimensions.

**Step 4:** The molten plastic is then send to the die cavity by mean of nozzle at the same time the coolant is on to solidify the pipes. The seizors & automatic guide ways are provided for movement of pipe along the production line.

**Step 5:** The finished pipe is then cut in the specified length. The company is currently using manual hand operated cutter.

**Step 6:** This finish product is then taken away to the storage area manually where quality check visually. For ease of understanding of the process we prepare a process flow diagram with the use of various symbols used in method study

**Recognition of need:**

Before starting the work we have discuss the requirement of the company in future & following are the need recognized from the manager of the company:

1. The top managerial person need improvement in productivity.
2. The employees of the company need to be involved & concern about organization achievement.
3. Need of reduction in accidental hazards while cutting the required length pipe manually.
4. There should not be too much of capital investment in productivity improvement as the company is batch type & small scale

**V. Objectives**

An objective of this study is:

1. To improve the productivity of the organization by applying a Kaizen philosophy.
2. To reduce the sales order processing time & stock out situations.
3. Identify time losses at production area.
4. Identify opportunities for kaizen improvement using a problem solving approach.
5. Describe the effects of the improvement.

**Problem definition:**

After analyzing the overall scenario of the company, the following are the problems which need to be focused.
The company is manufacturing various varieties of pipes ranging from 400mm to 1000mm. There is much time involve in maintaining the stock of finish good.

2. The lead time for sales order is higher

3. Production cycle time is more than required.

Time calculation before Kaizen implementation:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Time Factor</th>
<th>Calculated Time (in Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Idle Vises &amp; Repairs &quot; in &quot;</td>
<td>2.54</td>
</tr>
<tr>
<td>2</td>
<td>Machining &quot; in &quot;</td>
<td>2.00</td>
</tr>
<tr>
<td>3</td>
<td>Sorts &quot; in &quot;</td>
<td>1.25</td>
</tr>
<tr>
<td>4</td>
<td>&quot; in &quot; Production of pipe 75mm/4kg</td>
<td>3.33-3.54-4.27-2.12</td>
</tr>
<tr>
<td>5</td>
<td>Lead time to produce &quot; in &quot;</td>
<td>1 to 35 days [depend on manufacturer]</td>
</tr>
</tbody>
</table>

As the company is working continuously with the closing on Wednesday. The next working day will require approximately 3.5 hour for preparation and initial setting of the machine.

Similarly the company is utilizing about 90% of efficiency of the machine & 10% is lagging. So our main aim is to improve the machine utilization.

After analyzing the whole process flow & layout of the company some of the areas are found to be improved. These identified areas are discussed below;

X is demand per month
\( \mu \) is the mean demand
\( \sigma \) is the standard deviation
Therefore \( \mu = 25.5 \) Units/month
\( \sigma = 7 \) units/month
\[ X = \mu + Z \times \sigma \]
\[ X = 25.5 + (Z \times 7) \]

2. Lead time follows the uniform distribution

LEAD TIME:\( (3.5 - 1) \times (1 - 0)) \times F(t) + 1 \)

3. DEMAND ABOVE AVERAGE

Demand above average will be calculated as:
(Demand/month-Average Demand)* Lead time

Note: The data is collected during the questionnaire session with production manager for the analysis of some last month order processing & causes of backorders of the given production order.

Estimation of stock out

Before starting the implementation process we are trying to estimate the possible stock out situations as there is an increased lead time.

A mathematical model is formulated by drawing the usual probability distribution pattern of demand & lead time. We take 10 samples for validation of this mathematical simulation table.

The Demand & lead time of particular product i.e. 75mm/4kg pipe is discussed below using Monte-Carlo simulation method.

The demand of PVC pipes of 75mm/4kg pipes for a company follows the normal distribution with a mean of 25.5 units/month and standard deviation of 7 units/month. The lead time is distributed uniformly from 1 to 3.5 month. If the company is maintaining the safety stock of 7 units, the estimated probability of stock out using Monte-Carlo simulation technique is shown in table below:

The lead time probability function & cumulative probability function is shown below

1. The demand pattern of the particular pipe specification follows Normal distribution, which can be shown with:

DEMAND:

\[ Z = \frac{(X - \mu)}{\sigma} \]

Where

\( Z \) is normal deviation of demand (derived from normal distribution curve)

In order to analyze the stock out situations in the case company, we have prepared a case based simulation model for ten consequent orders to determine the probability of stock out situation being happened due to some flaws discussed in problem identification of this section.

Table 3. Estimation of lead time & stock out situation before Kaizen implementation

The first 12 demand collected from the companies production manager are
While studying the identified problems are:

1. Improper Utilization of stored space for finished product.
2. Improper Utilization of stored space for raw material.
3. Improper arrangement of supporting tools for production.
4. Improper arrangement of raw material in store.
5. Improper arrangement of finish good.

The problematic identified areas are shown in the following figures:

Fig.3 Improper stock of Finish good

Fig.4 Improper arrangement of raw material

Fig.5 Poor working area

Fig.6 Improper arrangement of supporting tools

Implementation
The implementation process involves the following areas:

1. Countermeasure for poor working area and improper stock maintenance
2. Countermeasure for safety stock determination
3. Calculation of safety stock

Before starting kaizen process, we had focused on 'Why' - 'Why' analysis in the identified problem areas. As Kaizen is a continuous as well as slow process, the estimated duration for implementation would be 4.5 months.

In order to find that the selected process is successfully implemented & the desired target is achieved or not, a pre-process & post-process lead time estimation analysis will be done.

VI. Scope
This study will thoroughly focus on reducing time losses while at the same time reducing the lead time of sales order processing in XYZ company and indirectly improve customer satisfaction. This condition will create a win-win situation between company and customers.

5 ‘S’ System

Establish and maintain a clean, neat and tidy workplace. Translation of 5 Japanese ‘S’s, what is 5S and why do we want to do it? 5S represents 5 disciplines for maintaining a visual workplace (visual controls and information systems). These are foundational to Kaizen (continuous improvement) and a manufacturing strategy based “Lean Manufacturing” (waste removing) concepts [16].

5S is one of the activities that will help ensure our company’s survival. Fig. Sort / Arrangement (SEIRI) (Eliminate unnecessary items) Through the suitable sorting it can be identified the materials, tools, equipment and necessary information for realization the tasks. Sorting eliminates the waste material (raw materials and materials), nonconforming products, and damaged tools. It helps to maintain the clean workplace and improves the efficiency of searching and receiving things, shortens the time of running the operation. The 1S rules proceedings.

A) On the first stage one should answer to so-called Control Questions: - Are unnecessary things causing the mess in the workplace? - Are unnecessary remainders of materials thrown anywhere in the workplace? - Do tools or remainders of materials to production lie on the floor (in the workplace)? - Are all necessary things sorted, classified, described and possess the own place? - Are all measuring tools properly classified and kept? On the basis of the answer to the above questions it is possible the estimation of the workplace in terms of the 1S rule so littering the workplace. If on any question answer is yes, it should execute sorting of things, which are in the workplace.

B) On the second stage one should execute the review of all things which are in the workplace and group them according to the definite system. According to carried out sorting it should execute the elimination from the workplace the things, which were found „unnecessary“.

C) To permanent usage the 1S rule is so-called the Programmed of the Red Label. It means giving the red label to things, which operator will recognize as useless within his workplace. This label will make possible not only the elimination of the given thing, but through its own formula will make possible the liquidation of the reasons of appearing on the workplace this given thing.

Set in Order / Neatness (SEITON) (Efficient and effective storage method) Especially important is visualization of the workplace (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, colored labels permit to identify the material, spare parts or documents etc.). Implementing the 2S rule It should execute the segregation of things and mark the places of their storing. Used things should always be divided on these, which should be: - In close access (1st degree sphere), - Accessible (2nd degree sphere), - In the range of hand (3rd degree sphere). To the estimation of the workplace in terms of the 2S rule that is setting in order things serve the following Control Questions: - Is position (location) of the main passages and places of storing clearly marked? - Are tools segregated on these to regular uses and on specialist tools? - Are all transport palettes storage on the proper heights? - Is anything kept in the area of devices against the fire? - Has the floor any irregularity, cracks or causes other difficulties for the operators movement? Things used occasionally and seldom should be on the workplace but outside the direct using sphere. Their distance and location from the place of work should depend on the frequency of using these materials or tools. Places of storage should be marked in the manner making possible their quick identification. It can be used colored lines, signs or tool boards.

Shine / Cleanliness (SEISO) (Thoroughly clean the workplace) Regular cleaning permits to identify and to eliminate sources of disorder and to maintain the clean workplaces. During cleaning it
Implementing the 3S rule

The first step of realization the 3S rule is renovation the workplace. It is assumed that „the first cleaning“ forces the exact checking of usage two of the previous rules. The usage of the 3S rule relies on everyday keeping in faultless cleanness the workplace. It is executed by the operator of the given workplace. To the estimation of the workplace in terms of the 3S rule, that is cleaning the workplace, serve the following Control Questions: - Are the oil’s stains, dust or remains of metal found around the position, machine, on the floor? - Is machine clean? - Are lines, pipes etc. clean, will they demand repairing? - Are pipe outlets of oils not clogged by some dirt? - Are sources of light clean?-Are the workplace is clean. Are the storage areas are clean

Standardize / Order (SEIKETSU) (Order and control to be established for) Worked out and implemented standards in the form of procedures and instructions permit to keep the order on the workplaces. Standards should be very communicative, clear and easy to understand. Regarding this during preparation and improving, it should be involved all participants of the process on the given workplace, it means direct workers. The group knows the best specificity of its own activities, and process of elaboration and after that, usage gives them possibility of understanding the essence and each aspect of the operation. In the aim of assuring all the easy access, obligatory standards should be found in constant and visible places. It is assumed that standards should not be implemented only in the typical operational processes e.g. production, movement maintenance, storing, but also in the administrative processes, for example: book-keeping, customer service, human resources management, or secretariat service.

Sustain / Discipline (SHITSUKE) (Sustain new status quo,everything in its place) Implementing the idea of the 5S will demand from workers the compact self-discipline connected with implementing and obeying the rules of regularity in cleaning and sorting. It leads to increasing the consciousness of staff, and decreasing the number of non-conforming products and processes, improvements in the internal communication, and through this to improvement in the human relations. It is also important to understand the need of executing the routine inspections of usage the 5S rule. This inspection is executed by helping of so-called Check List and created on its basis the radar graph of the 5S, which serves to estimation of the workplace. The inspection of realization of the 5S rule is executed once a month by chosen team implementing the 5S rule – the control team

Preparation of Kaizen sheet

Implementation Of5s Techniques
Sort all unneeded tools, parts and supplies are removed from the area. The company layout is fixed according to process but the company does not consist of a systematic arrangement for various material handling and storage.

Fig. 7 Set in Order A place for everything and everything is in its place.

Fig.8Shine The area is cleaned as the work is performed
Fig.9  Standardize  Cleaning and identification methods are consistently applied. Daily improvement process followed by using machine process chart & production plan board Before 5S

After 5S

Fig. 10  Production information chart for worker

Safety stock determination]  
As discussed earlier the company is following any scientific method for maintaining a safety stock and this is also a main reason for stock out situation. For solving this problem it is very necessary to find the amount of stock the company should maintain for effective service level.

Safety stock is determined by assuming the probabilistic distribution of demand during the lead time the distribution may be assumed as normal distribution or Poisson distribution based on the previous record. As per the data collected during the questionnaire session with the production manager the last order in the previous year the demand is normal in random manner. Therefore, we assume the normal probability distribution for the demand.

To find out the safety stock level, we draw the usual demand pattern of last twelve month demand and calculate the mean and standard deviation of the demand during the lead time which is calculated as 25.475 & 15.94 respectively.

Note: values of mean and standard deviation are calculated in earlier part of this chapter.

If R is the rate a consumption demand),L is the lead time, then  
Consumption rate during the lead time = RL  
If s is the safety stock , and Q is the re-order quantity, then  
Maximum stock level, Q+s  
Minimum stock level, S=s  
Production Point = Safety stock + consumption during lead time  
= safety stock + mean lead time consumption

Now consider normal distribution of lead time consumption  
As shown in figure the area under the normal curve give probability of demand of order point or less during the lead time. If the production point of the customer is the stock level available at the point of order comes , then this area will indicate fraction of order periods without stock out. Thus, area under the normal curve for x=Production point give the service level.
Normal variate,\[ z = \frac{x - \mu}{\sigma} \]
From normal distribution table, for area under normal curve we can find the value of \( z \)
that correspond to the area equal to the service level expressed in decimal fraction, Then,
\[ \text{Safety stock} = z \times \sigma \]

**Calculation of safety stock:**
In this first we have to find the probability of stock out when the company is maintaining the minimum stock of 18 units i.e 1800 pipes (one specific item). mean demand is 25.475 and std. deviation is 15.94, the probability that the demand comes more than 18 unit is calculated as

\[ X=18 \text{ in terms of } z \]
\[ Z = \frac{(18-25.475)/15.94}{-0.46895} \]
\[ = \text{Area right to } z=-0.47 \]
\[ = \text{(area between } z=0 \text{ to } z=0.47) + 0.5000 \]
\[ = 0.1808+0.5000 \]
\[ = 0.6808 \]
i.e 68.08% of probability of stock out when the company is maintaining a safety stock of 18 units. Then what should be the safety stock?

For the usual demand pattern drawn from the observation and production manager the mean and standard deviation was found to be 25.475 and 15.94 respectively. The policy of the management is to have 95% of the service level.

For approximately 95% of the service level (approximately 0.9495 and 0.9405) The values of area for \( z \) = 1.64 and \( z \) = 1.65 which can be calculated as:
Approximate values from table are
\[ A = 0.9405 \text{ and } A = 0.9505 \]
which are taken from \( z \) = 1.64 and \( z \) = 1.65.

By interpolation actual value of \( z \) will be
\[ Z = 1.64 + \frac{0.9505-0.9405}{1.65-1.64} \times (1.65-1.64) \]
\[ = 1.68475 \]
\[ \mu = 25.475 \text{ and } \sigma = 15.94 \]

Therefore, \[ \text{Safety stock} = z \times \sigma \]
\[ = 1.68475 \times 15.94 \]
\[ = 26.28 \text{ approximately (26.3 units) } \]

Thus the company should maintain a safety stock of 26.28 units for 95% of the service level.

**Validation after implementation process**
After successful implementation of any technique it is necessary to find out the result of implementation. As the purpose behind implementation of Kaizen and 5S technique is to reduce the lead time similarly estimate the lead time and stockout situation before and after implementation.

In earlier part of work the first and foremost objective i.e estimation of probability of stock out before implementation was completed which shows the probability of 50% stock out. To reduce this probability we have practice the Kaizen and 5S technique in the case company. In this part of work our objective is to again formulate a simulation model after the determination of safety stock which is calculated to be 26.3 units (probably) for 95% of the service level as discussed by the management personal.

We have developed a simulation model for estimation of stock out for same demand pattern in future with lead time 25.475 and standard deviation of 15.94 but the difference is earlier the company is maintaining a safety stock of 18 unit without any scientific method for inventory control which is now change to 26.3 unit(by calculation).

**Time difference calculation (Before and after implementation)**

1. **Raw material preparation time**
   - Before implementation = 0.54 hour
   - After implementation = 0.495 hour
   - Difference = (0.54 - 0.495) = 0.045 hour
   - Approximately time reduction of 3 min

2. **Actual machining time or processing time**
   - Before implementation (95% of efficiency of machine) = 2.70 hour
   - After implementation (99% of efficiency of machine) = 2.38 hour
   - Difference = (2.70 - 2.38) = 0.32 hour
   - i.e before implementation 37 pipes will be manufactured in one hour and after implementation the figure will be improved to 42 pipes in one hour.

3. **Socket making time**
   - Before implementation = 75 min i.e 1.25 hour
   - After implementation = 69 min i.e 1.15 hour
   - Difference = (1.25 - 1.15) = 0.1 hour
   - Therefore total production time after implementation total production time = (machine warm up time + raw material preparation time + actual machine time + socket making time)
   \[ = (3.29 + 0.495 + 2.38 + 1.15) \]
   \[ = 7.315 \]

4. **Dispatch time (searching time for finished goods)**
   - Before implementation = 25 minutes i.e 0.417 hour (for dispatching a particular time from store to vehicle)
After implementation = 17 minutes i.e 0.28 hour (as the stock is maintained according to specification)

Difference = (0.417-0.28)=0.137 hour

Now,

Lead time after implementation will be

**Lead time = (total production time + dispatch time + transportation time)**

= 7.315+0.28+0.28 hour + (1 to 3.0 days)

= 0.3047+0.01167+ (1 to 3.0)

Lead time now will be

= 0.3047+0.01167+ (1 to 3.0 days)

VII. Result & discussion:

After discussing with the production manager and the middle level management team during questionnaire thewhole layout including the working conditions and other factors was analyzed and after going through the entire problem faced by the company Kaizen and 5S technique is being successfully implemented in the case company.

Similarly the successive difference occurs before and after implementation is shown in tablebelow :

Before implementation:

Machine is producing 37 pipes in 60 min

Machine time for 1 piece will be = 1.62 minutes

Actual machine time (before implementation) = available time per shift of 8 hour /time per pipe.

= 8*60 / 1.62

= 296.29 pipes (actual output)
Future Scope
In future we suppose to develop the real time simulation model for the analysis & estimation of stock out situation for improvement of productivity in computerized manufacturing era.

Acknowledgement
As a author, we wish to thank to all the concern authority who give guidance for conducting the case study. Similarly we also wish to thank to the Industry’s production manager & all the employee for being successfully participating in the activity. We also wish to thank to top management concern of the organization for making availability of supporting data required for conducting the implementation process. At last we wish to thank to all the reference journal author for publishing a valuable & supporting literature concerned with Kaizen & its implementation.

Reference
16. Mihail Aurel Titu; Constantin Opriican and Daniel Grecu IMECS-2010